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HESSIAN FLY IN MISSOURI.

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HESSIAN FLY IN MISSOURI.

Cecidomyia destructor, Say.

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SUMMARY.

I. There are usually three broods of the Hessian fly each year in Missouri, although in some years there may be only two, while in other years there may be as many as four. This great variation in the number of broods from year to year in a given locality is a result of the influence of temperature and especially of wet or dry seasons in accelerating or retarding their development.

II. The last or fall brood and the first or spring brood are the two most destructive, and since each brood comes from the preceding brood, the extermination of any one brood during the year will usually result in practical freedom for one year.

III. The simplest and in many respects the most satisfactory, economic and effectual method of destroying the Hessian fly is to prevent the development of the fall brood. This is accomplished by sowing the winter wheat just as late as can be done safely. The Hessian flies will then be compelled to deposit their eggs on

grass and other plants, where they will ultimately perish, and when the wheat comes up it will be free from this pest which will not occur in damaging numbers the following spring.

IV. The destruction of all volunteer wheat, and the burning over or plowing under of the stubble soon after harvest and before the adult flies have emerged, will be found an effectual check and preventive of noticeable damage for one year. The stubble should be turned under as deep as possible, and the field rolled so as to pack the earth and prevent the possible escape of the adults that may hatch under the ground.

V. The Hessian fly is extremely subject to the attack of a number of parasitic insects, that greatly assist in holding the pest in check, and commonly reduce its numbers from fifty to ninety per cent. Hot and dry weather of long duration is also detrimental.

INTRODUCTION.

The Hessian fly is found throughout the entire state of Missouri, and is, next to the chinch bug, the most destructive insect attacking our wheat and menacing the general farm revenue.

Judging from the large number of letters received by this office each year making inquiries in regard to this insect and the best means of suppressing its ravages, the average agriculturist does not understand the life history of this pest, or the few simple methods of farm practice which may be varied so as to prevent its destructive work. Unfortunately there is no literature on this subject that is accessible to our people, and to which they may be directed for information, and hence

no apology is necessary for the publication of this bulletin, which was preceded by three years continuous and successful tests, on sixteen widely-scattered farms, of the methods of combating this insect herein described.

Although the original home of the Hessian fly is not known, it is generally believed to have been introduced into the United States by the Hessian soldiers during the war of the Revolution. It is probable that it was transported in the "flaxseed" stage in straw used for bedding and other purposes by the soldiers, and thus obtained a foothold in Long Island, New York, in about 1776. From this locality it gradually spread at the rate of about twenty miles each year, until it occupied the wheat-growing region of the eastern United States, and ultimately and more rapidly spread to all the wheat-growing regions of the United States east of the Rocky mountains, south of the 45th degree of latitude and east of the 100th degree of longitude, and now has established itself in California.

The name Hessian fly was first applied to this pest about 1778, but it was not until 1817 that it was scientifically described by Say, who gave it the appropriate name of *destructor*.

HABITS AND LIFE HISTORY.

Means of dispersal.—The adults of the Hessian fly have two well-developed wings, which enable them to fly about and to spread over the neighborhood, thereby extending the distribution of the species; but it is doubtful if they travel in this way more than ten miles as a rule unless aided by the wind, and ordinarily they will deposit their eggs and perish in the immediate vicinity

where they emerged, provided food plants be plentiful. The life of the adult is ordinarily of very short duration, lasting only long enough to enable them to mate and to deposit their eggs. The distribution and spread of the species over long distances is no doubt usually attained by the transportation of the puparia or "flax-seeds," either in the straw or in the chaff.

Food plants.—The Hessian fly attacks wheat, barley and rye, but has not yet been known to infest oats, although in California it is said to be able to exist to a limited extent on certain grasses, not enough, however, to threaten contamination from that source. We have no record of its perpetuating itself on grasses in Missouri. It is well to note, however, that according to Marchal the oats of France is now attacked by a closely allied species that he believes has directly descended from the Hessian fly.

