

**EFFECT OF THREE FOOD PLANTS OF *ACYRTHOSIPHON PISUM* (HARRIS) (HEMIPTERA : APHIDIDAE) ON THE OFFSPRING SEX RATIO OF ITS PARASITOID *APHIDIUS ERVI* (HALIDAY) (HYMENOPTERA : BRACONIDAE : APHIDIINAE)**

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**ABSTRACT** : The sex-ratio of *Aphidius ervi* was found to be density dependent. It was observed that the sex ratio decreased with the increase of parasitoid density. The decrease in the sex ratio, i.e. production of more males than females, was maximum in the case of *Dolichos lablab*-bred aphids and minimum in *Pisum sativum*- bred aphids, while *Solanum tuberosum*- bred aphids occupied an intermediate position. The texture of leaf surface and possibly the allomones of food plants have been suggested as influencing the sex ratio. Results showed that to obtain maximum female progeny, a low release of parasitoids at any release site would be better. With increasing host density, the sex ratio of the parasitoid first of all increased and, thereafter, formed a plateau in the case of all the aphids bred on the three tested food plants. The non-linear correlation coefficient was found to be significant in the case of all the three tested food plants.

**KEY WORDS** : Parasitoid, sex ratio, food plants, intrinsic factor

## INTRODUCTION

A parasitoid's reproductive strategy should be based on optimal conditions for the exploitation of its host<sup>14</sup>. To achieve this one way is the control of the sex ratio in response to host cues<sup>2</sup>.

*Aphidius ervi* is a promising bioagent which has been well tested against a widely distributed aphid *Acyrtosiphon pisum* (Harris)<sup>12,13</sup>. *A. ervi* is an arrhenotokous-species i.e. mated females lay both haploid parthenogenetic, male-producing, and diploid, female producing eggs. The sex ratio is an important factor in the utilization of a parasitoid in biological control programmes because it is the female wasp which brings about parasitisation and death of the pest<sup>9</sup>. The effect of food plants on the sex ratio of *A. ervi* at different parasitoid and host densities is still unknown. The present investigation is aimed in this direction.

## MATERIALS AND METHODS

The parasitoids *A. ervi* and its host *A. pisum* were bred in the laboratory at 22-25°C and 60-75% RH13. Third instar aphid nymphs bred on *S. tuberosum* were transferred onto potted plants of *P. sativum* and *D. lablab* for rearing. Third instar nymphs (the stage most preferred by the parasitoid)<sup>14</sup> of the third generation were drawn from each of the three cultures and were utilized as hosts. One day old females, fed with 30% honey solutions, reared on the aphids bred on *P. sativum*, *S. tuberosum* and *D. lablab* plants, mated and experienced to oviposit in *A. pisum*<sup>17</sup> were used as parasitoids.

To study the role of each of the food plants on the sex ratio of *A. ervi*, two sets of experiments were performed. In the first set, 200 third instar *A. pisum*, drawn from their respective cultures, were placed on each of the trimmed leaves of *P. sativum*, *S. tuberosum* and *D. lablab* and were allowed to settle for half an hour. Leaves were trimmed to a diameter of 4 Cm. to keep the area of leaf constant for

each of the tested food plant. Thereafter, these leaves were placed individually in four market petri dishes (15 x 2 Cm.) with moistened filter paper in their bottom. One, two, four and eight female parasitoids were introduced as a group in the first, second, third and fourth petri dishes, respectively, and were allowed to attack the aphids for two hours. There were ten replicates of each treatment.

In the second set of experiments varying densities of aphid hosts (i.e. 5, 10, 25, 50, 100 and 200) were placed on equal size, trimmed leaves (4 Cm. diameter) of *P. sativum*, *S. tuberosum* and *D. lablab* and were allowed to settle for half an hour. These leaves were then placed individually in marked petri dishes as in the first set of experiment. One female parasitoid was introduced into each petri dish and allowed to attack the hosts for two hours. The experiment was replicated ten times.

