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Review Article.

A Review of Investigations on the Breeding of the Sweet Potato, *Ipomoea batatus* Lamk.* (Part II)

by

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RESULTS OF BREEDING EXPERIMENTS: U. S. A.

Louisiana Agricultural Experiment Station (Miller 1955; Miller *et al* 1958):

1. New seedlings with higher sugar and twice the starch content of any of the table varieties were developed.

2. Seedlings with almost three times the carotene content of the standard variety Unit I Porto Rico were developed.

3. In 1944, over 6000 seedlings were grown. The progenies were analysed not only for disease resistance but also for starch, sugar, carotene and proteins.

4. The work under the co-operative breeding project with the U. S. D. A. resulted in the release of varieties, Pelican Processor, Queen Mary and Ranger. Pelican Processor, an industrial type was resistant to stem rot. In addition, the variety was only slightly susceptible to white rust. Queen Mary and Ranger are table types.

5. It appeared from crosses between resistant and susceptible lines that resistant × resistant gave a higher percentage of resistant seedlings, resistant × susceptible gave occasional resistant seedlings while the F_2 and back cross behaviour of resistant × susceptible suggested that resistance is recessive and conditioned by more than one gene and was somewhat complicated. In breeding for wilt resistance, certain lines were particularly valuable since they combined considerable resistance, high yield and starch content.

6. Whitestar, a variety intended for livestock consumption was released.

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7. Cooking tests with 23 promising seedlings showed that 18 of them had a better flesh colour than Porto Rico, the standard variety. Two to four proved to be equal or better than Porto Rico in quality.

8. At the end of 1956, there were three lines which were resistant to soil rot, two resistant to black rot, one to Fusarium wilt and black rot and one in which no internal cork had been found.

9. In tests of the reaction of sweet potato seedlings to weevil attack it was noted that the potatoes of seedlings that showed the lowest infestation were high in moisture and carotene contents and low in starch and conversely those that showed the highest infestation were low in moisture and carotene contents but high in starch.

10. The most promising seedling in 1958 was 3-77 which out-yielded significantly all the other varieties and seedlings in the tests at Louisiana. It was one of the better bakers and canners with promising prospects.

11. A compatibility chart prepared showed that most of the seedlings and varieties were self-sterile. Only one seedling 3-80 was found to be highly self-fertile.

12. A viability test for pollen viz. the peroxidase test was developed.

North Carolina: A breeding programme was initiated in 1947 in the North Carolina Agricultural Experiment Station (Anon, 1948) to develop varieties resistant to wilt, black rot and internal cork. Preliminary studies showed that irregular chromosome behaviour giving rise to unbalanced and slowly germinating gametes was partly responsible for the sterility.

South Carolina: Selections combining high yielding quality, deep salmon flesh colour and resistance to internal cork were produced at the South Carolina Experiment Station (Anon, 1948).

Georgia: Over 3000 seeds from known crosses were produced in 1947 and some 2000 plants were grown from them in 1948 at the Georgia Coastal Experiment Station (Anon, 1948). Seedlings with exceptionally high carotene content and seedlings with high yield and stem rot resistance were obtained.

Mississippi: A canning variety named Australian Canner was introduced in co-operation with the U. S. D. A. at the Mississippi Agricultural Experiment Station (Anon, 1948).

Oklahoma : At the Oklahoma Agricultural Experiment Station, (Anon, 1950a) variety Allgold was developed from an open pollinated seedling of a parent which was the product of a cross between a selfed seedling of Creole and an open pollinated seedling of Triumph. In two years' test, it gave double the yield of Porto Rico and considerably higher contents of ascorbic acid and carotene. It showed resistance to stem rot in inoculation tests. Red Gold, another variety with moist golden flesh, attractive dark skin and a considerably higher vitamin content than Porto Rico was developed. This variety is tolerant of stem rot and wilt.

A study (Anon, 1950 b) of 40 seedlings and 4 varieties indicated that nematode resistance is a recessive character with a relatively simple mode of inheritance.