Effect on plants.—The effect of the presence of the Hessian fly upon the plants is very characteristic and differs with the season, or rather with the stage of development of the plant. In the fall the eggs are deposited upon the leaves of the young plant, and the larvae, as soon as hatched, crawl down the leaf into the sheath, and down as far as the surface of the ground, or below, and even to near the roots. Their presence and feeding at this point causes an increased local growth of the base of the leaf and culm, resulting in a swelling, which is scarcely enough to be called a gall, but which is very noticeable. The plant when first attacked develops a dark-green appearance, and the infested tiller later turns brown and then yellow. If the

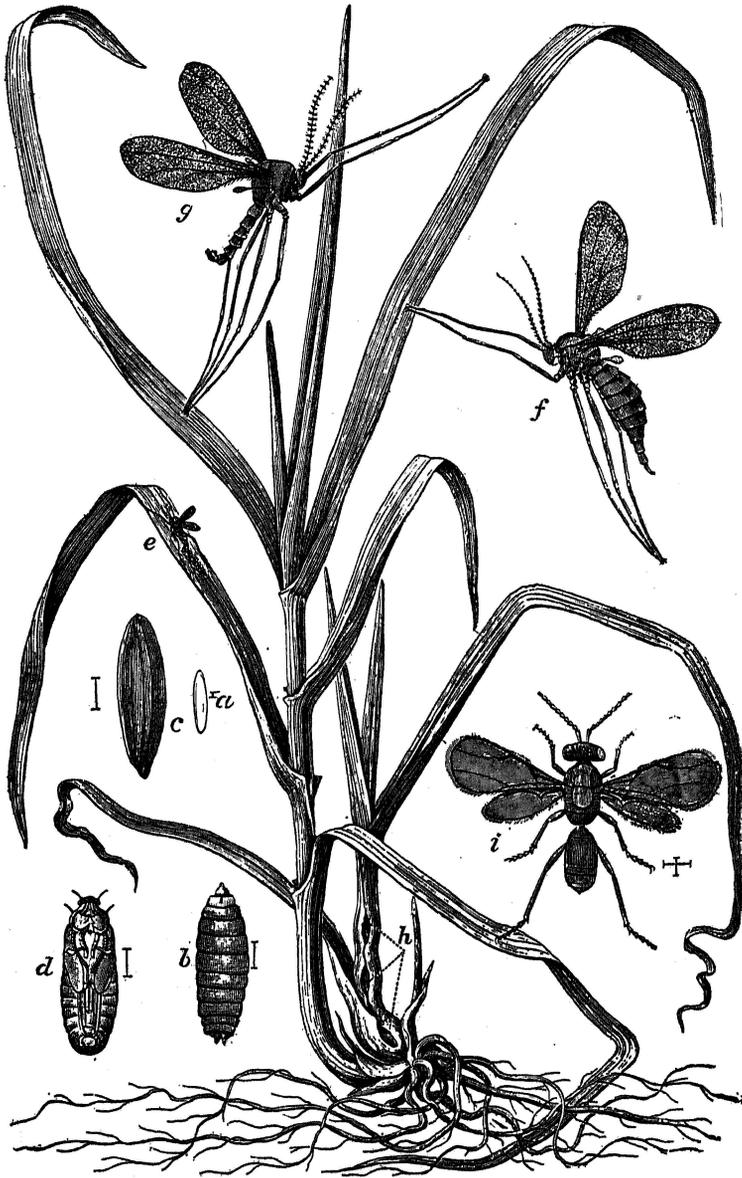


Fig. 1.—Wheat Plant with Hessian Fly in all stages of development, and parasite at *i*.

a, egg; *b*, larva; *c*, puparium or "flaxseed"; *d*, pupa; *e*, adult female; *f*, adult female, enlarged; *g*, male, enlarged; *h*, "flaxseeds."—From Packard, *Third Report U. S. Entom. Comm.*

plant is attacked early it may fail to tiller, and the death of the entire plant will be the result. If the plant has already started to produce tillers, the larvae may attack only part of them, and the other tillers may develop into healthy plants. In the spring, the plants being larger, the eggs are deposited on the lower leaves, and the larvae when hatched crawl down the sheath to just above the first joint as a rule. Here they feed, and so weaken the stalk that it bends over until the upper portion is horizontal. Occasionally the larvae will be found higher up the stalk, to the second or third joint, but not often; and sometimes they will be down even below the ground, but this is rarely the case, and when it does occur, the stalk falls at this point.

