Improved Varieties and Plant Diseases

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In all discussions on crop production the importance of crop diseases as factors in reducing yields has to be recognised. Estimates of crop losses have been prepared in some countries like the U. S. A. and Germany. These show that the average annual losses from diseases vary from 10 to 12 per cent in grains, 20 to 25 per cent in potato, 10 to 12 per cent in fruits and ten percent in vegetables. All the above estimates of losses are in spite of the more or less general use of disease control measures. The losses are bound to be much more in countries where the control measures are adopted but rarely.

General control measures consist of seed treatment with chemicals, protection of plants with fungicides usually as a preventive measure and cultivation of disease resistant varieties. The last mentioned method if practicable is the most economical of all the methods and this alone will be considered here. From ancient times farmers have recognised the existence of differences between plant and plant or variety and variety in their reaction to diseases. An unconscious selection has been in progress for centuries in all countries where agriculture has been established as an ancient industry. In the course of successive generations the susceptible types have succumbed to one or other of the diseases. Consequently, the well established varieties of our crops in any locality are those which have a considerable degree of resistance to the common diseases prevalent in that area.

Since the beginning of this century, especially after the rediscovery of Mendel's work, considerable attention has been devoted to breeding superior and improved varieties of cultivated plants and notable achievements have been made in a number of crops. But more often the breeders have concentrated on characters affecting yield, quality, duration etc. Outbreaks of severe epiphytotics in the improved varieties have necessitated purposeful selection and breeding for resistance to specific diseases as a measure of control. Biffen's discovery that factors influencing resistance are inherited in Mendelian fashion gave an impetus to this aspect of breeding. It must be recognised that unless resistance to the major diseases in the locality is also infused into improved varieties disastrous results may follow after years of labour and expenses due to the incidence of destructive diseases wiping out the improved varieties. Very often the incidence of some of the common diseases is more in the newly developed varieties or in the breeding plots. Rice varieties Adt. 10 and Co. 13 are examples of improved varieties developed for their high

yields. If there is no disease they yield well but when conditions become favourable for blast infection these varieties are completely destroyed. The samba wheat on the Nilgiris is highly resistant to black rust but the yield is not satisfactory. Improved varieties like N. P. 111 giving higher yields were introduced but these became heavily rusted. Several other examples like these where improvement has not included resistance to diseases can be cited. Therefore it is emphasized that before attempting to spread the cultivation of a new variety its reaction to the diseases prevalent in the new area should be ascertained and the variety allowed to spread only when it exhibits reasonable resistance.

Resistance to diseases is a complex phenomenon influenced by genetical, cultural and other environmental factors. A variety resistant to a disease in one locality need not behave in a similar manner when cultivated in another environment. Conditions in the new home may be different from those prevalent in its original home. The soil and weather in the new locality may be such as to be favourable for the onset of the disease. Or the strains of pathogen present in the new surroundings may be more virulent. One or other or all these factors may contribute to the break down of the resistance in the new area. Numerous instances of this type have been recorded. In Sudan a number of strains of cotton resistant to black arm have been evolved. Some of these when grown at Coimbatore were so badly infected that the plants were completely knocked out when they were about six weeks old. Russian experiments have indicated that disease resistance in cotton is not constant and that it can be greatly influenced by the environment not only in the present generation but in the preceding generations also (Moskovetz, 1950). The variety of rice Co. 25 is highly resistant to 'blast' and has behaved uniformly so in Tanjore, Tiruchirapalli, Mathurai and Coimbatore. But when grown in Wynaad (a place of higher altitude i. e. about 2500 feet) its resistance broke down. In sugarcane the varieties Co. 210 and Co. 213 enjoyed a wide distribution and were outstanding commercial canes of North India. In 1939—'40 a severe epiphytotic of red rot completely destroyed these varieties in Bihar. This is attributed to infection by a highly virulent strain of the causal fungus in that area. In its home district however this variety had actually pushed out of cultivation some of the susceptible varieties *(Vellai* and *Poovan).* This again indicates the limitation to the spread of the improved varieties imposed by diseases.

The extention of cultivation of any variety (though agronomically satisfactory), over a large area without testing its resistance to the major diseases of the crop prevalent in the area is beset with danger. When millions of plants of a variety bred for yield or other characters without regard to its resistance to diseases occupy a compact area it gives ample scope for the pathogens to multiply and spread rapidly. Ultimately this leads to large scale destruction of the crop. Banana cnltivation was

extended on a large scale in the West Indies and Central America. Gros Michel, a variety with good commercial possibilities was preferred to others. Unfortunately this variety was susceptible to wilt disease. In a few years whole plantations were wiped out. In South India the same disease is prevalent in a mild form and has been reported from many districts. In some parts of Tirunelveli the variety locally known as *Peyan* is highly susceptible to this and its cultivation may have to be given up sooner or later. The variety Gros Michel is being recommended to be tried in different districts. It would be better to remember its history in the West Indies before it is taken up for large scale cultivation in this State. The restricted incidence of this disease in our State may be due to the large number of varieties under cultivation which differ in their susceptibility to wilt. In Tirunelveli itself three or four varieties are cultivated. Of these only *Peyan* appears to suffer badly. Even in modern forestry pure stands of trees are not favoured but mixed planting is advocated so that diseases do not spread rapidly but are checked in their progress by the intervening inhospitable plants.

