

CURRENT RESEARCH IN SPAIN ON WALNUT FOR WOOD PRODUCTION

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ABSTRACT—The Department of Mediterranean Trees at the Institut de Recerca i Tecnologia Agroalimentàries (IRTA) in Spain initiated a research program in 1993 to examine the variability among walnut species for wood production and to establish orchards with improved selections. The main objective of the programme is to obtain superior Persian walnut (*Juglans regia* L.) selections, half-sib progenies or clones, for wood production. Another important goal is to use controlled crosses among different walnut species to produce new hybrids, especially Persian x black (*J. nigra* L.) for wood production adapted to Spain's Mediterranean climate.

Fossil evidence indicates that Persian walnut (*J. regia*) was present in Europe as long ago as the end of the Pliocene and later widely spread by the Greeks and Romans through the Mediterranean basin, including the Iberian Peninsula (Manchester 1989, Rivera and others 1997, Leslie and McGranahan 1998). Wild walnut trees in large numbers grew throughout Spain for centuries. During the 1940s and 1950s, the dire social situation in Spain after the civil war led to the removal and sale of many outstanding trees. There was little regeneration, and as a consequence the number of wild walnut trees in the countryside decreased drastically (Ministerio de Agricultura Pesca y Alimentación 2001).

In Western Europe, the demand for quality timber is leading to farmers to plant deciduous hardwoods, particularly *Juglans* spp. This trend started few years ago in France, Italy, and some countries of central Europe. However, in Spain the interest in timber production is recent; new plantations in fields previously designated for horticulture appeared only 10 years ago. In the 1990s, the EU started programs for reforestation and plantations for timber production. Several large enterprises decided to invest in the production of quality wood using intensive management practices, and many farmers started to show an interest in shifting from horticultural orchards to woodlands.

Farmers and companies wondered what they should plant. No Persian walnut timber selections were available. Biotypes or land-races such as 'Lozeronne' or 'Charente' in France or 'Bleggiana', 'Feltrina' or 'Sorrento' in Italy were all that

was available. On the other hand, the French hybrid progenies, 'Mj209xRa' and 'Ng23xRa' (*J. x intermedia*) were outstanding for their vigor and growth habit (Aletà and others 2003, Fady and others 2003). In Spain, farmers decided to plant these hybrids since the climate in Spain is suitable for timber production in intensively managed orchards. At the end of 2003, nearly 5,000 acres of *Juglans*, mainly hybrids, were growing in Spain under intensive management.

Starting in 1993, the Institut de Recerca i Tecnologia Agroalimentàries (IRTA) initiated a research programs concentration on the selection of walnut for wood production and development of improved practices for woodland management. The main aims of the IRTA programme are:

- Evaluate variability within remaining Persian walnut populations.
- Selection of Persian walnut progenies for wood production.
- Selection of genitors for breeding new hybrid progenies.
- Clonal selection.
- Evaluation of training systems for wood production.
- Development of irrigation schedules to optimize supply of water.
- Design mixed planting systems for timber production.

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VARIABILITY WITHIN SPAIN'S WALNUT POPULATIONS

Morphological and isoenzymatic variability are being studied in different populations of wild Persian walnut. Fifty individuals from nine populations have been analyzed using six enzymatic systems. Morphological characteristics of trees in field/germplasm collections are also being evaluated on representative clones that originated in different parts of Spain.

In 2003, we collected seed from Persian walnut from throughout Spain. In 2004, seed from more than 50 wild populations will be sowed in three progeny tests planted in different environments near Galicia (northwest of Spain), Zaragoza (north central of Spain), Granada (southeast of Spain) and Catalonia (northeast of Spain). Progeny testing will allow for the preservation of germplasm and the study of the variability present in existing Persian walnut populations, especially variability in traits important for timber production.

We already have several publications on the variability within wild clones/populations of Persian walnut (Aletà and Ninot 1995, Malvolti and others 1998, Ninot and Aletà 2003). Our recent work shows large genetic differences exist between the northern populations and southern populations in Spain.

SELECTING FOR WOOD PRODUCTION

Many surveys in different areas of Spain have been made since 1982 looking for wild Persian walnut trees with exceptional traits for wood production (Germain and others 1997). Selected trees have been grafted and established in field collection to produce seeds. Seed is collected and planted in the nursery for 2 consecutive years. Progenies with seedling collar diameters less than 12 mm and survival less than 60% are rejected. Progeny tests of the juvenile growth of more than 40 half-sib families in the nursery have resulted in the identification of 28 families for further field-testing. Sixteen of these families are already under evaluation for further selection (Aletà and others 2004).

