J.Biol.Control, 4 (2), 116-119, 1990

Studies on Drought Tolerance in the Water Hyacinth Weevils *Neochetina eichhorniae* and *N. bruchi* (Coleoptera : Curculionidae)

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ABSTRACT

Laboratory studies on drought tolerance in water hyacinth weevils *Neochetina eichhorniae* Warner and *N. bruchi* Hustache showed that the adults could survive for up to 48 and 28 days respectively under high humidity (95%) in the absence of food and water. When water alone was provided, they were able to survive for 56 and 82 days respectively. Preliminary studies showed that muscle development did not take place in starved adults, precluding ability for migration from dried up tank beds. The weevils can therefore be recommended for releases even in tanks that dry up during summer. Reintroduction may not be required as they probably survive during periods of drought by remaining below plant debris or within crevices in the soil and water may be available to them in the form of dew.

Key Words : *Neochetina eichhorniae, N. bruchi,* biological control, drought tolerance

The water hyacinth (*Eichhornia crassipes* (Mart.) Solms) which ranks among the ten worst weeds world-wide (Holm *et al.,* 1977) is the most serious aquatic weed in India. Successful biological control of this weed was achieved within 3-4 years in 6 tanks covering 1000 ha of water surface in and around Bangalore by releases of *Neochetina eichhorniae* Warner and *N. bruchi* Hustache (Coleoptera : Curculionidae) in 1984 (Jayanth, 1987). Observations carried out over the next 3 years indicated that the weevils were capable of maintaining weed densities below 5% level although fluctuations in weed cover ranging from 2 to 50% were noticed (Jayanth and Ganga Visalakshy, 1990).

During the field evaluation period, two of the above tanks, at Hebbal and Nagavara, dried up completely in mid-April 1986. However, the plants were observed to re-establish soon after commencement of rains in June due to germination of seeds, which are capable of remaining viable at tank bottoms for as long as 20 years (Gopal and Sharma, 1981). Surprisingly, up to 8 adults of *Neochetina* spp. (mean 3.8/plant) could be collected on the freshly emerging plants, although there were no water hyacinth infested tanks nearby. As DeLoach and Cordo (1976) had reported that adult emergence was possible from pupae that were in an advanced state of development, even when the root hairs with pupal cells were separated from the mother plant, the probable reason for the sudden increase in the insect population was suspected to be due to emergence of adults from such pupae, which might have remained dormant during the drought period.

In the semi-arid regions of India, water bodies generally dry up during summer, destroying water hyacinth plants also in the process. As the weed is capable of recolonization, the capacity of *Neochetina* spp. to survive in dry tank beds can help in the maintenance of biological control without resorting to costly reintroductions. Therefore laboratory studies

Contribution No. 118/90 of I.I.H.R. Bangalore.

were initiated to determine the stage, duration and mechanism of insect survival during periods of drought.

MATERIALS AND METHODS

Healthy water hyacinth roots containing unopened pupal cells of *Neochetina* spp. were collected from the field. One set of 100 pupae were placed over moist soil in a jar and covered by a thin layer of sediment, collected from the bottom of a tank used for maintaining water hyacinth plants, thus simulating a slowly drying tank where the roots will first be covered by silt. The second set of pupae (100 nos.) were kept over a layer of moist sand in a jar, indicating exposed roots. A third set of pupae left floating in a jar of water acted as control. Observations were made daily on emergence of adults.

Adults collected from the field were released at the rate of 25 in 5 separate clear plastic jars (11x4 cm) and subjected to treatments as follows. One of the jars was kept completely dry and dry water hyacinth leaves were provided in another. In the third treatment, high humidity (95%) was maintained by keeping a smaller container (6x6.5 cm) with water and covered over by wire mesh to prevent direct access to the insects. In the fourth treatment, water, in the form of a moist cotton swab, was provided to the insects. Insects released on water hyacinth leaves in a jar with water acted as control. The treatments were replicated four times.

All the above jars, with the exception of the high humidity treatment, were covered with lids having wiremesh windows for aeration. The container used for high humidity treatment was convered with an air-tight lid for maintaining R.H. However, the lid was opended daily for observations thus ventilating the container. Observations were made daily on adult mortality and the sex of the dead adult was also recorded. Observations were continued in the control batch as long as the experimental insects in the different treatments survived.

Studies were carried out separately with *N. eichhorniae* and *N. bruchi*. Preliminary observations were made on wing muscle development in starved insects to determine the flight capability. The above studies were carried out at 25 ± 2°C and 70-80% R.H.in the laboratory.

