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EVALUATION OF TRAPPING METHODS OF OLIVE FRUIT FLY *DACUS OLEAE* (DIPTERA : TEPHRITIDAE) AND A STUDY OF ONE OF ITS PARASITOIDS

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SUMMARY

Field experiments were conducted at two locations , Baqa'a and Salt, to determine traps efficacy for capturing olive fruit flies. A successful attempt was done to design a new trap . At Baqa'a grove, nine treatments of traps and four replicates of each treatment were studied at approximately three hectars by using the completely randomized design. At Salt grove, similar treatments and replicates were studied at about the same area by using the randomized completely block design. Flight activity of the olive fruit fly was monitored at the two locations.

Fruit infestation was examined in the field . At Baqa'a grove , the examined cultivars were mostly used for pickling . At Salt grove, the cultivars were mostly used for milling to extract oil.

Female dissection and presence of mature eggs were carried out in the laboratory from Mcphail traps baited with protein hydrolysates or diammonium phosphate at Salt grove only .

The numbers and distribution of the parasitoid *Opius concolor* (Szepl.) during the season in the field were studied at the two locations .

Results of monthly caught flies showed that Mcphail trap baited with diammonium phosphate and yeast was the most effective from April to July at Baqa'a grove and from June to July at Salt grove . Pheromone trap was less efficient during the same periods. This was obvious in case of vertical yellow trap

baited 10 mg pheromone capsule. Twenty mg pheromone capsule baited vertical yellow trap was not placed during these previously mentioned periods. However , it gave significantly higher flies catches from August to end of December for the two locations. The two types of ovoid yellow traps were as effective as Mcphail traps with different baits for most of the periods . The vertical yellow trap without bait was found to be the least effective .

Vertical yellow trap baited with 10 mg pheromone or diammonium phosphate was the most effective in capturing fruit fly males, whereas Mcphail traps with different baits were the most effective in catching female flies. Vertical yellow trap baited diammonium phosphate was as effective as Mcphail trap with protein hydrolysate as a source of bait for total female captures . Ovoid yellow trap with bait gave encouraging results for total olive fruit fly male or female capture. It was as effective as Mcphail trap with protein hydrolysate as a source of bait. Vertical yellow trap without bait was the least effective in total males and females captures .

Higher numbers of male flies were captured in almost most trapping systems than females at both locations with the exception of Mcphail traps with either protein hydrolysate or diammonium phosphate as bait at Baqa'a grove .

No significant differences were found between ovoid yellow trap and the same trap with labaneh as bait for total male or female captures.

Vertical yellow trap baited 20 mg pheromone capsule caught male flies more than double than that of the same trap baited 10 mg pheromone capsule.

Mcphail trap with diammonium phosphate and yeast gave higher number of male and famale captures than those of the same trap baited protein hydrolysate or a mixture of protein hydrolysate and soluble pheromone at the two locations , although the differences were significant in case of the last mixture at Salt grove only. Mcphail trap with protein hydrolysate gave higher number of male and female cuptures than that of the same trap baited a mixture of protein hydrolysate and soluble pheromone at the two locations , although the differences were not significant .

The main flight activity periods for the olive fruit fly were from late July to mid-December at Baqa'a grove and from June to end of November at Salt grove. Three flight activity periods, representing three generations were recorded at the two locations . At Baqa'a grove, the first flight activity period was between late of July and end of August. The second flight activity period was between Septemeber and October . The third flight activity period was between November and mid - December. The highest captured number of olive fruit fly males and females were recorded during October . At Salt grove, the first flight activity period was between June and July. The second flight activity period was between August and early September . The third flight activity period was between mid-September and end of October . The highest captured number was recorded during August .

Fruit infestation showed that all the studied cultivars were susceptable to attack, but Nasouhi cultivar at Baqa'a grove and Nabali cultivar at Salt grove were the least ; it reached 29 and 22%, respectively . The cultivars Ascolano, Rase'e,

Shami and Souri were more susceptable to infestation attack. Infestation reached 48, 43, 40 and 40% , respectively .

Females dissection showed three peaks of mature eggs recorded between July and end of November. The first peak was in mid-July . The second peak was in late August . The third peak was in late October . Number of mature eggs during these periods were 13 , 9 and 7.5, respectively .

The parasitoid *Opius concolor* (Szepl.) was most abundant during September in both locations . Data from field observations showed that this parasitoid was also active from September toward the end of the season . This activity was not clear because parasitized larvae pupated in the soil .

INTRODUCTION

1. INTRODUCTION

The olive tree *Olea europaea* L. , is one of the most important economic fruit trees in the Mediterranean region . It is an ancient culture in the Mediterranean Basin , especially in Syria and Crete (Neuenschwander *et al.*, 1985) . Over the recent decades cultivation of olive trees extended throughout Australia , India , South Africa , North and South America . This wide distribution was due to the exceptional producing capacity of olive tree under different natural conditions that no other fruit tree can compete with (Abu-Yaman, 1963). In Jordan , cultivated area is increasing annually because of the need for olive products is increasing year after year . In 1982 , the number of olive trees was about 3 million trees cultivated in an area of about 26 thousand hectars , producing about 43 thousand tons of fruit . In 1990 , the number increased to 4.1 million trees in 36.5 thousand hectars , producing 63.7 thousand tons . Despite the large increase in the total cultivated area that reached about 60% of the total planted area of fruit trees and the increase in olive production , the importation of olive oil in Jordan by 1990 reached 4990 tons (Annual Agricultural Statistics 1982 and 1990) .

Throughout most of the Mediterranean Basin where almost of the world olive oil is produced *Dacus oleae* (Gmel.) is considered the most serious insect pest of olives (Neuenschwander & Michelakis , 1978) . In Greece, the Department of Agriculture estimated the total loss caused by olive fruit fly around 40 -50% in the years of heavy infestation (Haniotakis , 1981) . In Libya , the loss caused by the

olive fruit fly was generally estimated at 50 % of the crop as cited by Sharaf, (1980) . In Jordan , Abu-Yaman (1963) estimated the losses to be 50% of the yield . The infestation was widely distributed in Jordan , reaching high percentage in the main olive growing region . It was more than 45% in Irbid , Jubeiha and Salt (Al-Zaghal & Mustafa , 1987 a) .

