EFFECT OF HOST AND ENVIRONMENT ON SOME ASPECTS OF THE BIOLOGY OF HETERODERA AVENAE

BY

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Cysts of Heterodera avenae produced on the early maturing barley cultivar 2137, matured sooner, and rate of hatching of the freed eggs was faster than from those produced on the later maturing barley cultivar Prior, suggesting that time of hatching is related to maturity of the host. Irrespective of the temperature at which eggs were produced, subsequent hatch was incomplete, and hatching extended over a longer period than that taken for egg production. There was some evidence of an interaction between the temperature at which eggs were produced and the temperature at which they were hatched, on the extent of dormancy.

By delaying the maturity of the host, rate of egg production was correspondingly slowed, but more eggs were eventually produced, indicating that rate of maturation of the host exerted a greater influence on total number of eggs produced by the female than did rate of egg production.

Females had the capacity to continue producing viable, fully-differentiated eggs after removal from the host but this capacity declined as they approached their maximum rate of egg production. More undeveloped eggs completed their differentiation within females removed from the host, than as freed eggs. It was essential for the female, however, to continue feeding in order for all eggs to develop and survive.

In South Australia, newly formed eggs of Heterodera avenae Wollenweber undergo a period of development (phase 1) of variable duration, which proceeds most rapidly at about 10° but will proceed more slowly at temperatures between 5° and 20° and which must be completed before hatching ensues (Banyer & Fisher, 1971b). This variable period results in a characteristic extended hatch. To assess this extended hatch, two parameters, time for 50% “total” hatch and percentage “total” hatch are necessary (Banyer & Fisher, 1971b). It is not known whether this extended hatch is due to differences in age of eggs, for they are produced over a period of 3-4 months, whether it is under genetic control, or whether it is dependent upon the effect of the environment on the individual egg.

The main aim of these investigations was to determine the underlying reasons for this extended hatch. They included studies on the influence of host and environment on rate of reproduction, duration of egg-laying, fecundity, embryonic development and survival of eggs. A comparative study of hatch from cysts produced in the laboratory and in the field was also undertaken.

MATERIAL AND METHODS FOR INFECTING HOSTS

Hosts used in decreasing order of time for maturity were, wheat (cv. Heron), barley (cv. Prior), and an earlier maturing barley cultivar, C.P.I.2137.

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Seeds were germinated on moist filter paper then transferred to pots containing a sterilised potting mix for 10 days to develop a healthy root system before replanting into thoroughly mixed infested field soil. After exposure to infection for 12 days, plants were removed and the roots thoroughly washed before replanting in batches of three, into 13 cm pots of sterilised potting mix. The pots were placed in a controlled environment growth cabinet at 20° with a 14-hour day length and soil moisture was adjusted to field capacity two to three times a week throughout. Adult females from surplus plants were checked regularly to determine the commencement of egg laying at which stage half the pots containing wheat or 2137 barley were moved to another growth cabinet with the same light conditions but a temperature of 12°.

EFFECT OF ENVIRONMENT ON EMBRYONIC DEVELOPMENT AND SURVIVAL OF EGGS

Materials and Methods

Previous observations showed that eggs which had not developed to the second larval stage when removed from a feeding female failed to survive in water. The following observations were made to ascertain whether eggs within the female could survive and complete embryonic development whilst the female was not feeding.

Females on Prior barley were sampled at about weekly intervals for the first three weeks of egg production and then less frequently until they died and became cysts. At each sampling time, all females were removed from the roots from one pot and divided into two equal batches. One batch was used to determine average egg content per female by dilution (Moriarty, 1963) and the number of eggs which had already hatched was assessed by counting empty eggshells. Four replicates of about 100 eggs (fewer in the first sample because of insufficient eggs) were examined to determine the proportion of normal and abnormal eggs. The same eggs were then incubated in water in glass staining-blocks (Goodey, 1963) at 20° for two months to record embryonic development, loss of viability and hatching. The second batch of females was incubated in water at 20° for two months to assess hatching and the females were then squashed to determine average egg content and the proportion of normal to abnormal eggs.

Results

Females at each sampling time were of similar size. After two months in water, abnormal eggs were easily distinguishable by their very dark and vacuolated appearance, and in some there were also signs of disintegration of the contents and shell.

While a female was feeding, eggs continued to develop to second-stage larvae (Table I). However when eggs not fully differentiated were removed from a feeding female, as many as 77% failed to develop fully and survive after two months free in water. Eggs that had already reached the second larval stage when removed from the feeding female, survived. Partially differentiated eggs survived