RESULTS AND DISCUSSION

Both *N. eichhorniae* and *N. bruchi* were found incapable of surviving more than 7 days

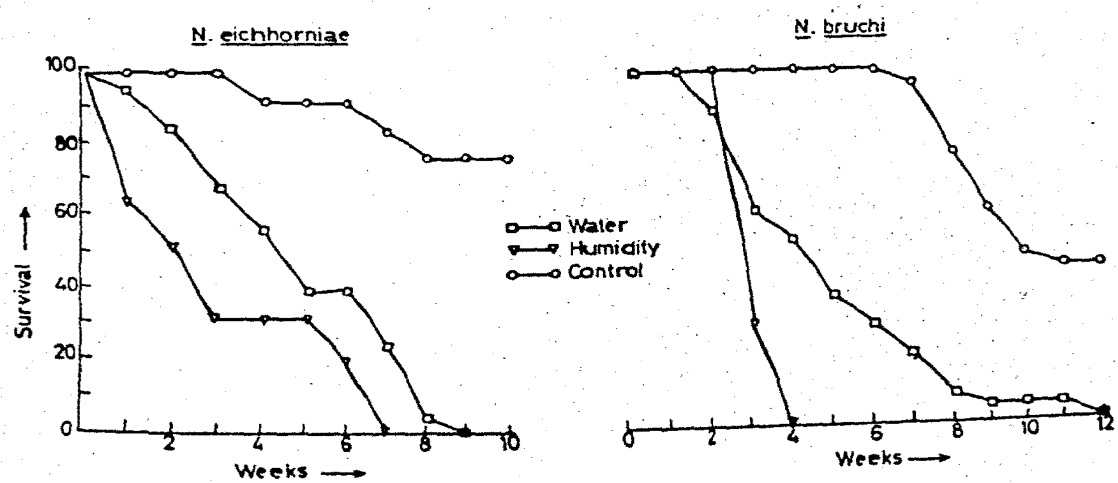

Fig 1. Survival of *Neochetina* spp. under high humidity with or without water

under drought conditions in the pupal stage. No significant differences in adult emergence were noticed in pupal cells buried in silt (11%), those left exposed over moist soil (10%) or the ones left floating in water (13%). As cocoons of unknown age were used, adult emergence could have occurred from pupae which were in an advanced state of development as reported by DeLoach and Cordo (1976). When pupal cells from which no adult emergence had taken place were dissected after two weeks, the pupae were found dead indicating that *Neochetina* spp. cannot tide over the dry season in the pupal stage as was suggested earlier (Jayanth, 1988). However, it is interesting to note that pupae in an advanced state of development can emerge even when water hyacinth roots were removed from water.

N. eichhorniae and *N. bruchi* adults could not survive for more than 3 days without food and high humidity. Similar results were obtained in treatment with dry leaves also. However, when the insects were released in jars in which high humidity (95%) was maintained, adults of *N. eichhorniae* were observed to survive for 48 days (7 weeks) and *N. bruchi* for 28 days (4 weeks) although water was not available to them (Fig. 1). The reduced survival rate of *N. bruchi* could be due to higher transpirational rates or structural or physiological differences like regulation of spiracular openings, relative wax effectiveness of the cuticle, etc., as observed in *Bembidion* sp. and *Asaphidin pallipes* (Duftschmid) (Coleoptera : Carabidae) which live in moist river beds (Anderson, 1985).

When adults of both the species were provided with water in the absence of food, *N. eichhorniae* survived for up to 56 days (9 weeks) and *N. bruchi* for 82 days (12 weeks). During the course of the study, only 34% of the adults of *N. eichhorniae* and 56% of *N. bruchi* in the control batch died. No significant difference in mortality between the sexes was observed in any of the above treatments.

Although *N. bruchi* survived significantly longer than *N. eichhorniae* in the treatment where only water was provided, 92% of the adults of the former were dead by the 8th week and 96% by the 9th week. The remaining 4% of the adults survived without further mortality for another 3 weeks. Studies by DeLoach and Cordo (1976) had shown that *N. bruchi* preferred low temperatures as compared to the preference of higher temperatures by *N. eichhorniae* in the range of 10° to 30°C. However, the present studies indicate that *N. bruchi* can do well under higher temperatures also.

In preliminary observations, no flight muscle development was noticed in starved adults belonging to both species indicating that the weevils may not be able to fly away from drought affected tanks. However, declining condition of water hyacinth plants caused by application of 2,4-D was reported to stimulate muscle development in newly emerging adults (Buckingham and Passoa, 1984). Therefore, some amount of migration can probably take place from drying plants also. But sufficient numbers of adults are likely to be left over in dry tank beds to act as a starter population when plants make their appearance once again after the rains.

The present studies indicate that *N. eichhorniae* and *N. bruchi* can survive for up to 2 months in dry tank beds, probably by hiding among plant debri, between cracks in the soil, etc. Water may be available to the beetles in the form of dew. However, it has not been possible to confirm the results obtained in the present study by actual field observations as the two tanks which had dried up in 1986 have remained full, due to the letting in of 5 million gallons of sewage water every day.

N. eichhorniae is reported to overwinter as larvae, pupae and adults in water hyacinth stands (Center and Balciunas, 1982). The weevils are unlikely to have encountered drought conditions in its range of natural distribution in *S. America*. Therefore, the capacity of the weevils to survive under drought conditions, observed under field conditions in Bangalore (Jayanth, 1988) and confirmed by the present studies is interesting. *N. eichhorniae* and *N. bruchi* can therefore be released for bilogical control of water hyacinth even in water bodies that dry up during summer months, which is a common phenomenon in many parts of India.

ACKNOWLEDGEMENTS

The authors are grateful to the Director IIHR, Bangalore for facilities provided and to Mr.N. Chandrasekhar for technical assistance.

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