After parasitization the aphids of each replicate of each treatment were gently transferred onto the fresh foliage of their respective potted plants with the help of a fine camel hair brush and were kept separately in insectaries<sup>16</sup> for further development. After mummification, the mummies, along with a part of food plant-leaf, were put singly in marked sterilized glass vials (2.5 x 10 Cm.). The mouths of the glass vials were kept plugged with sterilised cotton. These mummies were checked daily until the parasitoids emerged. Emergents were counted, sexed and the data were analysed statistically. The sex-ratio was calculated as a proportion of females in the population<sup>14</sup>.

## RESULTS AND DISCUSSION

Table 1 shows that as the parasitoid density increased the sex-ratio decreased in all aphids bred on the tested food plants (Table 1). This decrease was less on *P. sativum* bred aphids ( $r^2 = 0.96$ ,  $p < 0.001$ ), followed by *S. tuberosum* bred ( $r^2 = 0.96$ ,  $P < 0.001$ ) aphids and then *D. lablab* ( $r^2 = 0.99$ ,  $P < 0.001$ ) bred aphids.

As the host density was increased the sex-ratio of the parasitoid increased up to the host density of 100 and, thereafter, it tended to stabilise with a significant correlation in the case of all the aphids bred on the three tested food plants (The sex-ratio was maximum in the case of *P. sativum* ( $r^2 = 0.94$ ,  $P < 0.001$ ) followed by *S. tuberosum* ( $r^2 = 0.93$ ,  $P < 0.001$ ), and *D. lablab* ( $r^2 = 0.83$ ,  $P < 0.001$ ) bred aphids (Table 2).

The sex-ratio of the parasitoids is of great biological significance from the point of view of host suppression, i.e. the control of insect pests of the crops<sup>15,16</sup>. In the past<sup>3</sup> postulated a 0.5 sex ratio, i.e., 10:10 of the offspring for sexually reproducing organisms, which was based on the assumption that natural selection acts to ensure equal parental investment in the production of either sex. Previously it was also predicted on that equal number of males and females are found in the population of arrhenotokous species<sup>4</sup>. However, distinct variations in female-biased sex ratios have been reported<sup>7</sup>.

The results displayed in table 1 clearly indicate that in addition to several extrinsic and intrinsic factors food plants also influence the ability of females to lay fertilized eggs. They lay fertilized eggs when hosts are suitable while unfertilized eggs are deposited into unsuitable hosts.

The suitability of the host depends on its age (= size)<sup>2</sup>, shape and condition of the hosts (parasitized, probed or touched by the parasitoid) and host quality<sup>19</sup>. the parasitoid and host quality<sup>19</sup>. Because the host quality is influenced by food plants<sup>18</sup> hosts are differentially preferred by the parasitoid if they have fed on different food plants. Higher sex ratios on *P. sativum* and *S. tuberosum* show that these are suitable food plants for the parasitoid as far as the sex ratio of the the sex ratio as illustrated in table 1. The presence of volatile or contact chemicals (allomones) in varying quantities in the food plants,

**Table-1:** Effect of different food plants on the sex ratio of *Aphidius ervi* at four parasitoid densities. Each test utilized 200 *Acyrtosiphon pisum* bred on different food plants

Parasitoid density	Sex ratio of <i>Aphidius ervi</i>		
	<i>Pisum sativum</i>	<i>Solanum tuberosum</i>	<i>Dolichos lablab</i>
1	0.71 ± 0.05	0.65 ± 0.07	0.61 ± 0.08
2	0.63 ± 0.05	0.56 ± 0.06	0.51 ± 0.09
4	0.58 ± 0.06	0.52 ± 0.07	0.43 ± 0.07
8	0.56 ± 0.06	0.48 ± 0.06	0.39 ± 0.11
r <sup>2</sup> value	0.96	0.96	0.99
P	<0.001	<0.001	<0.001

**Table-2:** Effect of different food plants on the sex ratio of *Aphidius ervi* at six levels of host density with one searching female parasitoid