It is generally agreed that the complexity of problems caused by the enemies of modern agriculture can be met only by an equally complex strategy (Economopoulos *et al.*, 1977) . There is no single method able to satisfy our needs at present e.g. quantity , quality , without chronic effects , minimized pollution and environmental hazard , biological balance etc. The most recent trend depends on the use of combination of several methods for best results . Alternative methods to chemical control of olive fruit fly have been tried by entomologists in all interested countries (Economopoulos , 1979 ; Haniotakis , 1982) . The discovery of visual and sex attractants for this pest as well as the development of slow release formulation for odor-food attractants have stimulated researchers toward the development of traps for olive fly control (Boller , 1982) . Efficient trapping is an important method in integrated insect pest control programme , for population monitoring or mass trapping control . However , several trapping systems based on different lure have been developed (Economopoulos , 1986) .

The main objective of the coordinated activity reported here below was to compare the most promising traps . An attempt was made to develop a new low cost , simple to handle and easy to combine colour and odor attractant type of trap .

Flight activity was studied separately by each of the traps used for efficacy comparison . In addition , fruit infestation was studied for different cultivars planted in Jordan to have more evidence and to clarify the real size of the problem caused by olive fruit fly . Because egg production is an important feature of an insect reproductive biology , as well as timing control application is based today on a number of parameters , such as the presence of mature eggs in female flies . Female dissection for the presence , number and distribution of mature eggs was studied.

It has been reported that the parasitoid *Opius concolor* was the most abundant on olive fruit flies in Jordan (Mustafa & Al-Zaghal , 1987) . This parasitoid status was monitored in order to have an idea about its implementation as a biological control agent in the future .

LITERATURE REVIEW

II - LITERATURE REVIEW

II.1. Olive Fruit Fly As A Species :

The olive fruit fly *Dacus oleae* (Gmel.) , belongs to the family Tephritidae which contains about 4000 species . Members of this family are destructive insect pests of fruit . The olive fruit fly which is the most destructive insect pest of olive , is distributed in the Mediterranean basin , Northern , Eastern and Southern Africa , Canary Islands , India and Western Asia (Christenson & Foote , 1960) .

II.1.a External description :

The adult is small in size, it is 5 mm long and chestnut yellow in colour (plate 1) . Head is as broad or / broader than thorax , light chestnut in colour , eyes large with green - purple metalic sheen , antenna as long as head and chestnut brown (Talhouk , 1969 ; Mustafa & Al-Momani , 1990) . Dorsum of thorax is grey with longitudinal stripes , sternum brown , legs light walnut colour (Avidov & Harpaz , 1969 ; Talhouk , 1969) . Dorsal surface of abdomen is light chestnut -red , usually with 3 black variably sized spots . Wings are hyaline , bearing a conspicuous brown pterostigma and light brown veines (Talhouk , 1969) .

Eggs are cylindrical and elongated , milky white , measurements 0.75-0.80 and 0.17-0.18 mm with micropyle at one end (Avidov & Harpaz , 1969 ; Talhouk , 1969) .

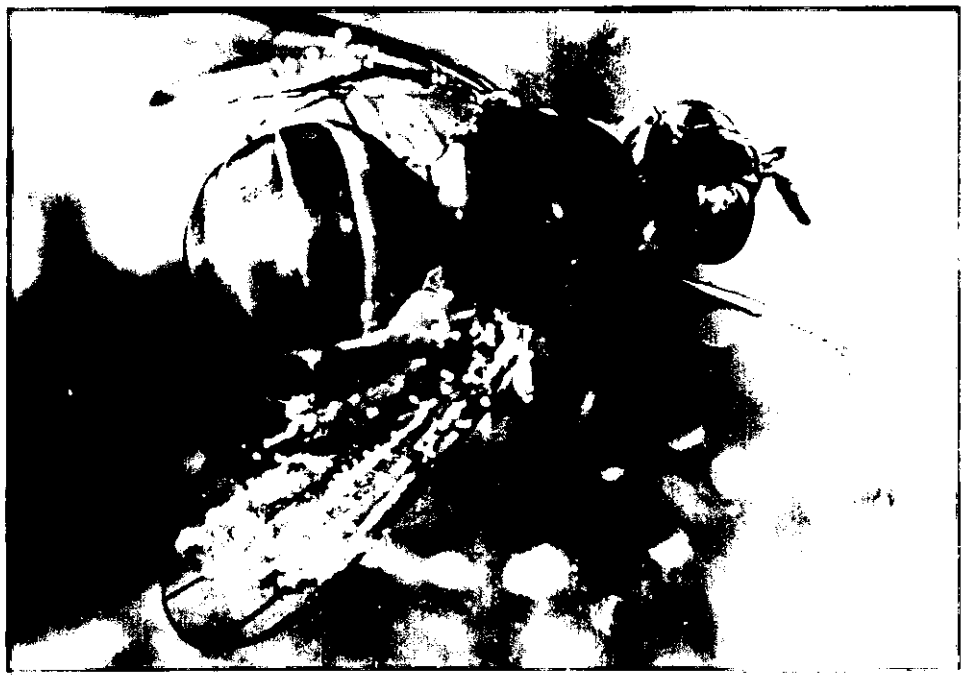

Plate 1 : Adult of olive fruit fly

Larva is elongated and conical in shape, whitish . It has three larval instars, final length is 7 - 8 mm . The anterior part of the body tapers to a point (Avidov & Harpaz , 1969 ; Talhouk , 1969) . Pupa is enclosed in yellow brown puparium , measurs 4 x 2 mm (Avidov & Harpaz , 1969 ; Talhouk , 1969) .

II.1.b. Life history:

Sharaf (1980) indicated that overwintering may take place as larval , pupal and adult stage . Overwintering flies congregated where shelter and food , mostly beneath fallen leaves . Talhouk (1969) stated that olive fruit fly seems to have no obligatory period of diapause during the winter season . In Libya , Sharaf (1980) stated that individuals overwintered in the adult stage were responsible for the first attack of young olive fruits in early June .

Adults of olive fruit fly required a preoviposition period of 2-5 days (Avidov & Harpaz , 1969) . Occasionally the fly made numerous punctures without oviposition . These were feeding punctures from which the fly imbibes the exuding juices . The number of these feeding punctures were lowest in early summer and reached a peak during the hot months of summer (Avidov & Harpaz , 1969 ; Sharaf , 1980) . In various studies , 150 - 200 eggs were found to be laid by a single female in Syria and Libanon (Talhouk , 1969) , 200 - 250 eggs in Jordan and Libya (Abu- Yaman , 1963 ; Sharaf , 1980) . Flies mated for the first time when they were 5-6 days old . This mating was repeated frequently in the course of about one month (Fornasari , 1985) . He added that oviposition occurred during

day time, but prevailingly in the morning , as female began to make sterile bites when they were about 5 days old and after 3 days they start to make fertile bites . Feeding or sterile punctures were grey in colour , while oviposition puncture turned slightly bluesh and sank little below the skin surface (Sharaf , 1980) .

