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True Seed in the Production of Potatoes in Pakistan

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A REPORT ON THE POTENTIAL FOR THE USE OF TRUE SEED IN THE PRODUCTION OF POTATOES IN PAKISTAN

The traditional method of planting potato crops is to use whole or sectioned tubers. This is true in both developed and developing countries. The use of tubers as seed, compared with the normal practice of planting botanical seed, presents problems for potato production that generally are more serious in developing countries than in developed countries.

Tubers are bulky and perishable, requiring costly storage, handling, and transport. In tropical zones, with year-around high temperatures, storage is a major constraint, often requiring expensive refrigeration. In temperate zones seed potatoes are normally produced in reasonably close proximity to production areas, thus avoiding high transport costs. In the tropics, however, seed tubers are often imported or produced at great distances from production areas. Tubers also carry with them a number of diseases from one generation to the next, a particularly acute problem in the tropics.

The total cost of production for potatoes in developing countries tends to be high, relative to developed countries, and the cost of seed often reaches 75 percent of all production costs. To avoid these costs, farmers save tubers from a ware crop for seed in their next crop. This practice, common in Pakistan, leads to loss of vigor (phenotypic deterioration) and the transmission of diseases. Availability of good quality, low-

cost seed tubers is the major constraint to the expansion of potato production in the developing countries, including Pakistan.

Most food crops are planted with seed that has been produced by the pollination of flowers and the subsequent development of the seed in the flowers or the fruit of the plant. This botanical or "true" seed is free of most of the problems and expense of tuber seed. The true seed is light in weight, easier to store, much less expensive to handle and transport, and relatively free of disease.

However, true seed presents its own set of problems in potatoes. Most varieties are highly heterozygous and therefore show high variability from one generation to the next. New seed must be introduced every year. Although tuber seed can be physically selected for uniformity, true seed cannot. The production of true potato seed requires a fairly high level of technical skill and is labor-intensive, and it is extremely difficult to produce a potato crop in the field with true seed. True potato seed is not known to be used anywhere for the commercial production of ware potatoes. The only practical applications are in breeding programs, family gardens, and to a limited extent, seed multiplication programs. As one might expect, interest in true seed technology is very high among plant scientists who work with potatoes, especially in the developing countries where the problems and costs associated with tuber seed represent a major constraint to potato production.

For a long time, scientists in potato-producing countries have used true seed in research programs to breed new varieties under highly controlled conditions. The only country known to be using true seed technology in a national seed production program is China, where the technology has been expanding over the past decade for the production of certified tuber seed. In China, true seed of improved varieties is planted in the first generation of a seed-bulking program. It is started in carefully managed seedbeds or greenhouses. The seedlings are transplanted to well-prepared fields to be grown out for tuber seed, which is then multiplied in one or two successive generations to obtain enough tuber seed to be distributed to farmers for ware crop production.

True seed is not directly sown in the field because of the demanding requirements for soil condition, temperature, and moisture to achieve adequate germination and early plant vigor.

Potatoes have a high nutritional value compared with other staple commodities. They also have the potential for very high yields per unit of land and water and a high return on labor and capital. If the constraints of tuber seed could be reduced or eliminated by introducing true seed technology, potato production in developing countries such as Pakistan would become considerably more profitable for farmers and the total production of potatoes would increase, contributing significantly to national food production and nutrition.

TRUE POTATO SEED IN RESEARCH

True seed fills a very important function in research programs. Under controlled conditions in the laboratory greenhouse, cross-pollination of known parents can be performed by hand to produce the true seed of a hybrid progeny. A large number of crosses can be made and evaluated in this manner in a comparatively short period of time in a breeding program that attempts to develop varieties with optimal characteristics for a given situation. Genetic material from different sources can be combined. Yield, disease resistance, uniformity, and nutritional value can be improved more rapidly by this type of breeding program.

Under natural conditions, potato is an open-pollinated plant, that is, it self-pollinates or cross-pollinates by insect action with only the female parent known. Therefore, unless the variety being produced is grown in pure stand under completely isolated conditions, a mixing of genetic material will occur and the resultant true seed or tuber is no longer pure. Open pollination can be tolerated in the production of seed tubers because the tubers can be graded for type and uniformity, thereby maintaining relative genetic consistency for ware crop planting. True potato seed cannot be physically graded. Thus, the multiplication of true seed is only practical only in the first generation, as is done in China. The scale of true potato seed production is constrained by the capacity to do controlled crosses and grow plants.

