NORTH CENTRAL FINE HARDWOOD TREE IMPROVEMENT COOPERATIVE PAST ACCOMPLISHMENTS AND FUTURE GOALS

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Abstract -- The North Central Fine Hardwoods Tree Improvement Cooperatives organization, goals, and objectives are discussed in relation to the initial accomplishments and future plans. The cooperative's ten year plan is presented. Additionally, the long term breeding strategies adopted for the genetic improvement of black walnut and red oak are discussed.

Key Words: black walnut, Juglans nigra, red oak, Quercus rubra, breeding strategies.

INTRODUCTION

The North Central Fine Hardwoods Tree Improvement Cooperative is an organization concerned with the long term genetic improvement of fine hardwoods in the north-central United States. Specifically, black walnut and red oak. It was formed in order to facilitate increased efficiency of the individual state tree improvement programs involved through interstate coordination and cooperation in the selection, evaluation, breeding, and production of genetically superior fine hardwoods. Member states include; Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.

How did the cooperative become a reality? Well a series of events occurred during the early to mid 1980's that led to the development of the North Central Fine hardwoods Tree Improvement Cooperative. Initially, many state forestry departments in the Lake States and Central States areas recognized the importance of tree improvement to the long term benefit of the forest resource and subsequently, developed long-term tree improvement plans for their respective states. In the tree improvement plans developed, black walnut was mentioned as important by all the states and to a lessor degree red oak.

At this time, only the states of Indiana and Missouri had full time tree improvement specialists in their conservation departments. To facilitate the implementation of these plans tree improvement specialists were hired or appointed throughout the region - Illinois, Iowa, Michigan, Minnesota, Ohio, and Wisconsin. The fact that many states were beginning to work on

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seedlings, but adults can also cause damage to foliage of more mature plants (U.S. Dept. of Agric., 1985). Damage is usually more severe in areas that contain grass, which may provide the white grub larvae with a more suitable food supply than the roots of a potential Forest Monarch.

White grubs have a one-, two-, three- or four-year life cycle, depending on the climate of the area in which they are found. Larval feeding may thus continue for up to three years. The life cycle is completed faster the farther south the beetles are found.

Eggs are laid in soil at depths of 8 to 18 cm during the period of adult emergence, usually in May or June. The larvae feed initially on plant detritus, then on the succulent roots of living plants in the vicinity. Control measures, where required, are usually accomplished with an insecticide, such as diazinon, applied to the soil.

Root collar weevils

Members of the genus *Hylobius* are weevils with larvae that feed primarily on the roots of trees, especially conifers. There are several species of *Hylobius* that attack trees in the Northeast, most notably the pales weevil, *H. pales*, and the pine root collar weevil, *H. radicis*. Although these weevils usually attack trees somewhat larger than those found in nurseries, occasional damage may be done to larger trees in nursery settings (U.S. Dept. Agric., 1985; Wilson & Schmiege, 1970).

Adult weevils feed on small branches, but lay their eggs in the bark of roots or in soil near the roots. Larvae feed on the bark of roots, and can easily girdle the root collar of small trees. Control efforts are usually not required in nursery situations.

Cutworms

Cutworms are the larvae of several species of moth, which feed on foliage and stems of young plants. Cutworms are not really root-feeding insects, but the damage they cause may result in symptoms that look superficially like damping-off. Most cutworms eat the cotyledons and new foliage of young seedlings, but some will attack the emerging hypocotyl at the ground line, causing the seedlings to topple over just as they do when damped-off (Palmer and Nicholls, 1981; U.S. Dept of Agric., 1985). Cutworms usually feed at dusk or after dark, and hide at ground level during the day. If cutworms are suspected, they should be sought at the times they are feeding, with a flashlight, if necessary.

Cutworms can be controlled with an insecticide such as diazinon or chlorpyrifos. Because eggs are laid on weeds and grass, some control can be achieved by practicing clean cultivation in the nursery beds.

Disease problems in nurseries

Damping-off

Damping-off is responsible for the loss of more seedlings in the nursery than any other cause. The term "damping-off' actually encompasses several different disease syndromes that affect the seedling during the first growing season. The diseases that are collectively called damping-off include:

1) seed decay (germination failure)
2) pre-emergence damping off (pre-emergence hypocotyl or root rot)
3) post-emergence or "classical" damping-off
4) late damping-off (early root rot, after suberization has commenced)
5) top damping (destruction of the cotyledons by seed-coat-borne fungi)

(adapted from Hartley, 1921).

