The rate of growth syndrome

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Summary

Although the overriding importance of growth rate in a tree improvement program is recognized, too frequently a value judgrnent is made on growth rate alone without proper inclusion of other criteria. This is especially serious when height growth at young ages is used as the basis for estimating success. Although gains from quality improvements have not been thoroughly documented, it appears that their value often equals or may exceed those from growth improvement alone. Recent tests have indicated this to be true for both solid wood products and paper products. The value of a program can be seriously jeopardized by not taking into account the quality of the wood produced; an example is P. *caribaea* when grown in certain environments. The need for better adaptability is becoming critical as forestry is being "pushed" onto more marginal sites. Even though the trees may appear to grow reasonably well, off-site planting produces stresses that make the plants more susceptible to pests and environmental extremes. Determination of the utility of a species or source for regeneration must be based on growth plus tree quality, adaptability, resistance to pests, and suitability of the product.

Key words: **Growth rate, adaptability, tree form, quality products, wood properties.**

Zusammenfassung

Bei der Durchführung von Züchtungsprogrammen mit Waldbaumarten ist die Wachstumsleistung wohl als wichtigste Eigenschaft zu beurteilen. Der Züchtungserfolg hängt jedoch gleichzeitig von anderen Eigenschaften ab. So ist insbesondere bei der Prüfung von Nachkommenschaften aus Kreuzungen das Augenmerk u. U. in erster Linie auf solche Eigenschaften zu lenken, die die Anpassungsfähigkeit an bestimmte Standorte verbessern können sowie den Gesamtwert der späteren Ware Holz ausmachen.

General

We are aware, as much as anyone, of the importance of plant growth rate as a major objective in a tree improvement program. In mast well-designed applied breeding programs, progress is assessed by growth rate improvement, measured by volume, dry weight production or yield of final product. Improvements in traits other than growth are usually restricted to the fastest-growing plants in the population, and only in special situations related to pests ar adaptability does growth rate receive secondary emphasis.

With that recognition, why is this article written? The answer is that the importance of growth rate, especially height growth, is currently being so overemphasized, to the exclusion of other factors by some researchers, that serious errors in decision-making are resulting. Some widely acclaimed improvement programs ignore the importance of tree quality or even of better adaptability in favor of faster tree growth. On rare occasions, breeding for pest resistance may be suppressed in the thrust to obtain faster-growing trees.

What is quality? How important is it?

Tree Form

Fast growth is of limited value if the resulting trees are excessively crooked, multistemmed or heavy-limbed. Genetic gains in volume production from our first-generation pine seed orchards is 10 to 20 percent, and we are convinced that this gain is approximately matched by improvement in tree quality.

The importance of improved product quality obtained from straight, small-limbed trees is obvious for sawn timber and veneer, but the resultant monetary gain has not been thoroughly quantified or documented although studies are underway to obtain this information. Results from one study evaluating the effect of tree form on plywood yield and quality[1]) showed a 12.7 percent greater monetary return from improved yields from straight, small-lmibed trees as compared to those of average form. Additionally, ply quality from the well-formed trees was improved over that of the average trees. Although the yields from the better-formed trees may have been somewhat overestimated because of their larger diameter (15.8" vs. 15.1"), it is evident a considerable value improvement in plywood production is obtained from trees of better form.

The effect of tree form improvement on pulp and paper production has been well documented for P. *taeda*[2]). In the referenced study, pulpings were made from straight small-limbed, crooked large-limbed, straight large-limbed, and crooked small-limbed trees. Best pulp yields and paper burst and tear were obtaind from straight small-lirnbed trees; a complete analysis indicated that improvement in bole straightness was of greater value than having smaller limbs.

Perhaps the most outstanding example of tree growth being sometimes emphasized to the detriment of tree form is with P. caribaea var. hondurensis in the Tropics. When grown as an exotic, this species sometimes has very poor form with large, long limbs, foxtailing, basket tops and multiple forking. Many provenance tests have been made and too often the best source has been identified mainly on height growth. Use of a fast-growing but very poorly formed source in an operational program is a costly mistake indeed and has resulted in forests of inferior quality. Similar mistakes are all too common with other fast-growing species such as P. *radiata,* P. oocarpa and P. kesiya when grown as exotics in tropical and subtropical environments.

Wood Quality

The objective of a well-balanced production-oriented tree improvement program is to grow as much desirable wood as quickly as possible. Sometimes the "game plan" only

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[1]) ZOBEL, B. J., JETT, J. B., and MCVICKER, G. W., Jr., 1977. Effect of tree form on yield and quality of plywood. Unpub. Mimeo. Report 6 pp.

[2]) BLAIR, R., ZOBEL, B., FRANKLIN, E. C., DJERF, A., and MENDEL, M.. 1974. The effect of tree form and rust infection on wood and pulp properties of loblolly pine. Tappi 57 (7): 46–57.

calls for growing a maximum amount of wood as quickly as possible. Growing quantity without regard to quality of wood is based upon a philosophy that one need not worry about quality, because whatever is grown can be converted into a usable product. It is true that within limits, different quality woods can be manipulated to the desired product, but usually this can only be done at the sacrifice of increased energy usage, reduced yield, increased cost, or loss in quality of the final product.