The large scale spread of proven resistant varieties even does not result in freedom from disease after the lapse of few years. It is true that a respite is obtained for some time but it is always a race between the host and the pathogen. If the parasitic organisms remain unalterable the breeding of resistant varieties will be quite simple and quickly accomplished. But in nature changes are taking place alike in lower and higher organisms in their struggle for survival. The cultivation of resistant varieties of plants is followed by the development of new strains of the pathogen capable of infecting the varieties which were previously free. These new strains arise by mutation or hybridisation. It is possible that these are continuously being formed but are not detected until the appropriate genotypes of the host are available. Breeding varieties resistant to all known biotypes of the pathogen is well nigh impossible. There is usually an interval between the time of introduction of a new resistant variety and the development of new strains of parasites capable of readily infecting them. This may vary from one or two years to a decade or more. This time factor determines the practical usefulness of any improved variety. The presence of the improved resistant varieties helps to build up the virulence of the pathogen. Reddick (in Sansome 1938) has shown how the virulence of *Phytophthora infestans* can be stepped up by repeated inoculations on a resistant variety of potato. In similar manner the host range of *Colletotrichum capaici* can be enlarged (Ramakrishnan, 1941) by cultivation of the organism on the particular host tissue.

The story of the spread of rust resistant wheats in America forms interesting reading. The ravages of the rust led to intensive breeding of resistant wheat. The first commercial rust resistant variety

was Ceres which began to spread from about 1926. By 1935 this variety succumbed to a race of the rust (56) which had only a limited distribution before. With the spread of Ceres, this race multiplied rapidly and the new variety went down. Another improved variety Thatcher was brought in to replace Ceres. In its turn the new variety became severely infected by the race 15 B. Still later the variety Newthatch has been evolved to replace Thatcher. A continuous struggle is maintained.

A similar loss of resistance in course of time has been observed in potato with reference to late blight. A great handicap has been the existence of several strains of the pathogen. Furthermore this pathogen has been observed to improve its virulence when in association with resistant varieties. Originally only one strain of the fungus was known and varieties of potato resistant to this were multiplied. Soon a second strain capable of attacking these varieties appeared. Promising varieties resistant to both these strains were bred but again the work was checked by a third strain. Thus the story goes on and the end of these reverses is not yet in sight, but in the meanwhile the fight goes on with undiminished vigour.

Every crop is susceptible to more than one disease. Resistance to one disease does not necessarily imply resistance to other diseases also. To combine resistance to all diseases in one variety is asking for the impossible. Very often varieties resistant to one disease easily fall victims to another disease. The rice variety Co. 25 is resistant to blast but not to leaf spot (*Helminthosporium oryzae*). Several varieties of oats were bred and introduced over a wide area in America. These were highly resistant to crown rust and smut. But unfortunately they were damaged by a leaf blight and culm rot caused by *Helminthosporium victoriae*. These examples show that the introduction of a new variety of even a widely cultivated crop may be followed by wholly unexpected disease developments.

About thirty years ago black arm of cotton was an unimportant disease in Madras State. Numerous varieties of American and Egyptian cottons were introduced with the object of improving the quality of cotton. Many new varieties have also been produced and have spread into cultivation. Black arm has also become a major problem in cotton cultivation now.

In the twenties of this century powdery mildew was the most serious disease of grape vines in Mathurai district and downy mildew was rare. From time to time other varieties have been introduced into cultivation and it is now found that downy mildew has assumed greater improtance and has spread to different districts where grape vine cultivation has been undertaken. In both cases it is quite possible that the pathogens were present in the country but did not assume importance

as the host varieties were not congenial. With the introduction of more susceptible varieties into cultivation the pathogens have multiplied and spread rapidly. Or more virulent strains of the pathogens may have been introduced into the country along with the new varieties of host plants.

The introduction of planting material or live plants from one country to another or from one part of the country to another may sometimes be followed by the introduction of new diseases with disastrous consequence. The blister blight of tea is an instance. This disease has been prevalent in Assam and its neighbourhood for nearly a century. Yet it did not occur in South India till 1946. The causal fungus is easily killed by exposure to unfavourable environment of higher temperature, bright sun, etc. Prior to the introduction of air transport the planting material took a long time in its journey from Assam to South India and had to pass through warm country. Therefore there was no possibility of the pathogen remaining viable when it reached its destination in S. India. But with quick air transport between Assam, Ceylon and South India the chances of the transference of viable fungal material were established. The new fungus found suitable hosts and favourable climatic conditions in South India and so quickly spread throughtout the tea districts.