West Virginia Experiment Station : Of 14 new strains, 12 had a lower percentage of cracking than Porto Rico at the West Virginia Agricultural Experiment Station (Anon, 1950 c).

U. S. Bureau of Plant Industry Co-operative Projects : The U. S. Bureau of Plant Industry and the Maryland Agricultural Experiment Station evolved a strain called Sunnyside, a moist type with good canning quality and superior to Porto Rico in carotene content but has the disadvantage of a bland flavour, tan coloured skin and susceptibility to wilt. Four varieties were developed as sources for commercial starch (Anon, 1949).

Puerto Rico : Inter-varietal crosses were made between the Jersey and moist flesh types. Use of more vigorous plants and starting crosses at 7·00 A. M. are believed to be responsible for higher percentages of fruit and seeds obtained in 1949 than in the previous year. Numerous tests in emasculation and crossing technique indicated cross-fertility and a high degree of self-sterility and detrimental effects of bags for protection against insects and the inadvisability of removing petals during emasculation as such flowers had little attraction for bees (Anon, 1949, 1950 b).

Japan : Ten varieties were found resistant to the nematode *Heterodera marioni*. Resistance to nematode appeared to be due to a chemical substance produced by the plant and to be a dominant hereditory character (Hirama, 1941).

India : Two Chinese white skinned varieties of good eating quality F. A. 17 (V. 2) and Tie shin Tun (V. 12) proved greatly superior in yield to local Punjab varieties. Pusa Suffaid, a selection

from Chinese material and Pusa Sunehri (Puerto Blanco × Wannop) × Australian Canner outyielded over 100 other varieties in New Delhi (Singh, 1951). Unpublished data from Madras State show that besides V. 2 and V. 12 mentioned above, three other varieties, V. 6, V. 8 and B. 219 were isolated as being worthy of replacing the local variety.

U. S. S. R.: Certain varieties are reported (Anon, 1937) to have been produced by the Research Institute for Humid Tropics that are no sweeter than the common potato which they excel in fineness of flavour and nutritive properties.

DISCUSSION:

The sweet potato has been grown exclusively by vegetative means. This continuous asexual propagation appears to have greatly contributed towards the persistence of any type of sterility that might have existed in the original seedling or of any type of sterility which might have developed later. Asexual propagation is believed to allow the accumulation of recessive gene mutations which may be more often detrimental to sexual processes. If the original mutation had a tendency towards sexual incompatibility clonal multiplication seems to extend the incompatibility part to the individual and the entire variety.

The non-blooming habit is another obvious condition which enforces sterility of the species. The plant is adapted to long growing conditions and its blooming is conditioned by this adaptation. But the plant is able to thrive vegetatively and produce good crop of roots when the environment does not favour the formation of flowers. Throughout a certain area of its northern range, the plant seldom blooms. In the tropics, many, if not all, bloom and often in profusion. This may be a response to environmental factors such as temperature, length of growing season, length of day and intensity of light and perhaps a combination of these. Even in areas where flowers are readily and abundantly produced fruit and seed are most frequently not to be found.

The Cytological investigations of King and Bramford (1937) indicating that the cultivated species are hexaploids with approximately 90 chromosomes in somatic cells also help to contribute to an understanding of the high sterility in the species. It is probable that chromosomal non-disjunction and other irregularities are common. The high percentage of poorly formed pollen grains in commercial varieties strongly suggests that cytological abnormalities contribute to reduced fertility.

The Jersey type of sweet potatoes have been particularly difficult to flower in the continental United States. Hartman (1947) among others, has reported complete failure of flower induction in vine and bush types and several strains of Jerseys after a comprehensive series of investigations extending over a period of 8 years. Mikell, Miller and Edmond (1948) reported the production of six flowers on Maryland Golden, another Jersey type but no seed. Under tropical conditions, the Jerseys were less refractory. It would appear that Jersey varieties can be brought to flower and that they differ from other sweet potato varieties in being somewhat more exacting in their environmental requirements. Observations of Whittwer quoted by Miller (1957) lend support to the suspected influence of growth regulating substances on flower induction, also suggested by Lam and Wadner quoted by Miller (1937).

