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OPTIMUM MOISTURE AND DEPTH LEVEL IN FINE VERMICULITE FOR PUPATION OF ORIENTAL FRUIT FLY, *DACUS DORSALIS* HENDEL *(DIPTERA: TEPHRITIDAE)**

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Studies were conducted to determine an optimum moisture and depth level for pupation of *Dacus dorsalis* Hendel in fine vermiculite at 0, 10, 20 and 40% moisture and 1.2, 2.4 and 3.6 cm depth levels. It was found that pupation was significantly affected at all levels of moisture and depth. Adult emergence was not significantly different at various moisture levels, however, it was significantly higher at deeper depth level. On the basis of per cent mean pupation and adult emergence 10% moisture at 3.6 cm depth was recorded as an optimum level for pupation of this species in fine vermiculite.

INTRODUCTION

Several factors such as type of substrate, texture, temperature and soil moisture determine the depth of pupation in the olive fruit fly, *Dacus oleae* (Gmelin)[1,2]. Once the larva drops to the soil it searches for a suitable pupation site. Most of the larvae pupate in 5 to 10 cm of soil[1,3]. Depth of pupation seems to be influenced by soil moisture in *D. oleae*[1] and also diet moisture in *Ceratitis capitata* [4].

Several tephritid species pupate in the soil in shallow depths [5].. Delmas and Thermes[6] found that *C. capitata* pupated almost within 5 cm in the soil. Cavalloro and Delrio[1,4] and Tsitsipis and Papanicolaou[2] reported similar results in *D. oleae.*

Tsitsipis[7] found that larvae of *D. oleae* would enter moist sawdust and pupate inside it, while in dry or less moist sawdust most would pupate on the surface. Tsitsipis and Papanicolaou[2] correlated depth of pupation with sawdust moisture content and recorded that the wetter the sawdust, the shallower the depth of pupation.

In oriental fruit fly, *Dacus dorsalis* Hendel, the response of larvae to moisture and depth for pupation in fine vermiculite has not been reported. The present studies were, therefore, initiated to determine an optimum level of moisture and depth for pupation of this species in vermiculite.

MATERIALS AND METHODS

The culture of oriental fruit fly, *Dacus dorsalis* was maintained on an artificial diet by the method of Tanaka *et al.*[8]. One ½ litre of dry fine vermiculite was measured with a graduated glass cylinder and placed in one-gallon plastic containers. Four such containers were prepared with vermiculite. To each container water was added by volume per moisture treatment formulation as 0 (dry), 10, 20 and 40% and mixed thoroughly by hand. A total of 24 plastic cups, each of 450 ml capacity, were then marked at 1.2, 2.4 and 3.6 cm. depth levels. For each set of moisture treatment (0, 10, 20 and 40%), 80 ml of the water-vermiculite mixture was placed in the cup at each marked level of 1.2, 2.4 and 3.6 cm. depth, respectively. Thus each cup contained 80 x 3 = 240 ml mixture. All the three depth levels, being in one cup, were separated from one another by using 15-mesh fibre glass screen between the two layers. In this way each master treatment, comprising of one moisture and three depth levels, in the same cup, constituted a single set of experiment having four sub treatments. Four such sets were prepared, each replicated six times. Then ca. 10 ml of last instar larvae were measured in water in a graduated glass cylinder and poured into a 20-mesh hand sieve to leach water. The sieve was further gently pressed on a sponge so that any water contained with larvae was absorbed. The larvae were then transferred to each cup on the top layer from where they could pass easily through 15-mesh screen to the second and third layers at their choice for desired depth. The cups were covered with muslin cloth and secured with a rubber band. The cups containing the larvae were kept at an ambient temperature of 24-27°C and 75-80% R.H. After 4 days, the pupae were collected from

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respective depth levels by sifting the vermiculite through 20-mesh sieve and the number per level per treatment was recorded. For adult emergence, pupae were placed in paper bags, clipped and kept at the same ambient temperature and humidity conditions. Per cent adult emergence was recorded after 12-day of pupation by counting the uneclosed pupae. The data obtained was subjected to statistical analysis using analysis of variance and Duncan's New Multiple Range Test.