Of these five types, to be strictly true to the topic of this presentation, only types 3 and 4 can truly be said to affect the roots of seedlings.

A number of fungi have been implicated in the damping-off process in tree seedlings, most notably:

Pythium ultimum, *P. debaryanum* and others
Phytophthora spp.
Fusarium spp.
Rhizoctonia spp.

These are the organisms most often named, but there are many others for which pathogenicity has been demonstrated, including, but not limited to:

Alternaria
Botrytis
Cylindrocarpon
Cylindrocladium
Macrophomina (Sclerotium)
Moniliopsis
Phoma
Verticillium

black walnut tree improvement in ernest in the mid 1980's and others (Indiana and Missouri) had been working in applied programs for almost twenty years presented a technology gap between the two groups. Cooperation and technology transfer between the haves and have nots was important at this time. The contacts established between the state tree improvement specialists was essential to developing the cooperative spirit that eventually would spawn into an establishment of the formal cooperative.

The other important event that led to the development of the North Central Fine hardwoods Tree Improvement Cooperative occurred in 1985 when the U. S. Department of Agriculture, Forest Service, State and Private Forestry developed a new procedure for the distribution of federal funds to the states. This new procedure was known as Federal Focus Funding and was designed to distribute federal funds to specific programs with defined goals and objectives. One of the priorities of the federal focus funds was to encourage interstate cooperative projects. It was through this program that initial seed money was obtained to begin the cooperative.

Since the state tree improvement specialists were already cooperating to a degree on black walnut tree improvement, it was a logical step for the group to apply for federal focus funding to establish a formal cooperative. Beginning in 1986 the seven states of Illinois, Indiana, Iowa, Minnesota, Missouri, Ohio, and Wisconsin received for three years federal focus funding to establish the cooperative. The state of Michigan joined the cooperative the following year. The focus funding expired in the fall of 1988, yet the cooperative is now firmly established and continues to operate.

COOPERATIVE ORGANIZATION

The cooperative has established a technical advisory committee consisting of the tree improvement specialist in each member state and a representative of the USDA, Forest Service, State and Private Forestry. There are two elected positions in the cooperative: a chairman and secretary. The terms are for one year with the secretary becoming chairman in the second year. The state of Indiana has been designated as the central depository for the cooperative. Records of all "plus-tree" selections and plant material exchanges are kept there.

Membership in the cooperative is limited only by prospective members willingness to commit the time and resources necessary to select plus trees according to cooperative standards, graft the selections into clone banks, and make the germplasm available to other members.

To guide the cooperative in the future years the most important task that has been accomplished was the writing of a ten year plan to outline specific goals and objectives, and

develop a standard for selection, evaluation, and long term breeding efforts. The following is a summary of the ten year plan.

GOALS AND OBJECTIVES

The cooperative established three goals and a set of objectives to accomplish each of these goals to guide its long term planning and program development. These goals and objectives are as follows;

GOAL 1: To increase productivity of fine hardwoods through the use of genetic principles and practices to ensure the best adapted planting stock for the North Central Region.

Objective: Develop breeding strategies for each priority species that include delineation of breeding zones and standardized selection procedures.

Objective: Develop a multi-disciplinary approach to the genetic improvement and culture of fine hardwoods by utilizing experts in nursery management, pest management, and silviculture from state, university, federal, and private concerns in the improvement process.

GOAL 2: To conserve the genetic resource of fine hardwoods by establishing and maintaining a breeding population with a broad genetic base.

Objective: Make superior tree selections from throughout the range of the priority species.

Objective: Maintain clone banks of all selections replicated at a minimum of two locations.

GOAL 3: To identify and promote research on problems associated with the genetic improvement and culture of fine hardwoods.

Objective: Support and actively participate in ongoing research.

Objective: Utilize research results in operational programs to promote the advancement of new techniques.

Objective: Communicate problems encountered and anticipated to research organizations.