Life History.—The adult Hessian fly deposits her eggs in the furrows on the upper side of the lower leaves of the plant, and usually deposits a large number of them on a single blade. Figure 1, *e* shows an adult female, natural size, ovipositing. The eggs, one of which is shown enlarged at Fig. 1, *a*, hatch in about four days, and the young larvae crawl down the leaf to the sheath and between the sheath and the stalk to near the base of the culm, and there they feed. This position is usually below the ground in the fall wheat, and just above the first or second joint in the spring wheat. The larvae now remain at this point and feed until full grown, which usually takes about three weeks. A full grown larva is shown magnified in Fig. 1, *b*, and at its side a line indicating its natural size. The larva now shortens and shrinks away from its old skin, which now forms a puparium or “flaxseed” within which the larva remains in a quiescent stage for a varying length

of time depending upon the climatic conditions. At Fig. 1, *c* is shown one of these "flaxseeds" enlarged. It seems certain that moisture is now necessary for further development. If the conditions are right, this larva ultimately changes to a pupa within the puparium or "flaxseed," and here again, we find the duration of this stage greatly varied and dependent on climatic conditions of temperature and moisture. Figure 1, *d* represents a pupa much enlarged, the line at the side indicating its natural size. When the conditions are favorable, the pupa forces off the end of the puparium, and works its way out and up the sheath to the open, then the adult emerges. At Fig. 1, *f* is shown an adult female greatly enlarged, and at *g* an adult male also greatly enlarged.

Number of broods.—Under what may be termed normal conditions prevailing in Missouri the Hessian fly has three broods each year; but under more favorable climatic conditions, such as an unusually damp season, the insect's development is so accelerated that there may be four broods; while, on the contrary, an unfavorable season caused by an unusually dry one, will retard their development to such an extent as to allow the emergence of only two broods. Probably no other insect is more susceptible of variation in the number of annual broods for a given locality; and it is of the utmost importance that the cultivator understand the causes controlling these variations, in order that he may govern himself accordingly in his efforts to suppress their ravages, for upon it depends the success or failure of our most important remedial or preventive measures. It is the general want of a knowledge concerning these facts and

principles that results in so much failure, on the part of our grain growers to contend with this pest.

Under normal climatic conditions the adult Hessian fly will appear in October, and will soon deposit her eggs on the young fall wheat. By the approach of cold weather the larvae will have reached the puparium or "flaxseed" stage, and will, in this stage, hibernate over winter, and in the early spring change to pupae, and emerge as adults about the middle of April. These adults will now deposit eggs on the wheat and will mature adults about the latter part of May. These flies will now deposit eggs on the spring wheat, and will reach the "flaxseed" stage before harvest, in which condition they will remain until fall, when the adult flies will appear. If the summer and fall be unusually dry, the adults that emerge in the fall will be later than usual in appearing and depositing their eggs, in fact, an excessively dry and hot summer and fall will so retard and dry up the "flaxseed" stage of the Hessian fly, as to cause the death of a large per cent; while if the late summer and fall be an unusually moist one, the adults will emerge and deposit their eggs much earlier than usual. If the spring be an unusually dry one, the first brood will be so retarded that the insect will still be in the "flaxseed" stage by harvest time, thus cutting out one brood from the normal number. On the contrary, if the summer be an unusually wet one, the insects that normally would have passed the summer in the "flaxseed" stage will emerge as adults, which will deposit eggs on volunteer wheat, thus producing one brood more than the normal number.

Cause of variation in number of broods.—All the

facts of observation go to show that warm and moist weather will greatly accelerate the development of the Hessian fly, while cold and dry, or even warm and dry, weather will greatly retard their development. So great is this influence, that the number of broods may be doubled in unusually warm and wet seasons, to what they are in unusually dry years. While temperature has a marked influence on the acceleration and retardation of the rapidity of development of this fly, it is evident that humidity has even a greater influence; and the two influences combined may cause wonderful differences in the number of broods from year to year. It is generally known that the climatic conditions which favor the chinch bugs is unfavorable to the Hessian fly, and vice versa, so that we find the two pests alternate in their years of greatest destruction.

Description of the Hessian fly.—For many and obvious reasons it is desirable to have an accurate description of the Hessian fly, such as will enable one to separate it from closely allied species found feeding on closely allied plants. To this end we can do no better than to quote the excellent description given by Professor Osborn.

Adult.—“The adult (Fig. 1, *f. g.*), like other members of the family Cecidomyidae, to which it belongs, is a small, gnat-like, two-winged creature, about half as large as a common mosquito, which it resembles in form.

The female is about one-tenth of an inch long (2.5 m m.), of a dark color, the abdomen in freshly-issued specimens appearing red, with black patches or bands

of black, and with red bands at the articulations, depending upon the amount of distension.