There are numerous instances in operational forestry in which the wood produced by trees of fast growth and good form is undesirable or even unusable for manufacture of standard products. A prime example of inferior wood is that of *Pinus caribaea* grown in certain environments. In environments with a dry or cold period that induces a resting stage in the tree's development, this species produces a heavy wood with an abundance of thick-walled summerwood cells. However, when grown in certain "exotic" environments, very favorable to continuous growth, height extension may continue year round. Wood produced often contains little summerwood, annual rings that are practically indistinguishable, and specific gravity that may be less than half that of trees in the species' indigenous range, or in environments that induce a resting stage. In extreme instances, large quantities of wood from beautiful, fast-grown trees have been found to be essentially unusable because of substandard quality.

The wood produced by slash pine *(P. elliottii)* when grown in Zululand, South Africa, is extremely dense compared to that produced in its indigenous range of the southern United States. Numerous thick-walled summerwood cells are formed annually, resulting in a specific gravity so high that the wood is considered to be undesirable for a number of products. Conversely, in the higher elevation of the nearby Transvaal, slash pine produces wood considered normal for the species.

As illustrated by the examples of *P. caribaea* and *P. elliottii,* wood quality abnormalities are not unusual when a species is grown outside its natural range. It is absolutely *essential* in an exotic forestry program to assess wood properties of the trees grown on the new site before the species or strain is extensively planted operationally.

Silvicultural treatments that increase growth rate can adversely affect wood quality, especially when heavy nitrogen fertilizers are involved. It has been shown for *P. taeda* that the annual ring for a year or two following heavy nitrogen fertilization may contain very little summerwood and has an abundance of short, thin-walled cells.[3]) The fertilizer effect on wood often lasts only for a few years, and the overall change in the tree's specific gravity may hardly be detectable. But for solid wood products, a zone of weak wood with high longitudinal shrinkage similar to juvenile wood is formed which can produce serious defects in the finished product. When this happens, the considerable increase in growth achieved may be partially negated by reduced wood quality. Treasuring the growth stimulation from fertilization, while ignoring its possible effect on wood quality can lead to erroneous conclusions.

Adaptability

As pressures for agricultural land become greater, operational forestry is being increasingly forced onto marginal or submarginal lands. Foresters are usually greatly concerned with the adaptability of stock planted in marginally suitable environments, and mistakes are not too common. Yet we are seeing an increasing disregard for best adaptability, especially in areas where performance is measured in terms of volume production without serious regard to health of the trees. A comment often heard in such areas is "We know the trees are not healthy but they grow so much faster than 'species X' that we will continue to grow them until we are forced to change." This attitude assures one thing: Disaster will strike!!

Usually when trees are planted as exotics or a strain is planted on a marginal site, the trees will grow under stress. Stress must be kept to a minimum because trees under stress are susceptible to diseases, insects and other pests. Serious problems have resulted from "off-site" planting of certain fast-growing species such as *P. radiata, P. caribaea* and some of the eucalypts. Despite a highly acceptable rate of growth during the early years, a plantation under stress may develop dead leaders and branches, foxtailing, multiple tops, and grotesque limbs, an indication of impending danger. The stress can be caused by nutrient imbalances and deficiencies, moisture problems, latitudinal or elevational maladjustments or lack of adaptability to seasonal rhythms. It is mandatory to locate the best adapted individuals, races or species because stress and eventual catastrophe go hand in hand, no matter how rapidly the trees grow initially.

Any time a species or source is planted off-site, certain individuals within the population will be poorly adapted. As they develop, they will either show signs of poor health or will succumb. This concept was emphasized by Campbell[4]) for Douglas fir. He states, in part, "... we might expect that a planting of an adapted seed source will include only a few nonadapted seedlings. Thus, the suitability of a seed source to a site is indicated by the proportion of nonadapted trees it contains."

If the stressed source is vastly superior in growth to anything else that is under trial, a simple and often highly successful expedient is to select the best individuals from the stressed populations and use them as parents for future planting. Unless the source is totally unsuitable, the progeny of the best of the planted exotic usually will grow better and be better adapted than trees from untested seed. The local "adapted" selected source or land race is usually the one that should be used for commercial planting while other species and sources are being tested in the meantime. Although too infrequently done, indigenous tree species should be considered for planting if any are suitable and available.

We urge forest tree breeders around the world to take care not to recommend a genetic line, a source or a species for use when that recommendation is based solely on tree growth alone, especially at young ages. In addition to growth, criteria for evaluating species or source utility are site adaptability, tree form, resistance to pests, and quality of wood. Some traits, especially growth, can only be fully evaluated from trees approaching half to full rotation age.

[3]) Posey, C. E., 1965. The effects of fertilization on wood properties of loblolly pine (*P. taeda* L.). Tech. Rept. #22, School of Forest Resources, N. C. State Univ., Raleigh. 62 pp.

[4]) Campbell, R. C., 1975: Adaptational requirements of planting stock. Global Forestry and the Western Role. Permanent Assoc. Comm. Proc., Western Forestry and Conservation Association. pp. 103—107.