Larva passes three larval instars in 18 - 20 days to complete its development. In fact , duration of larval growth varies inversely with temperature . It extends from 2-3 weeks in summer to about 4 weeks or longer in autumn (Talhouk, 1969) .

Pupation takes place either in the fruit early in the summer or in the soil during the later part of the season (Mustafa & Al-Momani , 1990 ; Sharaf , 1980 ; Talhouk , 1969) . Pupa and empty puparia were found in depth ranging from 2.5-7.5 cm in the field under olive trees (Al-Zaghal & Mustafa , 1987 b) . The length of pupation depends mainly on temperature . At 26 °C adult emerges about 10 days after pupation , while at 14 °C it needs about 70 days (Avidov & Harpaz , 1969) . In Libya , adult emerges about 8-10 days after pupation in summer (Sharaf , 1980). The duration of one generation in Jordan was 35 - 40 days in summer (Abu-Yaman , 1963) , while in Libya was 30 - 35 days (Sharaf , 1980) .

II.1.c. Generations :

The number of generations per year varies from region to region . In Jordan and West Bank , there are 3 generations . The first generation began to appear in

the 2nd half of June , the second generation at the 2nd half of August , and the third generation at the second half of October (Abu-Yaman , 1963) . Similar results were recorded in Jordan by Sodah and Abu-Hassan (1985) . Al-Zaghal and Mustafa (1986) reported five periods of flight activity . The first two small periods were between mid-March and mid-April , and between mid-June and early July . The third period occurred between mid-August and mid-September . The fourth period was in early October , while the fifth period was between end of October and mid-November . In Palestine coastal region , 4 generations were produced a year (Avidov & Harpaz , 1969) . In Syria and Labanon 4-5 generations (Talhouk , 1969 ; Hariri , 1981) , in Libya 4 generations (Sharaf , 1980) , in Greece 4-5 generations (McFadden *et al.*, 1977) and in Italy 4 generations (Delrio & Cavalloro , 1977) .

II.1.d. Hosts :

The oilve fruit fly is a monophagous insect . The only larval host is being olive (Prokopy & Haniotakis , 1975) . *Olea spp* are apparently the primary host of olive fruit fly where larva lives and develops . *Olea europaea* is the host of the olive fruit flies found in the Mediterranean countries , *O. chrysophylla* , *O. verrucosa* in Africa and *O. capsidata* in Asia (Avidov & Harpaz , 1969) . In addition , fruit of wild olive trees (oleasters) are important primary hosts . Their fruits are attacked later in the season (Neuenschwander *et al.*, 1983) .

As secondary hosts , adults of olive fruit fly were trapped in walnut , cherry ,

apple , chestnut , arbutus and vine orchards (Economopoulos *et al.*, 1982) . Juices and nectars of flowering plants as will as homopteran honeydew constituted great part of the food sources of the overwintering adult flies (Sharaf , 1980). Larvae of olive fruit fly were successfuly reared on artificial diet containing water , cellulose , brewers yeast , soy hydrolyzate enzymatic , sucrose , olive oil , potassium sorbate, Tween 80 , Nipagin and HCL (Tsitsipis , 1977) .

II.1.e . Dispersal activity :

Two types of adult movement are discernible in natural population of fruit flies . The first is characteristic of individuals that inhabit an area where ample host fruits available for oviposition . Movements of adults in this case are associated with feeding , oviposition and mating . This movement is called nondispersive (Bateman , 1972) . The second type of movement is called dispersive , as the adults tend to move frequently and their direction may be oriented by the wind (Bateman , 1972) .

Olive fruit fly moves little from one tree to another . In fact , under certain conditions they hesitate to leave the contiguous canopy of olive tree (Neuenschwander , 1982) . It has been reported that the 1,300 or 2,000 m of olive tree space is not adequate for complete isolation , despite the immigration of even a very small numbers of wild - reared flies (Economopoulos *et al.*, 1978) . They added that wild flies possess greater flight ability than artificially - reared ones over long distances . In addition , Economopoulos *et al* (1977) reported that femals

possess an innate potential for long distance dispersal and dispersed at a more rapid rate than males , Fletcher and Kapatos (1981) added that the dispersal rate was 400 m per week when no new season fruit crop , while dispersal rates was 180 m per week when 30% of trees bearing fruit crop . Economopoulos *et al* (1978) reported that flies were trapped at distance of 2-4 km from the release site . While Michelakis and Neuenschwander (1981) reported that since no mass migration of olive fly were found , the population fluctuation in olive groves is not directly influenced by the immigarting flies .

II.2. Abiotic Factors Affecting Survival and Development :

No single environmental component stands out as a determinant of abundance of universal imprtance . The principal components of the life system of tephritids are temperature , moisture , light , food , and natural enemies (Bateman , 1972) .

II.2.1. Temperature :

Temperature is an important environmental factor that affects survival and rate of development , (Tsitsipis , 1980) .

1.2.1.a. Flight activity :

Avidov and Harpaz (1969) revealed that flies stay motionless at 16°C . When the temperature rose above 20°C and reached 23°C , flies began to move

about . The activity was greatest at 28°C , but above 29°C the flies become frenzied and take wing . As temperature approached 35 °C in the early afternoon most of the flies became motionless (Avidov & Harpaz , 1969) . The lower thermal threshold in Greece for flight activity was 12-14 °C (Neuenschwander & Michelakis 1979) . However , temperature between 2 and 20°C , 9°C in the average did not allow much activity (Economopoulos *et al.*, 1982) .

II.2.1.b. Adult longevity and fecundity :

Adult longevity and fecundity depend mainly on temperature and quality of food . Adult lives about 20 days at 28 °C and about 100 days at 16°C when they feed on rich artificial diet (Avidov & Harpaz , 1969) . Female laid an average of 44 eggs at 23°C when they recieved sugar and water only , but when yeast plus yeast hydrolysate were added , oviposition rose to 522 eggs at the same temperature (Avidov & Harpaz , 1969) . Adult of olive fruit fly lives for 3-8 weeks in summer (Abu-Yaman , 1963) . It has been reported that small numbers of overwintering adults died by low temperature (Sharaf , 1980) . Fletcher and Zervas (1977) concluded that olive fruit fly should cope with both large seasonal changes and wide daily fluctuation in temperatures e.g. 0 to 26°C in 24 hours .