COOPERATIVE PROGRESS

The initial point in the applied program establishment in the cooperative was to establish species priorities. Black walnut is the highest priority species in the cooperative

because of its value and has received the most work to date in the cooperative. Red oak is the next highest in priority. The level of intensity in the different states programs in regards to black walnut and red oak improvement varies with the relative priority of each specie in relation to other species in each states individual tree improvement program, and the size and scope of each states genetics program.

The next process involved the establishment of breeding zones. Breeding zones are similar to seed zones, they limit the movement of planting stock from zone to another. However, they also delimit the range of environments in which the breeding population will be selected for superior growth and adaptation. Black walnut in the north-central region was delineated into three breeding zones (Figure 1). Zone 1 includes Minnesota, Wisconsin, northern Iowa and northern Illinois. Missouri, Southern Iowa and Western Illinois are zone 2. Indiana, Ohio, Michigan, and eastern Illinois comprise zone 3. It has been decided by the cooperative to follow breeding zones for red oak that are currently being established by the NC-99 Regional Cooperative Project.

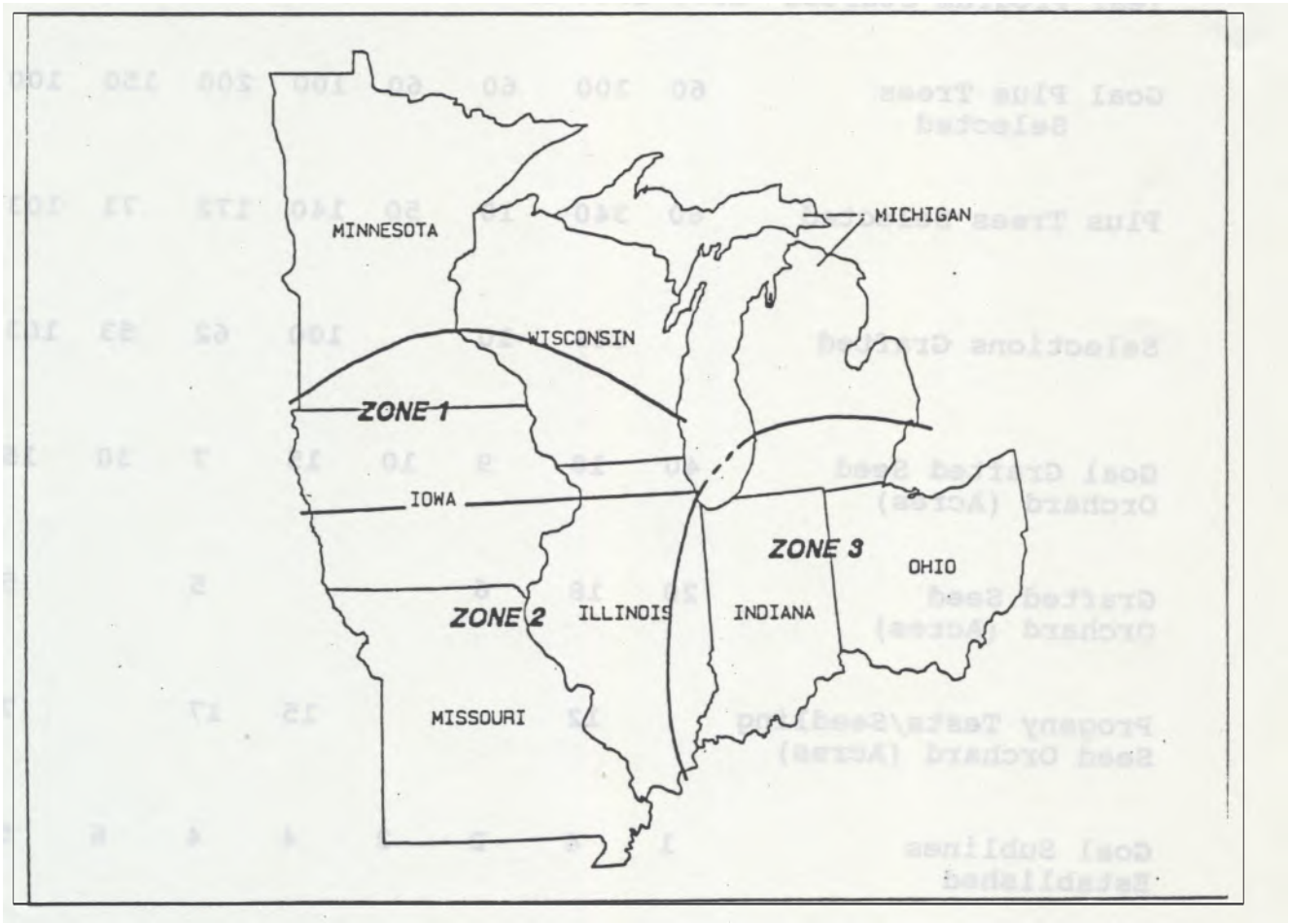

Figure 1. Black walnut breeding zones.