PRODUCTION OF TRUE POTATO SEED

In the production of true potato seed, small tomato-like berries, containing the true seed, that develop on the pollinated plant are harvested at the proper time. The seed is extracted by a specific but relatively simple process and dried. The true seed's normal dormancy of up to six months can be broken artificially by soaking the seed in a giberellic acid solution. The seed can then be planted immediately. With this system, genetic research in potato can be greatly accelerated.

The laboratory technique for controlled cross-pollination is standard for plant breeders and can be introduced into any breeding program with trained plant breeders and adequate facilities. The National Agricultural Research Center in Pakistan could manage this type of program with technical assistance from a scientist experienced with true seed.

For research purposes, true seed is usually grown in greenhouses under carefully controlled environmental conditions in prepared seedbeds or pots. Producing plants for field testing or further seed tuber multiplication can be done in shaded outdoor nurseries. The seedlings are then transplanted to the field. Because high soil and air temperatures are the main limiting factors to good seedling emergence and growth in the tropics, the use of shades is required. Soil moisture is also important. Soils in seedbeds should be high in organic matter to improve moisture-holding capacity and to reduce soil surface crusting, a condition that inhibits seedling emergence. Careful attention to nutrients is essential for seedling development. A

great deal of care must be exercised in preparing the seedbed and in planting the seed at the proper depth with correct spacing. Weeding and thinning are also necessary to produce vigorous seedlings.

All of this hand work is one of the principal reasons there is little interest in the commercial production of true potato seed in developed countries; labor costs are too high to make it practical except for experimental work. In developing countries, the labor costs might not be a major contraint to producing seedlings from true seed, but technical capability and physical facilities could be. Pakistan, however, has good capability in some of its research organizations. The facility at Mingora, with its moderate climate and excellent staff, is well suited to nursery production of potato seedlings. There is long-term potential for introducing true seed into the potato research program and eventually into first generation multiplication of certified tuber seed.

ROLE OF TRUE POTATO SEED IN PAKISTAN

The potato-breeding program in the National Agricultural Research Center might well benefit from the introduction of true seed technology in the laboratory. The time saved in making controlled crosses and evaluating progeny is considerable. The greenhouse space required for growing seedlings is also less when true seed is used. Pakistan needs to do considerable research in varietal development and particularly in disease resistance. True seed technology would greatly enhance and accelerate that

work. The main advantage, however, would be the ability to tailor new varieties to growing conditions in the various regions and to acquire resistance to diseases prevalent in Pakistan. The Mingora Station and the high altitude growing areas of the North West Frontier Province are important factors in this regard because the high temperature growing conditions of the lower elevations cause a "masking" of the viral diseases. When seed is multiplied in the cooler climates, the viruses can be more readily identified and plants rogued out.

As varieties are developed, the first generation of seed multiplication could be done with true seed. This, of course, would require that the technology be acquired. To achieve sufficient competence in true seed technology, the research staff should begin multiplying true seed on an experimental basis as soon as possible and then train the technicians. The rigorous demands of producing potatoes from true seed require that the people actually doing the nursery work have a good deal of experience. By doing it a number of times experimentally, they can work out any problems that arise in the Pakistan environment.

If the National Agricultural Research Center can acquire the capability in true seed technology for both research and seed production, a certain amount of the imported seed tubers could probably be replaced.

CONCLUSIONS

The technology for the production of true seed in potatoes is well enough developed that it could be done in Pakistan. The National Agricultural Research Center has sufficient capability to introduce true potato seed technology. Its use in the potato seed program in Pakistan could be introduced in the future once the technology has been mastered in the research program. The application of true seed technology in seed production would be limited to first generation multiplication.

It would not be practical to attempt to introduce true seed technology to ware crop production in Pakistan because even if the seed could be produced in sufficient quantities, a high level of technical skill and management are required to be successful. In addition, the fields would have to be shaded until the seedlings were well developed, a factor that alone renders it infeasible.

The International Potato Center (CIP), P.O. Box 5969, Lima, Peru, should be contacted for technical assistance in the introduction true potato seed technology. CIP has a staff person working in India and may be available for an initial visit.

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