Ovarian maturation depends on temperature also . Fletcher *et al* (1978) reported that at 23 °C all females were able to complete ovarian maturation regardless of whether they had access to olive fruits or not (R. H. = 45 $\pm$ 5 %) .

They added that high temperature 26-29°C in conjunction with low humidity 45±5% inhibited ovarian maturation .

II.2.1.c. Egg , larval and pupal development :

Constant temperature in the range of 12.5 - 30°C allowed larval and pupal development in *Dacus oleae* . Larval development ranged from 37.1 to 9.2 days and pupal development from 48.6 to 9.3 days on the previous two temperatures, respectively (Tsitsipis , 1980) . Temperatures between 20 - 25°C were the most suitable for egg incubation , while at 8 and 35°C hatchability was zero (Tsiropoulos , 1972) . Other reports cited by Tsiropoulos (1972) revealed 100% mortality in eggs and larvae after 15 days at 5 ± 1 °C . On the other hand , Pucci (1982) indicated that when the maximum temperature over a week reached 36 °C, the expected death rate was over 85 % for egg and first instar larvae and about 95 % for second and third instar larvae . In addition , 100% mortality was recorded at a minimum weekly temperature of -10°C (Pucci , 1982) . Pupae incubated at 11 °C soon after pupation , remained 69 days before the first adult emerged (Tsiropoulos, 1972). Pupation inside the fruit depends strongly on temperature , for example , at 36 °C 100 % of pupation was inside the fruit (Pucci , 1982) . The duration of development of egg and maggot together was dependent upon temperature , at 26 °C development lasted for about 11 days , and at 14 °C approximately 45 days (Avidov & Harpaz , 1969) .

II.2.2. Soil Inundation :

Larvae of fruit flies enter the soil soon after they leave the fruit in late summer or autumn and pupate within few days (Al-Zaghal & Mustafa , 1987 b ; Mustafa & Al-momani , 1990) . Water treatment of third instar larvae for 6 hours produced massive increase in mortality (Neuenschwander *et al.*, 1981 b) . No pupation was ever observed as long as the larvae was submerged , but puparia were found sometimes more than a day after the water had been removed (Neuenschwander *et al.*, 1981 b). Mortality of young pupae increased considerably when they were submerged for more than one day (Neuenschwander *et al.*, 1981 b) . Middle aged pupae exhibited an increase in mortality following more than two days inundation . Longer water treatment proved fatal even to old pupae . They added that out of 180 pupae placed at 1 cm depth in saturated soil for one month , only one adult emerged (Neuenschwander *et al.*, 1981 b) .

II.2.3. Light :

Light has an extremely important effect on fecundity of fruit flies , but has less direct effect on the rate of development and mortality (Bateman , 1972) . It affects fecundity in two main ways : first , by influencing the general activity of adult female especially feeding and ovipositional activity ; second , by its important role in synchronization of mating behaviour (Bateman , 1972) . He added that females olive fruit fly kept in bright light laid about six times as many eggs as those kept in the same room but in relatively dull light . Fornasri (1985) found that the maximum

number of matings occurred at 7 p.m., low numbers of mating occurred after the sun set , while in darkness did not happen any mating . However , copulation was never observed in the morning or at other time of the day (Fornasari , 1985) . It has been reported that the preferential attraction of olive flies in the Western located trap may indicate attraction to the sunny part of the tree (Economopoulos , 1977) . On the other hand Prokopy *et al* (1975) concluded that the olive fly was particularly attracted toward yellow colours that reflect highest amount of light between 520 - 580 nm and little below 520 nm .

II.2.4. Food :

Adult fruit fly has been reported feeding on a variety of nutrient sources such as honeydews , pollen , flower nectar , plant sap , juices and tissues of damaged or decaying fruit (Christenson & Foote , 1960) . Sharaf (1980) reported that juices and nectars of flowering plants as will as honeydew constitues a great part of the food sources of olive fruit fly .

Studies on the effect of pollen and honeydews on adult survival , preoviposition period, fecundity and fertility revealed that the shortest life span was recorded by the flies feeding on the sucrose solution , while the longest by the flies feeding on *Olea europaea* pollen 10% in 20 % sucrose syrupe (Tisropoulos , 1977) . He added that honeydew supported a good percent of hatchability . On other experiments , Tzanakakis *et al* (1967) concluded the nutritive value of the enzymatic hydrolysates as a source of essential dietary element other than sugar.

On the other hand , Tsiropoulos (1980) reported that for satisfactory survival of adult , the most important ingredient was sucrose. Two eggs were produced per female per day on a sucrose solution , but the addition of vitamines increased fecundity on diets containing sucrose , amino acids and minerals to 11 - 12 eggs / female per day . The same author (1983) reported that survival of the male flies was significantly shortened when the amino acids alanine , hydroxyproline and tryptophane were excluded , while threonine omission caused the highest drop in egg production .

Larvae of olive fruit fly in nature feeds exclusively in the olive fruit mesocarp and the softening of the fruits caused by the fungal invasion might facilitate the nutrition of the larvae (Sharkas & Tolba , 1974) .

II.3. Fruit Infestation :

Olive fruit flies recognize their only known host plant , the olive tree , from a distance by the colour of its foliage . Leaf pattern and leaf or fruit odor were not found to be utilized for that purpose (Prokopy & Haniotakis , 1975) . After arriving on the host tree , females locate individual fruits not by odor but solely by visual characters , in particular fruit shape , colour and size , and after arriving on a fruit some chemo or physico-tactile cues which enable flies to distinguish suitable oviposition sites (Prokopy & Haniotakis , 1976) . Female uses its pointed ovipositor to puncture the olive fruit and lays a single egg in the 1 mm deep cavity . Occasionally the fly makes numerous punctures without oviposition ; these are

feeding punctures from which the fly imbibes the exuding juice . In some cases , however, 5-6 eggs or larvae are found in one fruit , but this number is laid by identical number of females (Abu- Yaman , 1963 ; Avidov & Harpaz , 1969 ; Talhouk , 1969 ; Sharaf , 1980) .