Within each of these breeding zones a minimum of 300 "plus tree" selections are to be made for future evaluation and testing. Selections are made from both natural stands and plantations. Trees from natural stands are selected based on a set of minimum criteria and plantation trees are selected based on a four tree comparison method. Traits considered include stem form, apical dominance, growth characteristics, and site. To date a total of 946 "plus trees" of black walnut have been selected by the cooperative members and 617 grafted already (Table 1).

Table 1. Goals and accomplishments of North Central Fine Hardwoods Tree Improvement Cooperative's black walnut program through spring 1989.

	STATES							
	IL	IN	IA	MI	MN	MO	OH	WI
Year Program Started	1970	1964	1973	1987	1981	1967	1984	1976
Goal Plus Trees Selected	60	300	60	60	100	200	150	100
Plus Trees Selected	60	340	10	50	140	172	71	103
Selections Grafted		289	10		100	62	53	103
Goal Grafted Seed Orchard (Acres)	40	18	9	10	15	7	30	15
Grafted Seed Orchard (Acres)	20	18	6			5		5
Progeny Tests/Seedling Seed Orchard (Acres)		12			15	17		7
Goal Sublines Established	1	4	2	2	4	4	6	5
Sublines Established	1	1			2	2	3	

After grafting the clones are outplanted into sublines. Sublining is the long term breeding strategy being followed by the cooperative and is described in detail in McKeand and Beineke (1980). Sublining permits inbreeding within breeding populations (sublines), but insures that the seed produced in the production seed orchard is outcrossed, even over many generations (Figure 2).

The following is a brief description of how this breeding strategy functions in a single generation. Mating occurs among the 25-30 clones comprising the individual sublines. Open pollinated progeny produced from each subline are then tested in common locations within a breeding zone and the best individual performers in the progeny test are selected as parents for inclusion in the next generation of sublines. The integrity of the sublines is kept in tact over time by keeping the same families in their respective sublines. Only one or two clones per subline are selected, based on their progenies performance in the common test, to be grafted into the production seed orchard. Thereby, the seed produced in the orchard is outcrossed. *New* "plus-trees" can be added into the program at any time by just establishing another subline.

