

Selection of High-Yielding Clones of Tea Plant

By SHUN AMMA

Makurazaki Branch, National Research Institute of Tea

Tea breeding in Japan has been carried out exclusively by means of clonal variety at present. Generally, seedlings for selection are grown from artificial crossing seeds or natural crossing ones. The time of bud opening, cold resistance, cup quality, yield and disease resistance of individual seedling and the breeding material are investigated in a period from the nursery period to several years after the planting to field, and then promising seedlings are selected.

Subsequently, the rooting capacity of the selected seedlings is examined, and the clone of which rooting can be easily and well grown goes through a clonal test to be examined with its quality, yield and other characteristics during five to six years after the planting in the field. In the course of this test, promising clones are sent to other test fields to be examined on its local adaptability.

Finally, the clone of which yield quality and other important traits are promising both in the clonal test in the breeding station and local adaptability test in the examination stations is registered at the Ministry of Agriculture and Forestry as a clonal variety. To select a clonal variety by this breeding system, 15 years are needed at least from hybridization to registration.

One way to make more effective in shortening the breeding period is to study the genetics of important characters to produce breeding materials of excellent genes, and another way is to establish an early selection method of important characters to cull inadequate seedlings as early as possible.

Many researchers have studied, since old

times, on the early selection of important characters of the tea plant. In 1968, a special five-year project on the "Study on Early Selection Method in the Breeding of Perennial Arbor Crop" was started, and consequently, the early selection method of tea plant was developed rapidly and the selection method on frost hardiness and on cup quality of black and green tea was settled and used in practical breeding.

But the early selection method on the yield which is one of the most important targets of breeding is not yet established because the study on the yield could not be performed easily since about ten years are needed after hybridization to obtain final yield of mature tea of a clone.

In addition, the correlation between the young and mature tea or between the seedling and clone could not be clarified easily because many factors made these correlations obscure; that is, the yield itself is easily variable according to the conditions of climate and cultivation, the light receiving form and distribution of new shoot are not the same between the young tea and mature one because of different frame formation, and the root form of the seedling is different from that of the clone.

Since there is no effective early selection method of yield, the time of bud opening, cold resistance and cup quality are investigated in the early stage in the seedling selection and clonal test and the yield selection is carried out at the final stage.

Green¹⁾ also reported that no effective selection method of high-yielding clone exists in

Kenya other than the clonal test in the field. If the final yield of the clone can be detected indirectly from other characters in the earlier stage, the efficiency of breeding may be elevated remarkably.

Then the author et al. carried out some investigations on the early selection method of yield of tea plant and the results are described hereunder.

To establish the early selection method of yield, the relation between the characters, which were found in the course of the individual selection of seedling in the early stage, rooting capacity selection and mature tea selection of the clone, and the yield of mature tea of the clone must be clarified.

But no adequate datum is found at present; therefore, the author carried out the early selection referring to the combined results of many different experiments.

The problems were divided into four items for convenience as follows:

1. Correlation between the characters of young tea seedling at individual selection and the yield of the seedling at maturity.
2. Correlation between the yield of mature tea at individual selection and the yield of the clone at maturity.
3. Correlation between the characters of young tea of the clone and the yield at maturity.
4. Correlation between the yields of the seedling and clone at maturity and other

characters.

Correlation between the characters of young tea seedling at individual selection and the yield of the seedling at maturity

The correlation between an annual yield of eight years after planting and the seed weight, germination time, plant height, thickness of stem, leaf number of stem, total number of leaves and leaf area of the seedling in the nursery period is very low²⁾ as shown in Table 1.

A multiple regression equation was made with these seven characters as independent variables and the yield as a dependent variable, but the multiple correlation coefficients were 0.12 to 0.64 which did not seem so effective to presume the yield at maturity.

Thus, it is very difficult to presume the yield of mature tea from the characters of seedlings in an early stage. Since these results, however, were obtained from the tea plant seeded in the seedling bed of the field and transplanted to the field, the relation between the characters and yield of tea plants germinated and grown uniformly in the laboratory must be examined again.