II.3.1. Fruit drop :

Fruit drop is the consequence of a reduction in the force of attachment of olives to their petioles. As the olives ripen , their attachment becomes weaker due to the growth of an abscission layer as cited by Neuenschwander and Michelakis (1981) . However , attacked olives earlier in the season drop and lost from harvest . This type of damage is generally considered to be the most important as cited by Neuenschwander and Michelakis (1981) . The rate at which infested olives drop was related to the developmental stage of *Dacus oleae* larvae and to natural fruit abscission , while the influence of the infestation on fruit drop therefore depends on the time of attack and on eggs and larval mortality (Neuenschwander & Michelakis , 1981) . Females early in the season choose the larger fruit for oviposition , later in the season, perferrence shifts to less ripe olives where eggs and young larvae cause less fruit drop than old larvae (Kapatos *et al.*, 1977 a) . Experiments on the rate at which infested fruits drop revealed that olive with exit holes dropped at a rate of 2.5 and 3.3 times higher than those containing a larva in the Greece koroneiki and Tsounati cultivars, respectively and that from summer up to harvest . Olives containing dead larvae dropped at double the rate of uninfested

ones (Neuenschwander & Michelakis , 1981) .

II.3.2. Influence on yield and quality of olives :

Females of olive fruit fly insert their eggs in the fruits using the ovipositor for puncturing . The hatching larvae bore small feeding tunnels in the olive fruit causing several kinds of damage (Mustafa *et al.*, 1987) . In Greece , it was found that *Dacus oleae* larvae consumes about 50 mg of fresh pulp in Tsounati cultivar which corresponds to an oil reduction of about 3 % , while in the smaller Koroneiki cultivar consumption is estimated to be about 150 mg , leading to a 20 % reduction in oil quantity (Neuenschwander & Michelakis , 1978) . They added that fruit with exit holes showed an increase in the acidity . It increased four - folds in the Tsounati and two - folds in the Koroneiki cultivars .

In Jordan , Mustafa *et al* (1987) studied the influence of infestation by olive fruit fly on the water and fat contents as well as the acidity on the Shami , Kheli and Rasee cultivars . They found that there were no significant differences in water content between healthy and infested fruits except in Kheli and Rasee in late September . Similar trend were found in oil content as no significant differences were found among healthy and infested fruits except in Shami in late September and Rasee in mid and late October . In contrast , oil extracted from the infested fruits had significantly higher acidity than oil extracted from healthy fruits (Mustafa et al., 1987) . Acidity increased as a result of invading fungi and bacteria in the proccess of oviposition as well as when the maggot leaves the fruit to pupate

(Talhouk , 1969 ; Sharaf , 1980) . It was found that invading fungi often decreased the amount of carbohydrates , total nitrogen and fat content of infested fruits (Sharkas & Tolba , 1974) .

II. 3.3. Factors affecting cultivar susceptibility :

Factors influencing susceptibility are size of olive fruit , hardness of epicarp , colour and chemical factors (Neuenschwander *et al.*, 1985) . Olives become suitable for oviposition when they reach pea size (Sharaf, 1980) . Others reported that susceptibility of olives to attack by olive fruit fly increased with the size of the fruits up to a limit of 3.5 gm (Neuenschwader *et al.*, 1985) . Preferrence of infestation was more marked in the case of smaller oil olive cultivars as Koroneiki and Tsounati which were nearer the critical size than for the larger table cultivars as Manaki and Gordal (Neuenschwander *et al.*, 1985) . In contrast , Neuenschwander *et al* (1985) cited that females usually prefer the larger and heavier olives . On the other hand , Neuenschwander *et al.*, (1985) reported that susceptibility of unripe green olives of higher weights remained roughly at the same level , while in overripe black ones it declined .

It has been reported that only old and weak females made several attempts to penetrate the epicarps at the softest fruits , while vigorous females invariably choose the exact oviposition site without prior attempts at stinging (Neuenschwander *et al.*, 1985 ; Haniotakis & Voyadjoglou , 1978) .

Black olives were significantly less attacked than either green or rose

coloured ones , while green olives were preferred over rose - coloured ones (Neuenschwander *et al.*, 1985) . Two categories of chemical factors influence host seeking and acceptance were reported . These are attractants and deterrents (Neuenschwander *et al.*, 1985) . Attraction is attributed to the aglycone of oleoeuropine , atriterpene and more specifically to spontaneously produced volatile breakdown products (Girolami *et al.*, 1981) . On the other hand , following ovipostion the female drags its ovipositor over the olive , thereby smearing the surface with olive juice and making it unattractive for oviposition by other females . This behaviour increases dispersal of eggs among suitable olives (Cirio , 1971) . The principal deterrent stimuli are present in the oil fraction . These stimuli are likely to be acetophenone and benzaldehyde (Girolami *et al.*, 1981) . It has been reported that chemical stimuli have the greatest effect as up to 100% inhibition of oviposition can be obtained with unsuitable chemical properties of the fruit surface (Haniotakis & Voyadjoglou , 1978) . These chemical stimuli are percieved by antennal and tarsal receptors . Neuenschwander *et al* (1985) reported that if the fruit wax layer was removed by rubbing , washing with detergent and finally with alcohol , the olives became progressively more attractive .

II. 3.4. Cultivars planted in Jordan :

Al-Zaghal and Mustafa (1987 a) reported that Shami cultivar was the first to be attacked in Baqa'a area . It was more heavily infested than the other cultivars during June , while no significant differences in the infestation level among

Ascolano , Santa , Nasohe and Rase'e cultivars . Kheli and Naball cultivars were significantly the lowest . They added that the infestation rate for the whole season was : Santa > Shami = Ascolano > Rase'e = Kheli >> Nabali .

1.4. Traps :

For population monitoring or control of the olive fruit fly , several trapping systems based on different lures have been developed . They are distinguished to colour traps , food odor traps , sex odor traps and lure combination traps (Economopoulos , 1986) .

II.4.1. Colour traps :

Yellow sticky traps have been used for mointoring (Prokopy *et al.*, 1975 ; Orphanidis & Soultanopoulos , 1962) and control (Economopoulos , 1977) of the olive fruit fly . Yellow or orange colour did not confer a higher specificity of the traps (Neuenschwander , 1982) . He added that gray shades attracted both sexes of olive fly almost equally , where as yellow was especially attractive to male . Girolami and Cavalloro (1973) reported that flourescent yellow traps attracted more olive flies than orange , red , green , blue , and white traps . Similar result was reported by Prokopy *et al* (1975) . While Neuenschwander (1982) cited that in large scale investigation in which exactly the same traps were used , *Dacus oleae* showed no clear preferrence .

II.4.2. Food odor traps:

Mcphail traps baited with ammonium salt or protein hydrolysates have been used extensively to monitor population of olive fruit fly (McFadden *et al.*, 1977) and measuring dispersal activity (Fletcher & Kapatos , 1981) . Timing the first control application is based on number of parameters such as male : female ratio in Mcphail trap , presence of mature eggs in female flies caught by Mcphail trap (Haniotakis , 1982 ; Zervas , 1989) . This trap is also used in measuring effectiveness of applied control practices (Haniotakis & Skyrianos , 1981) .

