The Control of Insect Pests of Indian Fruits.

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FRUIT-GROWING is indeed one of the oldest occupations of the people of India, which will not appear at all strange if one keeps in mind the immense number of delicious fruits that thrive on the Indian soil even in a state of nature, that most fruit trees are perennial and once grown yield annual products for a large number of years, and finally the comparative ease with which they can be grown from seed, cutting and graft. But it does appear strange that with all these facilities India at present imports a large amount of fruit from other countries, whereas normally it should be able to export a variety of fruits to the different markets of the world.

The Indian fruit-grower works under a large number of handicaps not the least of which is the general mental apathy towards modern methods of fruit-growing. Recently, however, the fruit-growers of U.P. have given a lead in the matter by meeting together and considering the ways and means by which the fruit-growing industry could be improved by the application of modern methods. Now one very important factor that controls the productivity of an orchard is its insect pests. It is not unusual in certain years to find the whole crop of an orchard utterly destroyed by a certain pest; but it is usual for the average Indian fruit-grower to accept this as an inevitable calamity incapable of being averted by human agencies. They have not yet realised that the pests are more or less their own making and as such can only be controlled by measures adopted by themselves, a fact which has been amply demonstrated in the western countries.

Plants and insects exist in nature in a state of perfect balance and their specific numbers are more or less the same from year to year. No serious insect pests, as a matter of fact, exist for any one species of plant in its natural habitat. Nature's control of pests is three-fold. The weather may be favourable or unfavourable, insectivorous birds may be exceptionally partial to some, while entomophagous (insect-eating) insects play a not inconsiderate part in keeping the pests under control. All this constitutes what is familiarly known as the "*balance of nature*". But cultivated plants do not live in any such equilibrium. The mere fact of cultivation of the soil at once alters the whole state of things, for it modifies not only the number and kinds of plants but also the physical condition of the soil, its temperature and water and air content. In nature we do not find a great aggregation of the same species of plant such as man establishes in the form of orchards containing only oranges, apples or plums, with the necessary aggregation of insects that feed on them. The depredations of these insects can only be controlled by destroying them in one way or another. It is not essential that an insect should be attacked in its harmful stages; on the other hand, it is often much easier to destroy a pest in its harmless stages than in the harmful ones. Much depends, therefore, on the proper working out of the life-history of the pest concerned.

There are various kinds of insect pests that attack orchard-crops. From amongst the forms that have no wings in any stage of their life-history the spring-tails are known to do some damage to fruit trees; while all the other pests have wings in some stage or other. Amongst the latter are the notorious white-ants, thrips, aphids and scale insects, bugs, caterpillars, weevils, saw-flies and fruit-flies. They attack not only the roots, stem and leaves of a tree but extend their ravages to seedling, shoot, flower and fruit. But it is possible to control this weird horde of parasites because each species of fruit-plant is attacked fatally by only a few definite species of insects; and one can usually avoid serious damage to a certain orchard-crop by controlling a few species that may have otherwise done any considerable harm to the crop. For example, there are only two serious posts of the pomegranate (both butterfly larvæ); and two beetles, a caterpillar and the wooly aphis is all that the apple crop can succumb to. It should be borne in mind, however, that very often the number of species attacking a crop is inversely proportional to the actual aggregate of the individuals comprising the species, an idea of which may be obtained by observing migrating aphids.

Methods for controlling the pests may be

either *direct* or *indirect*. In the direct control measures the aim is actually to kill the insect by the application of some toxic substance or by mechanical means whereas indirect measures affect the conditions in which the insects may thrive. Of the various direct control measures adopted sprays and washes are indeed the most important. Now it is known that certain insects (*e.g.*, caterpillars) obtain food by biting off and chewing bits of plant tissue while others (*e.g.*, aphids) suck off plant juices by piercing into the tissues. It is apparent that different measures should be adopted for these two classes. Chewing insects are easily destroyed by the spraying of stomach poisons on the fruit tree or plant attacked which prove fatal to the insects when eaten along with their food; whereas contact poisons are used for sucking insects which are applied directly on their bodies. The problem is to find substances that will neither scorch the plant nor be too weak for the insects. For example, copper sulphate solution used on leaves may kill the plant, and therefore lead arsenate solution is used instead Again raw oil usually scorches the plant whereas oil emulsion can be safely used.

In the west, lead arsenate solution is used as stomach poison; but as it is dangerous for man and cattle if not handled properly lead chromate should be used in Indian orchards. A solution of 1 lb. in 32 gallons or $1\frac{1}{2}$ oz. in 1 kerosene tin of water will be quite efficacious; but in case of bad attacks the strength of the solution may be doubled. A hand sprayer (in the case of small trees) or a wheel sprayer should be employed and a fine spray spread over buds, etc., evenly until every leaf becomes yellow. If the leaves do not wet easily a little *rosin compound* solution should be added to the mixture. This if applied properly will successfully keep in check all kinds of caterpillars and weevils that do so much damage to foliage, flower and fruit. As contact poison either *rosin compound*, *crude oil emulsion* or *vermisapon* may be used. *Rosin compound* is easily prepared by powdering 2 lbs. of rosin, boiling 1 gallon of water with 1 lb. of washing soda, then adding the rosin and boiling again. Water should be added from time to time during the last process to make the solution upto three gallons. For use 4 pints of this should be made up to 4 gallons with water. *Crude oil emulsion* consists of 20% of soft (fish-oil) soap with 80% of crude mineral oil; for use $\frac{1}{2}$ pint of emulsion should be stirred in one kerosene tin of water. *Vermisapon* can be used in place of crude oil emulsion. In practice these should be sprayed with some force into the buds, fruits and branches so that they may come in close contact with the insects. All sucking insects, except the mealy bugs and scale insects, are destroyed by this method. For the latter a solution of nicotin or nicotin sulphate with soft soap is very effective. 6-12 fluid ounces of nicotin and 2-3 lbs. of soft soap in 100 gallons of water should be used. Spraying of fruit trees (such as apple) to check fruit-boring insects should be done after the petals have fallen when the young fruit is just set; it should not be done whilst the trees are in full bloom. Washes, though not so important as sprays, may be beneficially used when the plants are dormant. Caustic soda wash, lime wash and tar distillate—all serve to kill moss, lichen and eggs of aphids and apple-suckers.