As Green has reported, since the correlation between the plant height, thickness and stump weight of young seedlings and the yield of

Table 1. Correlation coefficients between 7 characters of young tea seedlings in the nursery period and the yield at maturity of the same seedlings

Cross		n	Seed Weight	Germination time	Plant height	Thickness of stem	Leaf number of stem	Total number of leaves	Leaf area
Female	Male								
Whole (15 Crosses)		311	-0.05	-0.03	-0.01	0.06	-0.01	0.15*	-0.01
Ai 21	<i>Yamatomidori</i>	35	0.14	0.09	-0.02	-0.02	0.13	0.31	-0.15
Ai 2	C 17	30	-0.15	-0.03	-0.04	-0.04	-0.14	0.00	0.21
C ou	Ai 21	33	-0.15	0.21	0.09	0.04	0.08	0.12	0.09
Ai 21	<i>Yamatomidori</i>	32	-0.01	-0.02	0.12	0.15	0.08	0.29	0.01
C 17	"	33	-0.01	0.03	0.25	0.41*	0.17	-0.23	0.25
<i>Yamatomidori</i>	C ou	26	-0.06	0.00	-0.11	-0.06	0.23	0.12	0.17
C ou	C 17	49	-0.10	0.16	0.20	0.26	0.19	0.03	0.21

* Significant at 5% level

the mature tea grown from the seedling is very high, the relation between the characters of the immature period and the yield of mature tea should be investigated continuously with various materials in many cases.

Correlation between the yield of mature tea at individual selection and the yield of the clone at maturity

The correlation between the yield of tea plant at individual selection and that of the clone derived from the selection was calculated with the clones examined in the clonal test³⁾.

The correlation coefficient between the total yield of the third and fourth plucking of tea from the seedling of nine years after planting and the total yield during two years from the clone of four to five years after planting in the clonal test was 0.70**.

The materials used in this experiment were of the clonal test of a group of high-yielding clones of which yields are attainable above to a certain level, and the environmental conditions of each seedling at individual selection were not always the same. But the correlation between the yield of seedling and that of mature tea of clone was high.

From this result, it was found that the yield of the clone can almost be presumed from the yield of mature tea in the individual selection.

Correlation between the characters of young tea of a clone and the yield at maturity

1) Relation between the characters of rooted cutting in a cutting bed and the yield of mature tea of the clone

Harada et al.⁴⁾ obtained a correlation of 0.79** between the shoot length in a cutting bed and the yield of a clonal test, and recommended this method because the nursery selection does not require much field area and the test can be repeated easily.

Sakai et al.⁵⁾ reported that the selection in

a cutting bed may be available to presume the yield of a clone at maturity because the light receiving condition of the cutting bed is similar to that of a mature tea garden. From these points, the early selection of yield in a cutting bed seems effective.

2) Relation between the characters of young tea of a clone in the field and the yield of mature tea

Toyao⁶⁾ reported a high correlation of 0.91 between the leafiness of young tea and the yield in a clonal test. Yonemoto et al.⁷⁾ reported that the yield of mature tea is presumable by the weight of the first pruned branch. Thus, the yield of mature tea can be presumed in the early stage of the clonal test.

Correlation between the yields of the seedling and clone at maturity and other characters

Some indirect presumptions of the yield of mature tea have been tried on the basis of the characters of the immature period which are closely related to the characters of mature tea which show high correlation to the yield. It is reported that the weight of new shoot, number of new shoots, spread of plant and length of new shoot show high correlation to the yield of mature tea garden of a clone.

The author⁸⁾ also obtained similar results as shown in Table 2 and found that the length of new shoot is much related on the yield in a mature tea garden. Therefore, if some character of the immature period which is closely related to the length of new shoot of mature tea is found, the early selection of yield can be achieved easily.

On the other hand, in a mature tea garden of seedlings, it was found⁹⁾ that the less the weight of new shoot, the less the number of high-yielding plants. Therefore, if the culling of the seedling of which the new shoot will weigh less at maturity is possible in the immature period, the early selection of the yield is achievable.