Parasitoid density	Sex ratio of <i>Aphidius ervi</i>		
	<i>Pisum sativum</i>	<i>Solanum tuberosum</i>	<i>Dolichos lablab</i>
5	0.26 ± 0.25	0.18 ± 0.21	0.17 ± 0.32
10	0.24 ± 0.05	0.23 ± 0.19	0.21 ± 0.22
25	0.38 ± 0.08	0.29 ± 0.07	0.23 ± 0.03
50	0.49 ± 0.14	0.40 ± 0.06	0.24 ± 0.05
100	0.66 ± 0.09	0.62 ± 0.06	0.56 ± 0.06
200	0.71 ± 0.05	0.65 ± 0.07	0.61 ± 0.08
r <sup>2</sup> value	0.94	0.93	0.83
P	<0.001	<0.001	<0.001

the kairomones of the host (plant chemicals may become kairomones in the phytophage-parasitoid interaction<sup>11</sup>) with a varying attractive potential for the parasitoid to the vicinity of host, or both, might be affecting the allocation of haplodiploid eggs among the hosts. The differences in plant semio-chemicals are responsible for variations in the levels of parasitisation<sup>1</sup> as a result of which the sex ratio is also affected. The hairs present on the leaf surfaces of the food plants obstruct the movement of parasitoids<sup>17,18</sup> and decrease its longevity<sup>8</sup>. Since the leaf surface of *P. sativum* is smooth, the oviposition success of parasitoid is maximum. The leaf surface of *S. tuberosum* has spiny, stout & sparse hairs, while the hairs present on the leaf surfaces of *D. lablab* are more spiny long & dense, which obstruct the movement of parasitoid, and thus host searching on these leaves become more difficult<sup>12</sup>. This interference results in the laying of more haploid eggs, thereby lowering the sex ratio<sup>14</sup>. Parasitoid density<sup>18</sup>, post copulatory period following insemination<sup>7</sup>, host density<sup>18</sup>, virility of males that inseminate the females, parasitoid species and nutrient sources<sup>5</sup> also affect the sex ratio of parasitoid. The decrease in the sex ratio with increasing parasitoid density in all the three tested food plant bred aphids, may be due to the lower mortality of male progeny in super-parasitised hosts and to a decrease in the proportion of diploid eggs laid, owing to physical and chemical interference phenomena. The haploid eggs are placed in

unpreferred hosts while diploid eggs are deposited in preferred ones<sup>6</sup>. Somehow many of the parasitoids are able to discriminate between the stung and the unstung hosts by detecting factors left behind by the previous parasitoid either externally or internally<sup>19</sup>. With a decrease in the number of hosts per female parasitoid the chances of contamination of the hosts by the parasitoid (by probing or even touching) increases, resulting in the deposition of more haploid eggs or a greater production of males. This is the reason why the sex ratio was very low when the parasitoid density was increased to eight. This may also have to occur due to strong mutual interference<sup>14</sup>. The increase in the sex ratio of the parasitoid with increasing host density (5 to 100 aphids) (Table 2) in case of all the three tested food plants can also be discussed on the basis of chances of host contamination. As the host density increases the chances of contamination of hosts by the parasitoid decreases, resulting in the deposition of more fertilized eggs or greater production of females. At the very high host densities (200 aphids) two factors operate simultaneously: (1) higher host densities increases the rate of parasitisation<sup>17</sup> and in the situation the parasitoids oviposit rapidly so that their spermathecal glands, the secretion of which is necessary to activate the sperms, are temporarily exhausted and they lay an increasing proportion of haploid male producing eggs<sup>10</sup>. (2) The chance of host contamination is less at higher host numbers resulting in more female progeny<sup>14</sup>. As a result, the sex ratio tended towards stabilization (Table 2). The

natural selection favours a mechanism that ensures the production of at least some males in facultative arrhenotokous wasp<sup>7</sup>.

From the present work, it can be inferred that for mass rearing of the parasitoid *A. ervi*, *P. Sativum* is an ideal food plant, as by using this food plant considerably number of female parasitoids can be obtained in the population. If *P. sativum* is not available then the next choice should be *S. tuberosum* plants. Further, it would seem advantageous to use comparatively smaller numbers of parasitoids at any given release site in order to reduce the effect of interference.

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