II.4.3. Sex pheromone traps:

Mature virgin females release an air-born pheromone which attracts sexually mature males (Haniotakis , 1974 , 1977 ; Haniotakis *et al.*, 1977) . Female olive fruit flies begin to produce a detectable pheromone in the 3rd day after emergence . No pheromone peak could be detected in glands extract from 1 and 2 days old females (Mazomenos , 1984) . Mated females produce less pheromone than virgin females of the same age . Tzanakakis *et al* (1968) suggested that female olive fly receptivity is inhibited for a certain period with substances transferred by males during copulation .

Pheromone trap only attracted males at the reproductivity active state . This information is particularly useful in timing the first control application . However , pheromone trap can be more accurate in timing subsequent control application (Haniotakis , 1982) . Pheromone can be formulated in polyethylene vials , rubber

septa and cornel fibres (Jones *et al.*, 1983) . Volatile substances from the rectal glands of adult females can be extracted according to the method described by Vita *et al* (1979) . 50 - 100 glands were extracted by placing them in 1 ml of ethyl for 24 hours at 4 °C . Solution of glands were extracted with equal volume of ether for 24 hours (Vita *et al.*, 1979) . Field experiments showed that maximum attraction was achieved with 20 female equivalent (Haniotakis , 1981) . The half life of the pheromone decreased by approximately 1.5 times for every 5°C increase in temperature over the range studied 25 - 30 °C (Jones *et al.*, 1983) .

II.4.4. Lure combination traps :

Lure combination traps have been tested and found to increase catches in certain cases (Economopoulos , 1986) . The combination of sex `and food attractants in the same trap gives a more efficient trap than those which are baited only with one of either components (Zervas , 1989) . It has been found that combination of pheromones with ammonia in the same trap increased the number of olive fruit fly catches in yellow trap and resulted in a powerful long lasting trap (Economopoulos , 1986 ; Haniotakis , 1986 a , 1986 b) . Vertical yellow traps coated with sticky material on both sides and with 25 mg spiroacetal lure gave catches of male olive fly four times as great as those in case of delta traps with the same lure (Jones *et al.*, 1983) . On the other hand , Economopoulos (1986) reported that yellow trap was more pronounced with ammonium salt odor lure . The same author (1982) reported that combination of yellow trap with ammonia

dispenser seems to be more practical than combination with container filled up with liquid protein odor - lure .

Coating the Mcphail trap exteriorly with sticky substances increases its effectiveness 2-3 folds , but causes extra difficulties in handling (Prokopy & Economopoulos , 1975) . Combination of protein bait in Mcphail trap with a yellow colour with high light reflectance (520-580 nm) and low reflectance (below 520 nm) did not improve attraction of olive fruit fly (Prokopy *et al.*, 1975) . While Prokopy and Economopoulos (1975) reported that when the lure in Mcphail trap was 2 % ammonium sulphate or just water , the addition of fluorescent yellow colour resulted in higher catches . Haniotakis and Skyrianos (1981) reported that Mcphail trap with bait and pheromone dispenser suspended in the interior of the trap , reduced trap effectiveness .

1.4.5. Other traps :

For trapping experiments of olive fruit fly , several other traps were tested in the field. Jones *et al* (1983) studied the following traps with pheromone dispenser: small delta trap , corrugated plastic trap , pherocon 1 c , funnel trap , picka trap and horizontal board trap . In Jordan , Al-Zaghal and Mustafa (1986) used water trap to detect flight activity between olive trees within the grove .

Traps captures of *Dacus oleae* have been improved by varying the trap design , and by screening for more attractive colours (Prokopy *et al.*, 1975) .

II.4.6. Side effect of trapping:

Since attraction is achieved through stimulation , all insects attracted by the plant are likely to be trapped including the parasites and predators of the olive pests (Prota , 1986) , Catches by traps on which half of each surface was painted either white , grey or black , whereas the other half being yellow , showed that all the parasitoids and predators were equally or better attracted to yellow than *Dacus oleae* except for the night active chrysopids and coniopterygids (Neuenschwander 1982) . In mass trapping experiment in Greece , the overall ratio of parasitoids and predators to *Dacus oleae* caught in yellow traps was 16.1 (Neuenschwander , 1982) . However , the majority of parasitoids and predators came from the wild vegetation that do not attack olive pests (Neuenschwander , 1982) . Adults Neuropterans were captured in Crete olive orchards by means of protein hydrolysate baited Mcphail traps , as eleven species of chrysopids were recorded in relatively small numbers (Canard *et al.*, 1979 b) . Honeydew and pollen feeding species constituted the great majority of all Neuropterans that attracted to protein hydrolysate baited Mcphail trap (Neuenschwander *et al.*, 1981 a) . Chrysopids which are predaceous in the adult stage are not usually attracted to the previously metioned trap (Neuenschwander *et al.*, 1981a) .

II.5. Control :

II.5.1. Mass trapping :

Mass trapping techniques hold great promise and will certainly be more adopted as soon as an efficient , selective and inexpensive trap become available

(Prota , 1986) . Trapping should start early in the spring , so that maximum number of adults can be removed before mating (Haniotakis , 1981) . He added that mass trapping after the first bait spray which takes place in Greece in the last half of June may be able to eliminate the additional 2-3 sprays usually required for acceptable *D. oleae* control . The same author (1986 a) reported that adequate olive protection cannot be achieved by mass trapping in situation where insect immigration into the protected area is not excluded . The development of low cost insecticide impregnated wood trap which can be prepared to have a full active life of years for both attractiveness and toxicity , gives new prospects to mass trapping methods (Haniotakis , 1986 a) . In such system the combination of pheromones with ammonia on the same trap is essential , as it significantly increases female captures and decreases trap density . The same author (1986 b) reported that when the same traps were used in Crete at a density of approximately 1 trap / 3 trees in 30,000 olive trees , mean infestation at harvest time was 2.4 % compared to 0.7% in the nearby orchard which protected by bait spray . Zervas (1986) reported that continuous three years mass trapping by using Mcphail and sticky traps baited with food attractant at a density of 1 trap per 7 trees drastically reduced the population of olive fruit fly presents in the experimental orchard and also decreased fruit infestation to the level of 7% which was generally acceptable by the growers . Prota (1986) found that the use of super trap " the same yellow sticky traps baited with ammonium salt , protein hydrolysate and female sex pheromone " as one trap per tree gave successful protection during high

productivity years as infestation reaching no more than 10% compared to 50% in non protected groves . He added that despite the high percentage of parasites caught by each trap , damage to the ecosystem was observed to be minimal . Economopoulos (1977) showed that under optimal density of fluorescent yellow trap , one could achieve complete prevention of damage . He added that some degree of isolation may be necessary by hanging more traps / tree at the edge of the grove .