The head is small, somewhat contracted dorsally, with a row of bristles on the posterior margin; eyes black; antennae, long, black, semi-pallid, usually of 17 joints, this number varying in different specimens from 16 to 18; joints rather short, cylindrical, and joined by a very short, small filament, each provided with an irregular whorl of fine hairs. The thorax has two rows of long backwardly-curving bristles near the median line, and a patch on either side. The legs are long and delicate with a dense covering of blackish scales dorsally, the basal joint of the tarsus very short. The wings appear smoky black from scaly covering, but the scales are very narrow, not broad, as those on the body and legs. The halteres are yellowish, with broad blackish scales covering the outer part, the basal part naked, except a narrow border.

The abdomen is long, ovate when contracted, but capable of great extension for the terminal segments. The ovipositor is compressed, cylindric, very minutely hairy, with an oval lobe at the extremity, which is minutely striate and more densely hairy than the basal portion.

The male is smaller, more slender, and appears darker than the female. The antennae are larger, the joints more distinct, 17 to 19 in number or 16 to 20 for extremes, and connected by a much longer filament, and the whorl of hairs is much more prominent, the hairs longer, and arranged in a more perfect verticil. The outer claspers are very robust and apparently loosely connected to the abdomen. The basal part is heavy, with numerous strong tubercles and a few scattered

bristles. The distal part is, when at rest, at nearly right angles with the basal part, narrow, faintly tuberculate, very minutely hairy, and with a strong claw-like tooth at end. The inner claspers are broad, oval, minutely hairy, the posterior margin with a row of fine hairs, and toward the apex three or four blunt teeth. Between the claspers is a strong chitinous process, and anterior and dorsal to them two pairs of finely haired, slender, finger-like processes directed dorsally; anterior to these, and forming the posterior border of the abdominal segment, is a prominent hairy rim, broken at the median line dorsally."

Egg.—"The egg is characterized as about one-half millimeter long, cylindric, roundingly pointed at the ends, glossy translucent, slightly reddish in color, and becoming deeper red with développement."

Larva.—"The larva has usually been described without reference to distinct stages, but Marchal has defined three forms, the first of which, just issued from the egg, is capable of locomotion and travels from the point of hatching to the location under the sheath. Its size is slightly larger than the egg from which it hatches, and it presents thirteen segments, of which the first constitutes the head. It is distinguished from the second form principally by the presence of two triangular, fleshy, ear-like appendages, lightly in-curved below on each side, and comparable to tentacles; the anterior buccal border is tri-lobed, and beneath is the mouth in the form of a small triangular opening. The last segment is lightly emarginate posteriorly, and each of the two lobes thus formed carries four setiform papillae.

The second larva form, which is fixed to the stalk and is the one usually described by writers, is, when grown, 3 millimeters long by a little less than 1 millimeter wide, of a flattened, cylindrical form, and so transparent that the internal organs are easily seen. There are twelve segments besides the head, which is small and more or less retracted. The anterior end is narrowed and usually somewhat bent. The posterior end tapers, is bluntly rounded, with two lobes on the posterior segment. The segments are but slightly indicated externally, but are plainly marked by the internal masses of adipose tissue arranged in series along each side, as well as the respiratory organs, the spiracles being plainly visible under the microscope as minute openings in rounded yellowish tubercles. The mouth parts are indistinct, and the sternal spatula is, until the larvae is ready to pass to the next form, either entirely wanting or inconspicuous. The digestive, nervous, tracheary, and adipose systems, which are very plainly visible in the larvae, have been described in particular by Marchal, whose paper should be studied for details in this regard.

The third larva form — that enclosed within the puparium—is distinguished especially by the development of the sternal spatula or “breastbone.” In other respects there is little difference anatomically from the preceding, but it is a quiescent, not a feeding stage. The sternal spatula, which becomes conspicuous at this stage, is a horny structure projecting from between the first and second body segments, and is provided at its anterior extremity with two pointed spurs. The bifurcate form of this spatula is used by Marchal to separate this species from *avenae*, in which there is but

one point. The use of this organ, which projects forward under the first segment and rests against its ventral surface, has been a subject of considerable discussion. The explanation which is best supported was proposed by Enoch and is sustained by Marchal. This is that the spatula is used by the larva to reverse its position in the puparium so that, whereas the larva rests at first with its head downward and toward the roots of the plant, it rests, after turning, with its head upward and toward the upper part of the plant, a position which has obvious advantages when we consider the direction in which the pupa and imago must escape.