The necessity for combining resistance to diseases in improved varieties of perennial plants is obvious. The loss caused by outbreaks of diseases will be considerable and several years of labour spent in raising the plantation will go to nothing if proper tests on the resistance of the varieties or stionic combinations had not been carried out before the variety was sponsored. Sometimes new diseases may occur which could not have been anticipated but resistance to known diseases should be taken into consideration. We could also benefit from the experiences of other countries. For example sweet oranges are susceptible to various types of root diseases. This is sought to be controlled by the use of resistant root stocks. In Brazil and the U. S. A. sour orange was found to be resistant to brown root rot. Therefore plantations were largely grown with sweet orange on sour orange root stocks. In the course of a few years a new virus disease called 'quick decline' appeared and caused the death of millions of sweet oranges on sour orange stocks. The sour orange tree on its own roots is not however affected. Recently it has been found in West Africa, that die back traceable to virus infection is prevalent in seedling limes. Great caution and rigorous tests in as many places as feasible are therefore necessary before we can recommend these and other root stocks for wider adoption. Very often the infection remains latent and exhibits itself only at a late stage.

In the development of improved varieties more attention should be devoted to the inclusion of disease resistance besides other charaters which go to make a variety commercially successful. This may be neither easy nor certain of achievement. On the other hand it is often very difficult

to combine resistance with other desirable characters. The complexity of the factors governing resistance to many diseases is becoming more and more apparent as the studies are extended. The earlier plant breeders were confident that they could eliminate the diseases by breeding resistant varieties; but their enthusiasm has been damped by the magnitude of the problem and numerous reverses experienced. Neverthless the production and use of resistant varieties offer the most economical and satisfactory method of control to be hoped for against certain diseases. In this the need for a diversity of germ plasm has been recognised. Numerous observations have shown that the more uniform a plant is the more vulnerable it is to outbreaks of disease. Higher losses caused by diseases are to be found among self pollinated crops as wheat, oats, flax and rice than among cross pollinated ones like maize and rye. The 'clones' used by the horticulturists may sometimes be the weakest of all types in their susceptibility to attack as they actually represent but one plant.

There is an increasing tendency among breeders to hold in reserve supplies of germ plasm that may be needed in the future. The breeding programmes are designed for the maintenance of variability instead of for the isolation of pure lines. The factors for resistance are often found in related wild species. These are coming into greater use in breeding. Sterility problems often limit the scope of inter-specific or inter-generic crossing but these are got over by subsequent treatment of the hybrids by repeated back crossing and other methods. The advantages gained by hybridisation with wild species are well illustrated in sugarcane and potato. Explorations into the original homes of some of the cultivated plants have been undertaken to obtain valuable plant material exhibiting high resistance to important diseases affecting those crops. Andes and Chile for potato and the Pacific islands for sugarcane have been surveyed for this purpose.

The breeder and the pathologist should work in close co-operation in selecting the resistant varieties. If the elimination of susceptible material takes place in the initial stages alone much time and labour can be saved. The efforts should not be weakened when one or two resistant varieties are obtained but should be continued unabated so that better varieties will always be ready at hand when the earlier ones exhibit loss of resistance. The breeding of celery, resistant to *Fusarium* yellows is a good example. In the pathogen *Fusarium*, variations occur rapidly. Therefore new selections of resistant plants are made every year from those grown in heavily infected soil. The seed is multiplied in another station and returned to the original district to grow the commercial crop.

In the foregoing paragraphs the importance of breeding for disease resistance has been indicated. The first step in this is the search for suitable germ plasm carrying resistance. Adequate tests of the selections or progeny have to be made after heavy bombardment with the

pathogens to enable the selection of desirable ones. For this the active collaboration of the plant pathologist is essential. The real test is obtained when the variety is grown in a number of places under a variety of conditions to enable the selection of desirable ones. The most tedious and the most uncertain part of the programme is to obtain a variety combining resistance to the major diseases with other characters which go to make the variety acceptable to the farmer. But this should work as an incentive to concerted and continuous efforts on the part of the breeder and the plant pathologist. The necessity for resistant varieties is more for combating certain types of diseases than others. Resistance to diseases which can be easily controlled by cheap protective methods like seed treatment need not be sought after. But more attention should be devoted to breed for resistance to diseases which are not amenable to economic protective measures. Wilt diseases, root rots, rusts and similar diseases affecting extensive field crops are examples of diseases for which production of resistant varieties will be desirable.

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Methods to be Adopted to Maximise Production and Development of Groundnut Strain Suitable for Summer Cropping in the Madras State

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Introduction: The Groundnut (Arachis hypogaea Linn.) reported to have been introduced into India in the 16th century has now become well established in the country. It has obtained a high status for the country in the international market for oilseeds and it is the first money crop among the few important crops which earn plenty of dollars for this country at a time when she needs them most. It has also become an important food crop for men and cattle, builder of soil and its protector and on top of all an important industrial crop. India is the largest producer of groundnut in the world contributing more than 40%. In Madras the area under this crop is about four million acres (40% of the