In addition to sprays and washes a few other accessory measures may help in completely controlling the pest. *Hand-picking* is very useful when the insect is just appearing. Egg-nests, insect-nests and attacked fruits and leaves should be removed and either burnt or buried deep under the earth. This is effective against apple-sawfly in fruits, pear-leaf-blister mite in leaves and apple-blossom weevil in the closed capped blossoms. *Running of poultry* in orchards effects the destruction of most pests that pass a part of their life-cycle in the soil. *Banding of trees* for pest that crawl up and down the trunk is another effective measure against some caterpillars and beetles. A band of sticky material or bands of hay and sacking should be placed half-way up the trunk which detain insects and may be burnt later. Finally, root-pests like the wooly-aphis of the apple can only be successfully destroyed by *soil-fumigants* like carbon di-sulphide. But this should be done under expert supervision as otherwise the reagent may injure the plant itself.

Indirect measures of control will often enable the fruit-grower to considerably reduce the severity of the insect attacks. For example, some insects have their winter quarters in rubbish, moss and lichen, and if these be removed, however favourable the summer conditions may be, the pests cannot thrive. It is much better, therefore, to completely destroy badly infested trees

rather than clean them. Another method of minimising the harm done by insects is to make the trees more resistant to insect-attacks. This immunity can be obtained by starting from immune breeds, to determine which the difference in susceptibility already shown by the marketed fruits may be taken into advantage. But standing crops will gain much in the matter of immunity if proper food supply is given and a general clearing up of the orchard maintained.

A very interesting control of insect-pests, little of which is known and still less used in India, is their *biological control*. This method of control has been tried on a large scale in the West and has been found signally successful. Biological control takes advantage of the fact that certain insects prey upon other insects in one stage or another of their life-history and has succeeded in so breeding, introducing and naturalising one or more species of parasites of an insect-pest in the region where the latter thrives that the parasitic species have completely subjugated the pest in that region. Special breeding stations are formed from where millions of parasites are distributed to the various fruit-growers who release them in their orchards. Needless to say that specialists must first be employed to discover the parasites which attack a definite species of pest. All this is done in the West by forming an association of fruit-growers and maintaining an efficient staff of specialists at their own cost. A similar move in India will not be less paying than it has been in countries where this has been tried and not found wanting. It may be pointed out here that in the artificial control of insect-pests one should be careful not to destroy friend and foe together, for then the epidemics may be more virulent than when the things were left to nature.

It is expected that Indian fruit-growers will take full advantage of methods that have been tried over and over again for the suppression of insect-pests of orchard crops and which, with its little necessary expenditure, will increase the annual output of an orchard by 25%. When all is said one may remind the fruit-grower that as with the human body so with the best cultivated orchard, a 'doctor' is always required to keep it in a condition of maximum efficiency.

Letters to the Editor.

A Note on the Embryo Sac of *Sagittaria sagittifolia* L.

IN a recent paper Prof. K. V. O. Dahlgren[1] has described the development of the female gametophyte in *Sagittaria sagittifolia* and finds it to have a six-nucleate embryo sac arising in the same way as described for some other *Alismaceæ* in his earlier paper[2]. My material collected from Lucknow in February 1934 shows some variations in the number of nuclei in the mature embryo sac.

Upto the four-nucleate stage the embryo sac develops in the same way as described by Prof. Dahlgren. Usually the two chalazal nuclei do not divide further and the mature embryo sac is six-nucleate, but sometimes, one or both of them may divide producing a seven and eight-nucleate embryo sac respectively. Sometimes, the lowest chalazal nucleus of the tetra-nucleate stage may undergo fragmentation and thus increase the number of the antipodal nuclei. The results obtained by me in *Sagittria sagittifolia* agree with my previous observations on *S. guayanensis*.[3]

In his work on *S. latifolia* Schaffner[4] mentioned the presence of three antipodal cells. Cook[5] on the other hand says that there are three ephemoral antipodals in *S. lancifolia*. Dahlgren[1] criticises both of them and definitely states that there are no antipodal cells in *Sagittaria*.

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[1] Dahlgren, K. V. O., "Die embryosackentwicklung von *Echinodorus macrophyllus* und *Sagittaria sagittifolia*," *Planta, Archiv für wissen., Botanik*, 1934, **21**, 602-612.

[2] Dahlgren, K. V. O., "Die embryologie einiger *Alismataceen*," *Svensk Bot. Tidskr.*, 1928, **22**, 1-17.

[3] Johri, B. M., "A note on the life history of *Sagittaria guayanensis*, H. B. K." *Current Science*, 1934, **2**, 428-29.

[4] Schaffner, J. H., "Contribution to the life history of *Sagittaria latifolia*," *Bot. Gaz.*, 1897, **23**, 252-273.

[5] Cook, M. T. "The Embryology of *Sagittaria lancifolia* L." *Ohio Nat.*, 1907, **7**, 97-101.