4.....Cattle-Fly Repellant. For repelling flies from cattle, horses and mules the following may be used:—

Fish Oil	...	...	...	4 litres
Tar	...	...	...	60 c.c.
Kerosene	...	...	...	500 c.c.

The mixture is lightly smeared over the limbs and back of the animal.

Silver Fish.— (Lepisma) This insect infests books and papers and often prove very destructive. Books may be protected from their attacks by applying to the cloth-binding, the following mixture:—

Corrosive Sublimate	...	...	1 oz.
Carbolic acid	...	...	1 oz.
Methylated Spirit	...	...	4 oz.

The mixture should be painted on with a broad flat camel hair brush and should not be allowed to come in contact with the hands.

A RHIZOCTONIA DISEASE OF VIGNA.

BY JOHANNES GANDRUP, Mag. Sci.

Translated from the Dutch, by H. L. Ludowyk, Librarian, Agric. Dept.*

In 1922, I discovered on a plot of *Vigna oligosperma*† in the Coffee Garden of the Experiment Station, some patches on which the plants were infected by a disease which totally destroyed the leaves. The patches were not large—about a metre in diameter. The disease had then just appeared, and its first appearance was noticed after some heavy showers. Soon after the disease had attracted my attention, it was found in other places; and the same disease symptoms were observed later on several estates. The disease then prevailed right to the end of the rainy season, at which time it disappeared and the plants began to recover. As the disease reappeared with the first showers of the rainy season, and it appeared that, on some estates, the infected areas were large—some 10 sq. metres—it seemed worth the trouble to investigate the disease more closely. In the following pages this investigation is briefly described.

THE DISEASE SYMPTOMS.

The character of the disease varies somewhat according to the degree of dampness. During heavy rains the disease may occur at once over a fairly wide area on which the leaves appear as though hot water had been poured over them. The leaf tissue becomes a slimy mass that cannot be lifted without breaking the leaves. This slimy mass has a green colour, somewhat darker than the colour of a healthy *Vigna* leaf. The shape of the leaves is still quite apparent. As soon as the drought commences, the dead leaves dry up and form a very thin and brittle layer which either lies flat on the ground or hangs on the surviving leaves and branches. The colour of this residual of leaves is yellowish to gray. When the leaves are killed at once through quickly spreading infection, the slimy consistency comes more

* Archief voor de Rubbercultuur Vol. IX, No. 4 (1925).

† The proper name is *Vigna Hosei* (Craib) Backer. Since the plant is known to planters by the name of *Vigna oligosperma*, we have used this name so as to prevent confusion.

to light. Often, at first, especially if the drying up has been rapid, the withered leaves are found to be of a colour resembling that of lead. Later, they become yellow. If infection takes place during a less rainy period, it is often not possible to find the slimy mass of leaves, for the shrivelling up and dying off of the leaves then involve but one process, and a yellow layer of leaf is directly formed. Then the patches too are generally smaller and recover more easily. If, after a severe infection, a long drought prevails, and the disease spreads no further, the *Vigna* branches generally begin to put forth new shoots, and then traces of the disease may soon disappear. If, however, the rains were to continue, it may even happen that the young shoots too may get infected and die. The older twigs offer greater resistance, but where the disease has prevailed for a long time the older twigs are also killed. They are then black to dark-brown in colour.

The infection of the leaves, which is the chief feature of the disease, occurs generally at a place where two leaves touch each other. The infected leaves become flaccid and lie on healthy leaves before they perish. A healthy leaf upon which a completely, or partly, perished leaf lies is always infected if the weather conditions are favourable to the spread of the disease. Very often we have been able to find leaves, one half of which had already been killed whilst the other half seemed to be still living and healthy. The fact that the infected portion of one leaf touches a leaf already dead often shows that the disease has passed over from the one to the other. When leaves thus touching each other are separated, they are found to be connected to each other by hyphæ. Where the disease has had rather a rapid course it is even possible to separate whole masses of adhering leaves.

In places that are more or less cut off from sunlight and drought, *e.g.* under the fallen leaves of Hevea or coffee or under a layer of withered *Vigna* leaves, there are found rather frequently on the infected leaves small white globules of flocculent hyphæ. In other cases the under surfaces of the leaves are covered with something like a wad of mycelium. Very often white strands of aggregated hyphæ are found traversing the leaves. Further, there are found here and there small hard bodies, in colour nearly resembling that of dry clay. These may be attached to leaves that have been infected a long time as well as to twigs and petioles that have been killed by the disease. Since they are not very striking and are also easily separated from the surface on which they occur, it is often quite difficult to discover them except with a magnifying lens. These small bodies are sclerotia—the resting bodies of the fungus, by the aid of which they are able to withstand protracted drought.