Seedlings of the best progenies are being planted in field progeny tests with different ecologies. In addition to evaluating wood production, progenies are tested for resistance to the soil diseases including Armillaria root and crown rot (*A. mellea*) and *Phytophthora*.

From superior half-sib progenies that have been identified using data from nursery and field trials, genitor clones are grafted. Grafts are established

in field to be used as seed producing trees. In parallel studies, seed clonal orchards have been prepared using some pre-selected individuals to obtain controlled seeds of Persian walnut for timber production. Currently this material comes from five pre-selected IRTA-clones: 'MBT-122', 'MBT-218', 'MBT-231', 'MBSB-13' and 'MBPo-6'.

BREEDING NEW HYBRID PROGENIES

To increase the variability in our breeding germplasm, based mainly on Persian walnut, we have introduced black walnut (*J. nigra* L.), Argentine walnut (*J. australis* Grisebach), California black walnut (*J. hindsii* Jeps.), and Arizona walnut (*J. major* Torr.) Heller materials in field collections. A genitor is evaluated both by the percentage of successful crosses and the growth characteristics of its progenies. For several years we have been doing controlled crosses between Persian walnut clones and some black walnut trees. The aim is to produce Persian x black walnut hybrids suitable for woodland plantations. In 2004, we will be evaluating 15 full-sib progenies from controlled crosses. The programme of controlled crosses is going to continue for 3 more years to increase the number of individuals per progeny.

CLONAL SELECTION

The decision as to which individual to clone is based on the characteristics of both the mother plant and the environment where the tree grows. Trees must show a suitable growth habit and high vigour plus some resistance to soil diseases or to drought to be cloned. We are testing some selected clones, together with pre-selected progenies, for Armillaria root and crown rot soil disease. Outstanding trees are micropropagated and studied in field trials together with commercial progenies, 'Lozeronne' provenance as *J. regia* reference or 'Mj209xRa' and 'Ng23xRa' as references for hybrid materials. In field trials clones will be evaluated for at least 10 years. At present an IRTA clone, IRTA X-80, is being made available commercially as micropropagated plants. IRTA X-80 is a hybrid walnut of unknown origin having excellent growth and stem form that is well adapted to areas with a long growing season.

TRAINING SYSTEMS FOR WOOD PRODUCTION

Persian walnut and *Juglans x intermedia* are not forest species and training in juvenile orchard

stage must be done to get timber quality. Two training systems are under evaluation involving these two species: 'dynamic pruning' and 'systematic pruning'. Trees grown under 'dynamic training' are pruned, either in summer or in winter or in both seasons, looking for a clear leader dominance, eliminating all branches which compete with the leader; lateral shoots measuring more than 1 inch in basal diameter are cut. In contrast, 'systematic training' involves removing all lateral shoots during the summer so that there are no branches on the log below 3 m height. Under this kind of pruning trees need a high tutor. All results are still preliminary but it has been observed that half-sib progeny of 'Ng23xRa', are well adapted to 'dynamic training'. This system allows reaching logs taller than using 'systematic pruning' in which secondary growth is faster too. However, 'dynamic training' could cause bigger wood internal defects.

IRRIGATION PROGRAM DEVELOPMENT

In the Mediterranean basin, walnut trees need to be irrigated to produce regular trunk growth. We have calculated water demand based on potential evapotranspiration corrected by Persian walnut crop coefficients (Kc) established for fruit production. To optimize water use in relation to tree growth, two schedules of water supply using drip irrigation, in Persian walnut and 'Ng23xRa', are being evaluated. The first irrigation programme irrigates during the vegetative period and for the second programme, the hydric support finishes when first growth stops. Diameter contractions during the vegetative period are measured continuously by dendrometers placed on the trunk. Until the fourth growing season, there are no differences in juvenile growth between the two irrigation calendars.

MIXED PLANTING SYSTEMS FOR TIMBER PRODUCTION

Starting in 2000, the effects of inter-row planting of shrubs to naturally train walnut for timber production are under evaluation. Progeny of the hybrid 'Ng23xRa' was established, at 6 m x 6 m spacing, with European hazel (*Corylus avellana* L.), at 2 m from the walnut trees, and autumn olive (*Eleagnus umbellata* Thunb.), at 1 m from the walnut trees. After three growing seasons, some natural stem training and reductions in branching with European hazel have been already observed.

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