II.5.2. Natural enemies :

II.5.2.a. Parasitoids :

The parasitoid complex associated with the olive fruit fly in the Mediterranean area is known since the beginning of this century (Neuenschwander *et al.*, 1983) . The chalcid ectoparasites are polyphagous , attacking *D. oleae* and other tephritids (Michelakis , 1986) . From which *Eupelmus urozonus* (Eupelmidae : Hymenoptera) as it occurs mainly in Crete groves during summer and disappears during autumn (Neuenschwander *et al.*, 1983 ; Michelakis 1986). This parasitoid was observed in association with 2nd and 3rd larval instars of the olive flies and also with the pupa inside the puparium (Michelakis , 1986) . It is observed as a hyperparasitoid of the pupae of *Pnigalio mediterraneus* (Neuenschwander *et al.*, 1983) . On the other hand , Talhouk (1969) cited that the presence of *E. urozonus* seems to reduce the population of *Opius concolor* since the larva of *E. urozonus* destroys the olive fly maggot as will as the larvae of *O.*

concolor inside it . Louskas *et al* (1980) reported that during the summer , *E. urozonus* parasitized *D. oleae* as pupae , controlling up to 95.3 % of the fly population in August . While Bigler *et al* (1986) reported that the unsatisfactory control achieved by this parasite is generally attributed to the preferrence of this species for other hosts . The second chalcid ectoparasite is *Pnigalio mediterraneus* (Eulophidae : Hymenoptera) which was observed through out the season in Crete , but it became abundant only from August onward reaching a peak in October , having no winter diapause (Michelakis , 1986) . On the other hand , Bigler *et al* (1986) reported that for the development of one *P. mediterraneus* 1.6 to 1.75 3rd instar larval of *D. oleae* were killed . Other workers reported that *P. mediterraneus* larvae were observed on the 2nd and 3rd larval instar of *D. oleae* (Neuenschwander *et al.*, 1983) .

The parasite *Opius concolor* (Braconidae : Hymenoptera) is the only endoparasite which attacks *Dacus oleae* in the Mediterranean region (Michelakis , 1986) . This species originally from Tunisia as it was obsereved on the tephritids *Carpomia incompleta* and *Capparimyia savastoni* (Neuenschwander *et al.*, 1983). This parasite developed normally in the 3rd larval instar (Liaropoulos *et al.*, 1977) . It has been domenstrated that overwintering as immature stage in the pupae of *Dacus oleae* in the soil was possible up to January (Neuenschwander *et al.*, 1983). In artificial mass - rearing of *O. concolor* using *Ceratitis capitata* as a host , the production of this parasite was highest when the larvae of the hosts were

exposed to the parasite (4-7 days old) for four and half hours (Alvarez , 1977) . *O. concolor* can locate and parasitize *D. oleae* larvae efficiently in the very ripe fruits presented on the trees in late spring . This parasite is able to work well in large trees with extensive canopies (Kapatos et al., 1977 a) .

The olive fruit fly normally migrated and pupated in the soil after it was parasitized by *O. concolor* , as the parasite developed indicating its fitness to the hypogeal phase of the soil (Canard *et al.*, 1979 a) . Manikas and Tsiroyannis (1982) reported that *O. concolor* can reinforce or replace chemical control in certain situation .

Several other parasitoids were found invading the various stages of the olive fruit fly. These parasitoids were *Cyrtoptyx latips* (Pteromalidae: Hymenoptera) which is an ectoparasite . In addition , it parasitizes several curculionids . In Crete , it has only been reared from olives which were sampled between the beginning of August and the beginning of October and in areas with high *D. oleae* infestation (Neuenschwander *et al.*, 1983 ; Michelakis , 1986) . The second ectoparasite is *Eurytoma martellii* (Eurytomidae : Hymenoptera) seems to be more abundant in the Western Mediterranean countries . It is active only in summer and gradually disappeared in autumn (Neuenschwander et al., 1983 ; Michelakis , 1986) . *Dirhinus giffardi* (Chalcididae : Hymenoptera) which is an exotic parasite of tropical region, seems to be unable to survive under South European conditions (Neuenschwander *et al.*, 1983; Michelakis, 1986). *Biosteres oophilus* (Braconidae : Hymenoptera) is an egg-pupal exotic parasitoid . In Hawai satisfactory control of

Dacus dorsalis has been achieved using the previous mentioned parasite on some fruit species (Neuenschwander *et al.*, 1983 ; Michelakis , 1986) .

In Jordan , Mustafa and Al-Zaghal (1987) reported that the most common parasites detected were *Opius concolor* (Braconidae : Hymenopetra) and *Tetrastichus sp.* (Eulophidae : Hymenoptera) .

II.5.2.b. Predators :

The abundance of the midge *Prolasioptera berlesiana* (Cecidomyidae : Diptera) as a predator was colsely linked to the abundance of fresh stings by *D. oleae* . It was estimated that this predator directly or indirectly destroyed a maximum of 30 - 50 % of the *D. oleae* eggs (Neuenschwander *et al.*, 1983) . Birds are important indirect predators of *D. oleae* larvae in oleasters between December and March , while ants are very active predators during spring (Bigler *et al.*, 1986). Among the predators of larvae and pupae in the soil , the *Carabus banoni* and *Pterostichus creticus* (Carabidae : Coleoptera) are most common . Spiders can prey teneral adults while they are unable to fly during several hours (Bigler *et al.*, 1986) .

II.5.3. Other means of control :

The use of bait sprays consisting of protein hydrolysates mixed with organophosphorous insecticides as preventive chemical control method against the olive fly and other flies of the family Tephritidae has been spread very widely in

recent years (Orphanidis & Kalmoukos , 1979) . This is because it is easy to use over large areas by means of low volume (LV) , very low volume (VLV) or ultra - low volume (ULV) application from the ground or the air . Pastre (1987) reported that deltamethrin insecticides has great possibilities in the control of the olive fruit fly , as the major advantage is its very short waiting time .