In very damp weather large portions of the infected plantations are sometimes covered with a very vigorous growth of white mycelium which looks like a thin layer of wadding spread over the plants.

THE CAUSE OF THE DISEASE.

The fungus that causes the disease belongs to the genus *Rhizoctonia*. It has not been ascertained whether this species is identical with the well-known *Rhizoctonia solani*, or is one that is closely related to it. The taxonomy of this difficult fungus has not yet been worked out. It may perhaps be necessary to create a new species of the fungus that has been

discovered here. However, since such species are of very little importance to botanical science, we have refrained from undertaking the protracted and, in the absence of comparative material from other countries, very difficult work of determining by what species of *Rhizoctonia* the *Vigna* in this country is infected. Besides, the literature regarding this genus is so widely scattered, that it has not been possible to collate even a considerable portion of it.

The hyphæ of this fungus are colourless and septate. Clamp formations often occur at the septa. These clamps have also been noticed in other species. The branching of the hyphæ show the same peculiarities as other species of *Rhizoctonia*. The branches are thinner at the base than higher up and arise from the primary hypha nearly at right angles to it. The hyphæ grow chiefly on the exterior of the leaves, but are also to be found in the leaf tissue. The latter occurrence seems to be more a secondary one. As said above, during the heavy rains there is noticed to occur much superficial growth that lies like a cobweb over the infected portions. This is often found to occur especially when a portion of a *Vigna* plantation that has so far remained healthy is infected for the first time.

The formation of sclerotia generally begins at the time when the dead leaves begin to dry. They originate from the above-described white globules of hyphæ. At the spot where a sclerotium arises the hyphæ begin to swell and to branch out more vigorously. The branches remain closely aggregated. Later, the more or less globular masses of hyphæ assume the shape of the sclerotium and become light brown in colour. When ripe they form a pseudoparenchymatous tissue of which the hyphæ of the outermost layer have thinner walls and larger cells. The outermost layer of hyphæ gives the brown colour to the sclerotia. These hyphæ form a protecting crust by the aid of which the sclerotia can withstand very long drought without losing their germinating power.

In shape and size the sclerotia of this species do not differ considerably from those of *Rhizoctonia solani*. It should be mentioned that they may sometimes be differentiated into a lower somewhat stick-like part and a more or less irregular spherical head. When the sclerotia fall off the thin white little stems remain on the host and they are but little noticeable.

CULTURE EXPERIMENTS.

It was necessary to observe whether the fungus that had been discovered was the cause of the disease, or whether it was only a fungus that occurred secondarily. Some sclerotia were isolated and examined under the microscope in order to ascertain whether there were even the most minute portions of the hyphæ adhering to them. The suitable sclerotia were then washed a few times in distilled water and then put in culture tubes with distilled extract of ripe plantain. After a day a countless number of hyphæ had sprouted from the sclerotia. These grew out radially in all directions, and, after two days, the fungus colonies seemed like white globules. The diameter would then have been as much as 5-8 millimetres. On plantain-extract agar the growth was less vigorous. The hyphæ did not penetrate into the agar. In none of these cultures were sclerotia formed. They were never found even when the agar cultures had slowly dried out.

In order to test the virulence of the fungus young twigs of *Vigna* were put in a glass box with ½ a centimetre of water at the bottom in order to keep the plants fresh. The ends of the stalks lay dipped in the water while care was taken to see to it that none of the leaves came in contact with it. A smaller glass box was placed upside down in the former box and on top of it was spread a piece of damped filter paper. The leaves of the *Vigna* branches were made to rest with their tips on this paper, and close to the edge of it. On one of the leaves or in the middle of the filter paper was placed a sclerotium which had already been growing for two days in the above-named cultures. Naturally, when transferring the sclerotium, the addition of a small quantity of the nutritive solution could not be avoided. The mycelia grew radially in all directions on the paper and reached the edges of the leaves that were supported by the paper. As soon as the leaves came in contact with the mycelium they directly began to show disease symptoms which were the same as those noticed on the plantation. The disease spread quickly through the leaf and was conveyed to other leaves that chanced to be in contact with one of those that had been first infected. Here and there—especially in the beginning—much superficial mycelia was formed in the cultures. This superficial growth too formed a connection along which the disease could spread. Finally all the leaves, some young shoots and stalks were killed by the fungus. The experiment was repeated several times and in no case did infection fail. There were always two glass boxes set up near each other at the same time, and of these at least one was infected. In all the control boxes the plants remained healthy until, in the course of time, they died for want of nutrition. Thus the infection experiments were quite successful, more successful than is generally the case with most disease-causing fungi. This shows that the fungus is very virulent. Only uninjured branches were used in these experiments. If a leaf bore a small injury caused by insects the whole branch was rejected. The disease thus occurs under the given conditions, even when the leaves have no mechanical injury on them.