Harada et al.⁴⁾ also reported that a high

Table 2. Phenotypic and genotypic correlation coefficients between the yield and the characters of new shoot

Characters	Phenotypic cor. coef.			Genotypic cor. coef.		
	1st plucking of tea	2nd plucking of tea	3rd plucking of tea	1st plucking of tea	2nd plucking of tea	3rd plucking of tea
Number of shoots	0.527*	0.551*	0.453*	0.610	0.747	0.652
Weight of 100 plucked shoots	0.473*	0.266	0.188	0.442	0.031	0.254
Length of shoot	0.640**	0.814**	0.698**	0.754	0.876	0.767
Number of leaves	0.371	0.594*	0.508*	0.440	0.851	0.522
Length of plucked shoot	0.306	0.477*	0.416*	0.581	0.428	0.021
Distance between leaves	0.251	0.666**	0.486*	0.028	0.649	0.496
Thickness of shoot	0.057	0.352	0.341	-0.000	0.248	0.037
Spread of plant	0.549*	0.782**	0.603*	0.750	0.838	0.688

**, * Significant at 1% and 5% level, respectively

correlation of the weight of new shoot exists between the seedling and the clone, and that the plant of which weight of the new shoot is little yields less and is not convenient for plucking. And they described, therefore, that the selection of yield is possible on the basis of the weight of new shoot of seedlings.

Wu, C. T.¹⁰⁾ also discovered some internal morphological characters of mature leaf which have significant relation to the yield of a clone.

Therefore, when the relation between young and mature tea on the characters which have high correlation to the yields of a clone and seedlings is clarified, the indirect early selection of yield may be possible. Further researches should be advanced on this point.

For the time being, the final presumption of the yield of a clone at maturity is possible at the close of individual selection, the period of cutting bed, or at the early stage of the clonal test.

But in the practical breeding, effective individual selection should be performed as early as possible; therefore, a correct and simple method, which is applicable at the seedling bed or at least in the early stage of planting in the field, is needed urgently.

References

- 1) Green, M. J.: An evaluation of some criteria used in selecting large-yielding tea clones. *J. Agric. Sci. Camb.*, 76, 143-153 (1971).
- 2) Amma, S.: Relationship between the characters of young tea seedlings in the nursery period and the yield at maturity of the same seedlings. *Study of tea*, No. 45, 6-10 (1973).
- 3) Matsushita, S. et al.: Testing for the important characters in the early stage of Assam hybrid tea plant (1). Correlation of the main characters between seedlings and those clones. *Kyushu agricultural research*, No. 31, 71-72 (1969).
- 4) Harada, S. et al.: Studies on the method of early selection in tea breeding. *Bulletin of the tea division Tōkai-kinki agricultural experiment station*, No. 8, 1-29 (1961).
- 5) Sakai, S. & Nakayama, A.: Varietal difference of tea production. Breeding of arbor crop: Development and utilization of early selection method. 229-251 (1973).
- 6) Toyao, T.: Correlation and genetical analyses of the several characteristics at the stage of individual selection in the tea plant. II. On the correlations among yield, number of leaves per plant and characters of leaf in the clonal varieties for green tea. *Study of tea*, No. 30, 1-4 (1965).
- 7) Yonemoto, T. et al.: The relation between the first training and the yield in tea plant. *Kyushu agricultural research*. No. 30, 97 (1968).
- 8) Amma, S.: Young plant testing for important characters in tea breeding (Part 1). Correlation and path coefficient analysis between the yield and the characters of shoot in clones for black tea. *Study of tea*, No. 40, 1-7 (1970).
- 9) Amma, S.: Correlation between the yield and the weight of 100 plucked shoots in

- mature tea plant. *Study of tea*. No. 45, 1-5 (1973).
- 10) Wu, C. T.: Relationship between the yield of green leaves and some of the anatomical

characters of the leaf and shoot of tea plant.
Journal of Agricultural Association of China, 70, 42-57 (1970).