Pupa. The pupa when first issued from the puparium is white, but acquires a rosy tint. It presents a very delicate appearance, the pupal case being extremely thin. On the front is a prominent pointed chitinous rostrum of a brown color, the function of which is considered to be the cutting of the puparium to permit the exclusion of the pupa. Above the origin of the antennae are two horns called by Marchal the cephalic horns and posterior to them two larger, curved, thoracic horns which contain, according to Marchal, trunks of the tracheary system.

NATURAL ENEMIES.

The great importance of the work of various parasitic insects in destroying the Hessian fly and preventing its undue increase can scarcely be overestimated. Undoubtedly these parasites kill practically every year from fifty to ninety per cent of the Hessian flies before they reach maturity, and in some years even a greater

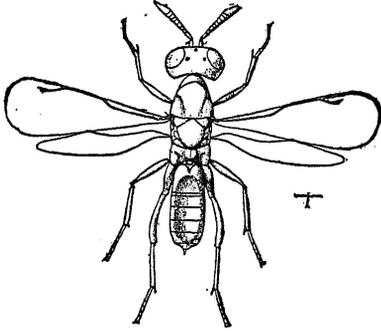


Fig. 2.—*Eupelmus allynii*, male, parasite of the Hessian Fly.

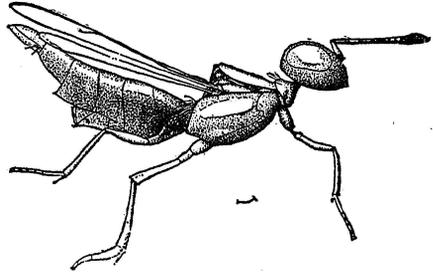


Fig. 3.—*Eupelmus allynii*, female, parasite of the Hessian Fly.

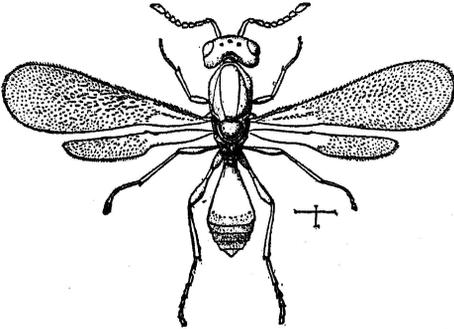


Fig. 4.—*Platygaster herrickii*, a parasite of the Hessian Fly.

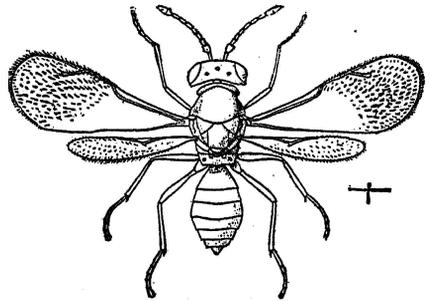


Fig. 5.—*Merisus destructor*, a parasite of the Hessian Fly.

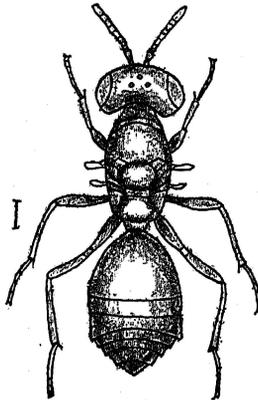


Fig. 6.—*Baetomus subapterus*, a parasite of the Hessian Fly.

per cent are thus destroyed. Still, notwithstanding this great reduction by parasitic insects and also by unfavorable climatic conditions, these insects frequently become unduly numerous and consequently destructive. It is not only because of the economic importance of these parasites of the Hessian fly, but also because of the fact that otherwise the cultivator would not as a rule be able to distinguish them from the Hessian fly itself, that we have thought best to give an illustration of the more common species of these parasites found in this State. A glance at the illustrations shown in Figs. 2, 3, 4, 5, and 6, will go much farther toward acquainting the average agriculturist with these insects, and of enabling him to recognize and separate them from the Hessian fly, than any amount of description would do; and hence we will not enter into a description of each species. *It should be observed* that the Hessian fly has but one pair of wings, the second pair being represented by a slender club-like rudiment; while in all the parasites there are two pairs of wings, the first pair, however, much larger than the second pair. In one species, *Baetomus subapterus*, Fig. 6, the insect is frequently found without wings at all. Although the Hessian fly and its various parasites look alike to the casual observer, the above facts will enable one to note the difference, if followed with a little close observation and sharp eyes, especially if one be provided with a hand-lens.

REMEDIES.