The flowering of sweet potato when grafted on other non-tuber forming Ipomoeas has been attributed by Miller (1959) to the accumulation of carbohydrates. Miller does not believe that translocation of any flowering substance takes place from the stock to the scion as suggested by Stino and Hassan (1954). Further investigations to determine the exact causes seem called for.

The past decade has witnessed a phenomenal progress in sweet potato research. The Louisiana Agricultural Experiment Station alone has been responsible for release of strains possessing such attributes as earliness, heavy yields, superior quality, attractive skin colour and high starch, carotene, ascorbic acid and protein contents. Strains resistant to wilt, soil rot, black rot and internal cork and to pests like weevils have also been produced. The work of the co-operative projects (Anon, 1948 ; 1949 ; 1950 b ; 1950 c) has resulted in the release of varieties which are of great industrial value. Varieties with low susceptibility to white rust and leaf blight, two of the minor diseases and varieties for livestock consumption, baking and canning were among those newly evolved. Work in other States in the U. S. A. was centred on the production of high yielding varieties and those resistant to nematodes (Anon, 1950 a) and internal cork (Anon, 1948) both of which are dreaded by the sweet potato grower. While the work in other countries is more or less along the above lines, it is interesting to note that in U. S. S. R. a strain resembling the potato has been developed (Anon, 1937).

Sweet potato research continues to make strides in many countries and notably in the U. S. A., where further work is being concentrated on bringing about major improvements in the breeding

methods and technique, selection of parent material, fertility studies on pollen and more rapid methods of selection of seedlings having superior qualities. The production of foundation seed which is the backbone of the sweet potato industry forms a major item of work. The Louisiana State University Agricultural Experiment Station, for instance, supplies each year 2000 bushels of foundation seed of the leading varieties for distribution to certified seed growers and individuals who grow seed. The Station not only furnishes seed to the Louisiana growers but also supplies research material to collaborating groups in the country and has distributed seed to most areas of the world where sweet potatoes are grown.

As far as the industry is concerned most canners in the U. S. A. are contracting with the growers to produce potatoes for canning. The research at the Louisiana State University has shown that if a uniform grade of sweet potatoes can be placed on the market the housewife will increase her purchase. Attempts are also being made to reduce the cost of production by introducing more mechanical aids for tillage and harvest.

Interest in sweet potato research has been aroused to such an extent, due mainly to the efforts of Dr. Julian C. Miller and co-workers of the Louisiana State University Agricultural Experiment Station that this University now possesses a 300 acre farm at Chase, intended solely for research on the sweet potato and for multiplication of seed material of promising strains. The ability of this crop to thrive under diverse conditions together with its food value which is considerably higher than that of the Irish potato, has served to advance it to the position of second place among the truck crops grown in the Southern States of the U. S. A. and to the seventh place among the standard agricultural crops of the nation.

Hardly more than a beginning has been made in India towards the improvement of the sweet potato through breeding. The results of research in the other countries discussed in these pages serve to bring out the scope for improvement of the crop and the lines along which research can be planned. India possesses all the potentialities necessary for successful culture of the crop and more especially the ideal climatic conditions to bring the plant to flower which in the temperate regions has been a serious limiting factor. The long growing seasons and the prospect of obtaining more than one crop per year are additional points in favour of tropical countries. Considering the wealth of information that has accumulated on the subject and

the attractive possibility of securing seed material of improved strains from other countries it is not hard to visualise a bright future for the sweet potato industry in India provided suitable steps are taken to initiate a comprehensive nation-wide programme of improvement of the crop through selection and hybridization. This should necessarily go hand in hand with a vigorous drive to inculcate in the minds of the public the healthful properties of this root crop and the important role that it can play in the daily diet as a rich source of carbohydrates and vitamins.

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