Since the method of infection did not permit of working with pure cultures of this fungus, and since it is very difficult to make perfectly pure cultures of fungi that bear no spores, it was necessary to observe whether the fungus which showed so much virulence in the experiment box was the same as that which gave rise to the cultures prepared in artificial nutrient solutions.

The leaves that were killed in the infection experiment appeared, on microscopical examination, to be covered by hyphæ which wholly corresponded with those found in nature. The agreement in the presence of clamp connections was of very great importance in this case, for the majority of parasitic fungi do not possess such clamps. Besides, large numbers of bacteria that strongly accelerated the process of decomposition were present. In the decomposed parts of the plants nematodes were found. Even on the leaves of the plants that died in the control glasses for want of food, eelworms were sometimes found as well as bacteria; but, since the control leaves did not in a single instance show disease symptoms, it is not possible that the eelworms that were present caused the disease. The hyphæ that were typical of the diseased plants were never found on the control leaves.

It was only as an exception that fungi other than the species cultivated were present. As the cultures grew older various species appeared, but this occurred only after certain mites that live on fungi had stolen into the glass boxes, and this was when the original culture was beginning to wither. They occurred also on the dead leaves in the control boxes.

In the course of time sclerotia appeared in nearly all the infection cultures. It seemed as if their occurrence was dependent on the available quantities of nutrient matter in the cultures. It has already been stated above that these were never found in the cultures that were prepared in artificial nutrients. In the infection experiments they occurred only when the majority of the leaves had become slimy. In a culture in which a very prolific formation of sclerotia had developed, the infection took place not on the paper, but directly on the leaf. Further, the hyphæ formed strands and ran over the paper. At the centre of the paper a large cushion of hyphæ was formed. This occurred in this particular culture only. Possibly that was a foreign fungus that had got in by chance. The culture was already very old at this stage. The hyphæ too did not seem altogether to be hyphæ of the infection fungus. The *Vigna* leaves were found to be in a slimy condition. The rotten leaves drooped and rested on the stalks. The pressure within the sclerotia is so high that water is pressed out through the walls just as in *Pilobolus* and other species of fungi.

The shape of the sclerotia found in this case agreed with that of the sclerotia of the fungus from which the culture was made.

The culture which has just been dealt with is the first culture that was prepared and sclerotia from this were taken for all the cultures made afterwards. The type remained consistent throughout.

We have thus been able to follow up the development of the fungus from sclerotium to sclerotium. In this manner we have been able to produce the same disease symptoms as those found in nature. We have found in culture the same form of hyphæ too as those occurring in nature, and disease symptoms, sclerotia, or hyphæ with clamp formations were never found in the control experiments. There is, therefore, no reason to doubt that the fungus is really the cause of the disease.

SPREAD OF THE DISEASE.

The disease described above evidently occurs over the whole of Java. In Besoeki it is fairly widespread over all estates in which *Vigna* is planted. According to the monthly reports, the disease occurs largely in Malang too. Last year we had the opportunity of seeing the infected plantations there. We found the disease symptoms quite in agreement with those observed in Djember. The disease is very probably present in West Java also. We repeatedly heard that in West Java *Vigna* had been attacked by a slimy diseasee. Since the slimy formation on the *Vigna* leaves is one of the most striking symptoms of the disease which is described in this publication, there can hardly be any doubt that the disease reported in West Java is also a *Rhizoctonia* disease. The description of the disease in "Het Handboek der Javaansche Theeonkruiden,"* is well in agreement with that of the *Rhizoctonia* disease.

* Baclor, C. A. and Van Sloten. Het Handboek der Javaansche Theeonkruiden Batavia, 1925.

In places other than the Dutch East Indies too the disease has been found to affect leguminous crops. Lately there was a description by Cipriano G. Nacion of a similar disease which occurred in the Philippine Islands.* There the disease infects *Phaseolus mungo* and is particularly injurious to plants that have a mat-forming habit, *i. e.*, plants that grow in the same manner as *Vigna*. The identical disease was studied by Shaw† in British India. Here too leguminous crops were severely infected. It would hardly be relevant to pursue in this article the very widely scattered literature farther and cite literature regarding the *Rhizoctonia* disease of potatos.

IMPORTANCE OF THE DISEASE IN THE PLANTING OF *VIGNA*.