The use of insecticides for the suppression of the Hessian fly is practically out of the question, and re-

course must, therefore, be had to preventive rather than remedial measures. To this end one must thoroughly understand and be perfectly familiar with the habits of the insect, and with the conditions affecting its early or late appearance and variation in the number of broods. Knowing these, it is possible to so alter and arrange ordinary farm practices as to practically escape damage from the Hessian fly. No single measure or method of procedure will give the excellent results to be attained by an intelligent and systematic application of two or more according to the climatic conditions of the season. Primarily, the modifications of the preventive measures are based on the prevalence of wet or of dry weather.

When the grain is harvested, if the weather is wet, the stubble should at once be burned over or deeply plowed under and rolled, while if the weather be very dry, this may be deferred until later in order to allow the parasites to emerge; but in all cases it should be done before the fall rains begin, and before it becomes grown up with weeds or volunteer grain appear. In either case the field should be plowed under and rolled as soon as volunteer grain appears, and hence the plowing under and rolling has an advantage over simple burning. All volunteer wheat about stacks should be thus destroyed.

The planting of winter wheat should be deferred as late as practicable in order that there may be no grain up when the fall brood of adult Hessian flies appear. The exact date when this fall planting can be safely done will vary greatly from year to year. If the summer and fall be a very dry one, it will have to be post-

poned much longer than will be the case if the fall be a wet one.

Late sowing of fall wheat.—From what has previously been said, it is evident that this method of escaping the Hessian fly is the simplest as well as in many respects the most effectual. Since there is such a considerable seasonal variation from year to year for a given locality, and since latitude, and temperature and moisture have such a marked influence on the early or late emergence of the adults, it is not wise to give definite dates for the sowing of fall wheat, even for a given locality. Our experience for the past three years, in many localities and with many agriculturists, has been that not more than one in ten will miss the proper time, when told to sow their wheat just as late as they possibly can for their locality and the season, and not to sow until after they have had some good fall rains. No doubt still fewer would miss it if they understood more fully the habits of the pest, and the conditions influencing and varying their development. Obviously, the wheat must be sown early enough to enable it to obtain sufficient growth to withstand the winter, and still be sown late enough so that it will not be above ground until all the Hessian flies have emerged, deposited their eggs, and died; and in order to do this intelligently, one must take into account all that has been said in this bulletin, and supplement it with a little observation. Should one succeed in escaping the Hessian fly by this late sowing of fall wheat, it will not be absolutely necessary, as a rule, to follow other methods, although advisable to follow both the above and the following for the best protection. But if one should fail to escape the fly in

the fall, it would be well the following summer not to neglect the practice of the following method:

Burning or plowing under the stubble.— This method of fighting the Hessian fly has for its immediate object the destruction of the insect while still within the wheat, and before it has emerged as an adult. Where the conditions are favorable, the burning over of the stubble will be found effectual. To this end, it is well to cut the wheat very high, so as to leave as much straw as convenient, in order to more readily burn over the field, and also to be the more certain not to remove any of the “flaxseeds” with the wheat. The burning should be done soon after harvest and before any of the adults have emerged, or before weeds have grown up in the field. Later, if volunteer wheat appears, it must be plowed under, in order not to allow the development of any Hessian flies from those that might have escaped burning.

If, for any reason, burning is not resorted to, then the stubble should be plowed under as deep as possible and the field then rolled, so as to compact the earth and prevent the emergence of the flies that might develop under the ground. Obviously, this plowing under of the stubble must be done before any of the Hessian flies have emerged. In many cases it can be done soon after harvest, and the field then planted to another crop, as corn, on which the Hessian fly does not feed. If the weather continues very dry after harvest, the plowing under of the stubble can be postponed, since the insect will not, as a rule, emerge, but will remain dormant, and those that may emerge, will not find volunteer wheat on which to rear another brood, and will perish without

doing any harm. If, however, the weather be wet during harvest, or should it later become wet, the Hessian flies will emerge and the volunteer wheat will appear, on which they will deposit their eggs for another brood. Hence it will, under these circumstances, be necessary to immediately plow under and roll the field, preferably before the Hessian flies have had time to emerge or the volunteer wheat to sprout.

While no sort of wheat is absolutely proof against the attack of the Hessian fly, it is a well known fact that those sorts or varieties that have a strong hard stem and develop tillers freely and these in turn freely develop secondary roots, will resist the attack and injury from this pest to a great extent. Such resistant varieties are the Clawson, Underhill, Mediterranean, Red May, Red Cap.