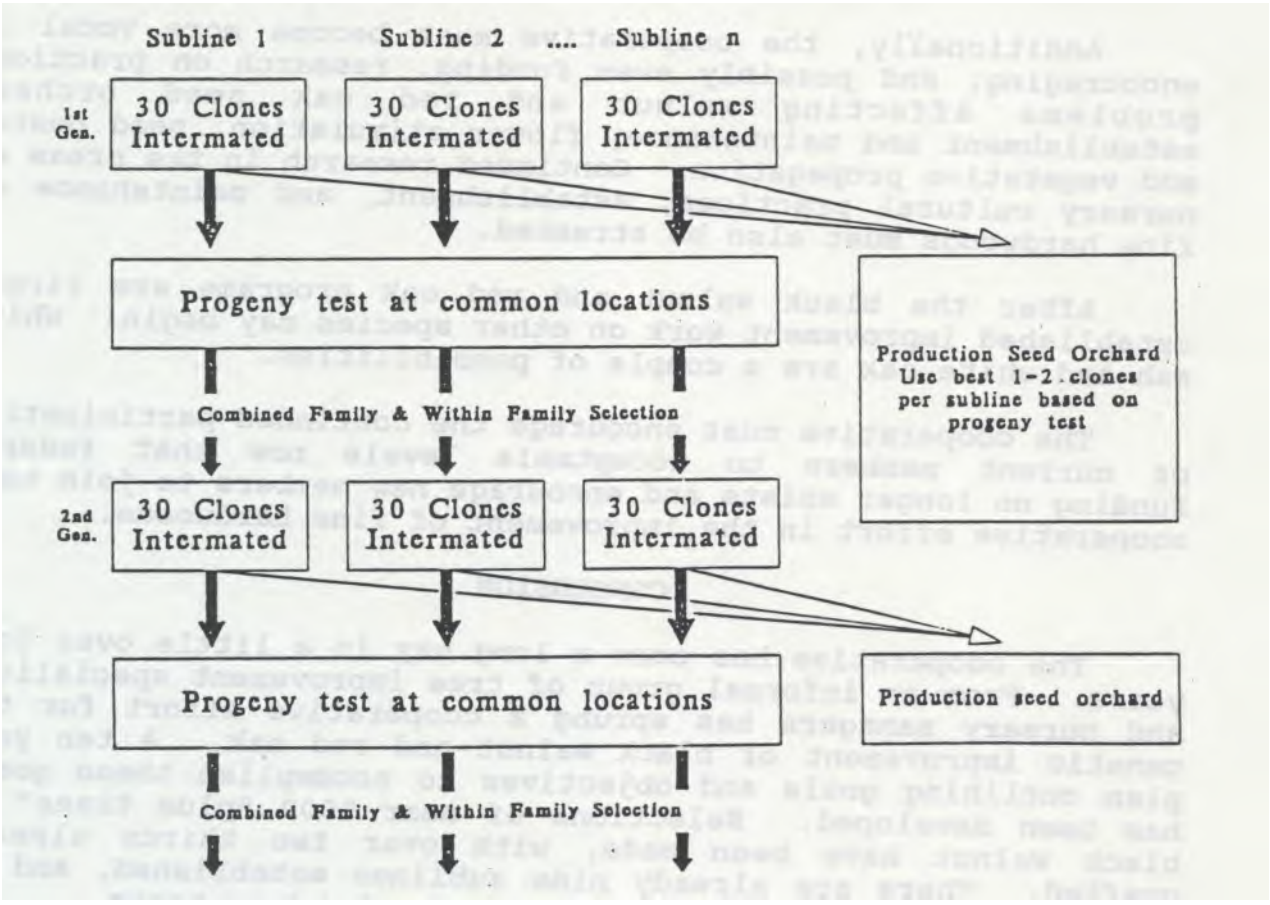

Figure 2. Sublining breeding strategy (McKeand and Beineke 1980)

The cooperative has also determined a standard design for its progeny test, the California Design (Libby and Cockerham 1980). This design features non-contiguous plots with interlocking replications. The advantages of such a design are that single tree plots give maximum efficiency with respect to information gained per tree, to cost, and to ability to distinguish genetic differences. It also permits systematic thinning of the test without loss of statistical design and maintains equal spacing between trees left after thinning.

LOOKING TO THE FUTURE

Recognizing that the individual states programs are at different starting points and have different levels of commitment, the most important short term priority of the cooperative members is to finish the initial selections for each breeding zone and to establish the initial sublines in order to carry out a long term improvement effort. Some states (Indiana) have already begun the progeny test phase with the materials they already have, but for most states this step is in the future after the sublines begin to flower and produce sufficient seed (possibly 10 years away).

Additionally, the cooperative must become more vocal in encouraging, and possibly even funding, research on practical problems affecting walnut and red oak seed orchard establishment and maintenance, flower stimulation, seed pests, and vegetative propagation. Continued research in the areas of nursery cultural practices, establishment, and maintenance of fine hardwoods must also be stressed.

After the black walnut and red oak programs are firmly established improvement work on other species may begin. White ash and white oak are a couple of possibilities.

The cooperative must encourage the continued participation of current members to acceptable levels now that federal funding no longer exists and encourage new members to join this cooperative effort in the improvement of fine hardwoods.

CONCLUSION

The cooperative has come a long way in a little over four years. From an informal group of tree improvement specialists and nursery managers has sprung a cooperative effort for the genetic improvement of black walnut and red oak. A ten year plan outlining goals and objectives to accomplish these goals has been developed. Selections of near 1000 "plus trees" of black walnut have been made, with over two thirds already grafted. There are already nine sublines established, and 55 acres of grafted black walnut seed orchards/clone banks.

With continued cooperative efforts from the state programs this action oriented tree improvement cooperative can produce

additional tangible results, **i.e.** genetically improved seed for your nursery programs in the future.

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