The Rhizoctonia disease when it attacks *Vigna* is not of such a nature that it compels planters to delete the name of this fine plant from the list of useful ground-cover plants, but, on the other hand, one cannot foretell what the position will be in a few years. When the gaps in a *Vigna* cover had become very large we noticed that they were not able to grow and close up again during the course of the rainy period. While the young shoots of *Vigna* are generally killed, or, in the most favourable circumstances, defoliated, by the fungus, all sorts of weeds spring up from the ground. After the rainy season has passed, the disease ceases to spread and the plants again begin to recuperate, but this takes place very slowly, and, in the event of intervening showers, just as the plants begin to thrive, the disease often occurs heavily again. If the gaps are smaller in area they may disappear, but in the next rainy season the gaps again become apparent on the identical spots. The larger gaps are generally to be found in shady places, the smaller on surfaces on which sunlight is able to play for a good length of time during the day.

The behaviour of other green manures with regard to the disease has to be considered. We had the opportunity of seeing *Centrocema pubescens* on a laud on which the *Vigna* plantings were suffering rather heavily from the disease. The disease infected the *Centrocema* too, but the gaps were not large and, further, the planting recovered considerably fast. This has given us the impression that this plant *(Centrocema)* is remarkably less susceptible to *Rhizoctonia* infection than is *Vigna*.

We have not yet made any experiments on this important point, but we regard it necessary that all new and already known green manures be separately investigated as regards their susceptibility to *Rhizoctonia* before these are used on a large scale for plantation. In any case, it is a fact that there are large portions of some of the earliest plantings of *Vigna*, that succeeded very well at that time, where, during the drought of 1924, hardly a single *Vigna* plant was to be found. These portions just referred to give one the impression more of a clean weeding that has not been very well maintained than of a cover planting.

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* Nacion, Cipriano G. Study of *Rhizoctonia* blight of beans. The Philippine Agriculturist, Jan. 1924.

† Shaw, F. J. F. The Morphology and Parasitism of *Rhizoctonia*. Memoirs of the Dept. of Agric. India, Bot. Ser., Vol. IV, 1912.

REMEDIAL MEASURES.

It will not be possible, very probably, to put into practice a direct method for combating the disease since one of the aims, among others, of cover planting is to keep down the cost of garden up-keep as low as possible. The treatment of the fungus will certainly be very expensive. The only thing that can be done then is to help the *Vigna* plants so that they may be able to grow and close up the gaps with the healthiest plants possible during the dry season and the beginning of the rainy season. This can perhaps be attained by giving the ground a good tilling in the places where the disease has prevailed.

THE SOUTH ANDAMAN COCONUT SLUG-CATERPILLAR.

Thosea unifascia. Wlk.

BY P. V. ISAAC B.A., M.Sc., (Lond.), D.I.C., F.E.S.

Summarised for the Tropical Agriculturist by J. C. Hutson, Entomologist, Department of Agriculture, Ceylon.

In the Agricultural Journal of India, Vol. XX, Part 5, September, 1925, there is an article, bearing the above title, which may be of interest to tea and coconut planters in view of the fact that several species of slug-caterpillars, or nettle-grubs, are known to attack tea and at least two species are minor pests of coconut in Ceylon. The South Andaman species of Thosea is not known to occur in Ceylon, but we have here at least three species of Thosea on tea, namely *Thosea recta*, the Morawak Korale nettle-grub, *T. cana*, the green nettle-grub, and *T. cervina*, while another species *T. aperiens* is occasionally found on coconuts.

OCCURRENCE OF *THOSEA UNIFASCIA* IN SOUTH ANDAMAN.

It was in February, 1922, that *Thosea unifascia* was first noticed as a pest of coconut palms in South Andaman, where an outbreak occurred during the dry weather on an estate near Port Blair after the estate had been thoroughly weeded. The damaged leaves were removed and the treated palms recovered after the monsoon rains had started. During 1924 the pest reappeared on the same estate and attacked a number of palms on other estates near Port Blair.

Mr. A. T. Weringg, the lessee of the estate where the first outbreak occurred, after persistent efforts to check the pest, approached the Imperial Entomologist with the request for the scientific investigation of the pest. At the suggestion of the Imperial Entomologist this investigation was taken up by Mr. P. V. Isaac who spent about six weeks from the middle of February, 1925, in the South Andamans and neighbouring islands in studying the habits of the insect and trying control measures.

The investigator gives the following description of the conditions under which coconuts are grown in South Andaman :—"The coconut plantations in South Andaman of any magnitude are all within the settlement of Port Blair. There are about 3,850 acres of land under coconut cultivation. The plantations belong to and were till recently managed by Government, but since