RESULT AND DISCUSSION

The results on the mean per cent pupation of *D. dorsalis* at various moisture and depth levels (Table - 1) indicate that pupation was significantly affected at all moisture and depth levels. Pupation at 3.6 cm depth was significantly better (P = 0.05) in 10, 20 and 0% moisture as compared to the other treatments. At 2.4 cm with 40% moisture, pupation was as good as 0 moisture at 3.6 cm . The pupal recovery in the remainder of the treatments was significantly lower and thus would not be useful for holding pupae. The results also show that significantly higher pupation was recorded at deeper depth levels in all the moisture treatments, except 40% where a maximum pupation of 51.0 ± 2.3% was recorded at 2.4 cm.

The results on the mean per cent adult emergence (Table - 2) show that the differences among the treatments i.e. moisture levels are not significant from one another, however, at various depth levels, they are significantly different but the statistical differences amongst th deeper depths viz: 2.4 and 3.6 cm are similar as revealed by DMR test.

The work regarding pupal distribution of various genera and species of fruit flies in different substrates and ecological conditions has been reported by many workers in the past[1-7] and [9-11]. However, the promising results of some of them briefly needs to be mentioned and discussed.

Table 1. Mean per cent pupation of *Dacus dorsalis* larvae at various moisture and depth levels in fine vermiculite (mean ± S.E.) a.b.

	% pupation at indicated depth levels		
% moisture	1.2 (cm)	2.4	3.6
0	17.5 ± 3.4 FG	21.0 ± 2.4 EFG	61.5 ± 5.2 BC
10	2.4 ± 0.2 H	25.7 ± 1.6 EF	71.9 ± 1.8 A
20	3.1 ± 0.2 H	28.3 ± 1.1 DE	68.6 ± 1.1 AB
40	14.1 ± 1.3 G	51.0 ± 2.3 C	34.9 ± 2.3 D

[a]Each value is a mean of 6 replicates. [b]Means followed by the same letter are not significantly different at 5% level of significance (Duncan's New Multiple Range Test).

Table 2. Mean per cent adult emergence of *Dacus dorsalis* pupated at various moisture and depth levels in fine vermiculite (mean ± S.E.) a,b.

	% adult emergence at indicated depth levels		
% moisture	1.2 (cm)	2.4	3.6
0	94.5 ± 1.5 A	98.8 ± 0.7 B	98.6 ± 0.3 B
10	97.7 ± 1.9 A	98.2 ± 0.6 B	98.8 ± 0.2 B
20	95.4 ± 2.3 A	99.4 ± 0.3 B	99.1 ± 0.4 B
40	96.1 ± 1.0 A	98.0 ± 0.4 B	97.8 ± 0.6 B

[a]Each value is a mean of 6 replicates. [b]Mean followed by the same letter are not significantly different at 5% level of Significance (Duncan's New Multiple Range Test).

Cavalloro and Delrio[4] believed that chemical factors did not have any influence on the depth of pupation. Their study revealed that the fruit fly *Ceratitis capitata* pupated deeper in cracked and dry soil than it did in wet soil. Shah *et al.* [9] found that in case of *Dacus* (Strumeta) *ferrugineus* Fabr, there was a variation in the depth of pupation in ploughed and unploughed soils. Similarly Ali Niazee[10] reported from a field study that cherry fruit fly pupae preferred to diapause within the top 10 cm. of soil depth. These results, irrespective of different experimental set up, procedure and species etc. are in agreement with our findings, because we also recorded significantly higher pupal recovery at deeper levels.

Ibrahim and Mohammad[11] studied pupal distribution of *Dacus dorsalis* and found that this insect prefers to pupate at 2 cm and 3 cm soil depth. We studied the pupation preference of the same species but in different substrate i.e. fine vermiculite and recorded maximum pupation at 2.4 and 3.6 cm. depth, almost the same depth levels as recorded by them. Therefore, our results are in close conformity with them so far the response of pupal distribution at deeper depths is concerned.

Moreover, we have found that pupation of *D. dorsalis* (in addition to being affected by various depth and moisture levels) also depend on the density of larvae per unit area of the substrate (unpublished data). It is also influenced by the size of the substrate particles. The coarser the particles, the deeper the penetration and pupation[2,4]. We obtained the same results using light-weight fine vermiculite.

Our findings of maximum pupation at deeper levels, except 40% at 3.6 cm, are in contrast to that of Tsitsipis and Papanicolaou [2] who determined shallower pupation in the wetter substrate. The reasons for this disagreement may be the different experimental design and environment (nature and texture of substrate, moisture, and depth levels), and even different insect species response.

On the basis of these results, 10% moisture at 3.6 cm depth is recommended as an optimum level for pupation of *D. dorsalis* in fine vermiculite.

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