The disruption of sexual communication of the olive fruit fly by means of massive liberation of sex pheromone has been used as a possibility in an integrated pest control in the olive grove (Montiel & Simon , 1986) . Measurements of fruit infestation in treated and control sites were made provided further evidence that mating disruption was achieved by using of one or two pheromone capsules per tree (Montiel *et al.*, 1982) . Artificially reared sterile insect release method has been studied (Economopoulos *et al.*, 1977 ; Economopoulos , 1982) . Inadequate control was mostly caused by not effective isolation of test grove (Economopoulos , 1982) . While a combination of limited use of two bait sprasy at the beginning of the season followed by weekly release of artificially reared gamma sterilized insects can keep the infestation at low levels (Economopoulos *et al.*, 1977) . Antibiotics were also tested to control olive fruit fly . and larval growth was inhibited when males and females were treated with streptomycin (Lambrou and Tzanakakis ,1978) .

MATERIALS AND METHODS

III. MATERIALS AND METHODS

III.1. The Groves :

III.1.1. Baqa'a grove :

This grove is located at Al-Hussein Agricultural Station in Baqa'a area, 15 km North West of Amman. It is about 700 m above sea level under irrigation (fig.1) .

The total field area is about 2.9 hectars consists of mixed cultivars of 25 years old olive trees planted in rows 10 m along and 8 m between rows . The pickling cultivars are Ascolano , Fransisco, Nasohe , Shami and Unani . Baroni , Rase'e , Telmesani and improved Nabali for milling and pickling. Itrana , Frantoyo, Grossa , Marayello , Nabali and Souri cultivars are for milling to extract oil . In additon , there are some grape vines between some rows , and 10 m high cypress trees bordering the South and West sides of the grove .

The grove is bordered to the East by building and grape vines , to the West a main road , to the North pruned olive trees and peaches , and to the South the Baqa'a refugees camp. This grove was chosen to conduct experiments on traps evaluations, fruit infestation and parasites occurrence . No insecticidal sprays were applied during the period of study , although , the other agricultural practices were carried out as usual.

III.1.2. Salt grove :

This grove is in Um-Jouzeh, a small town 6 km North West of Salt city . This grove is about 860 m above sea level under rainfed (fig. 2) . The total field area is

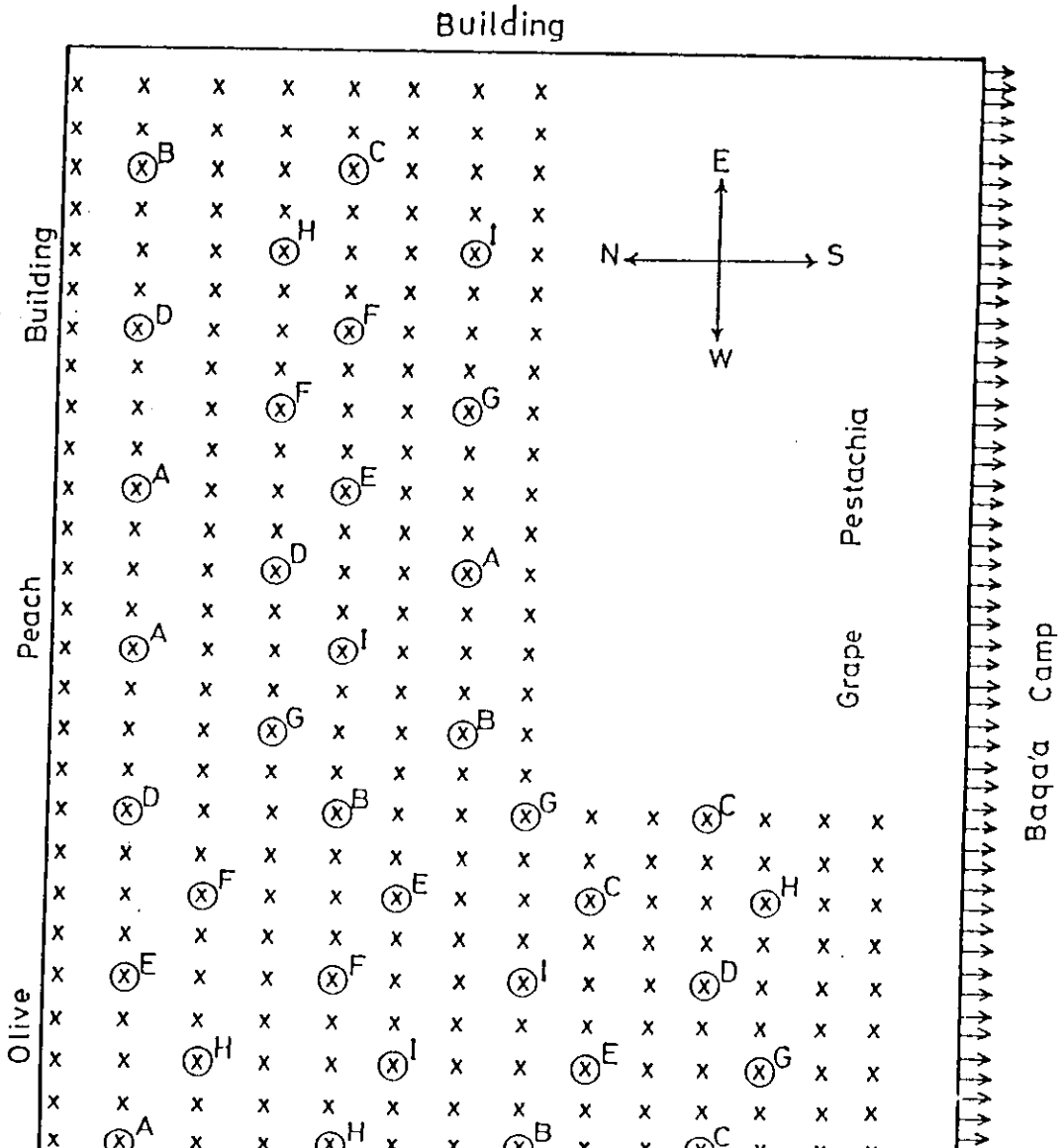

Fig.1 : Diagram of Baqaa grove

A : Vertical yellow trap
B : Vertical yellow trap with diammonium phosphate
C : Vertical yellow trap with 10 mg pheromone
D : Vertical yellow trap with 20 mg pheromone
E : Mcphail trap with diammonium phosphate and yeast
F : Mcphail trap with protein hydrolysate and borax
G : Mcphail trap with protein hydrolysate,soluble pheromone and borax
H : Ovoid yellow trap
I : Ovoid yellow trap with thick yoghurt
↓ : Cypress tree
x : Olive tree

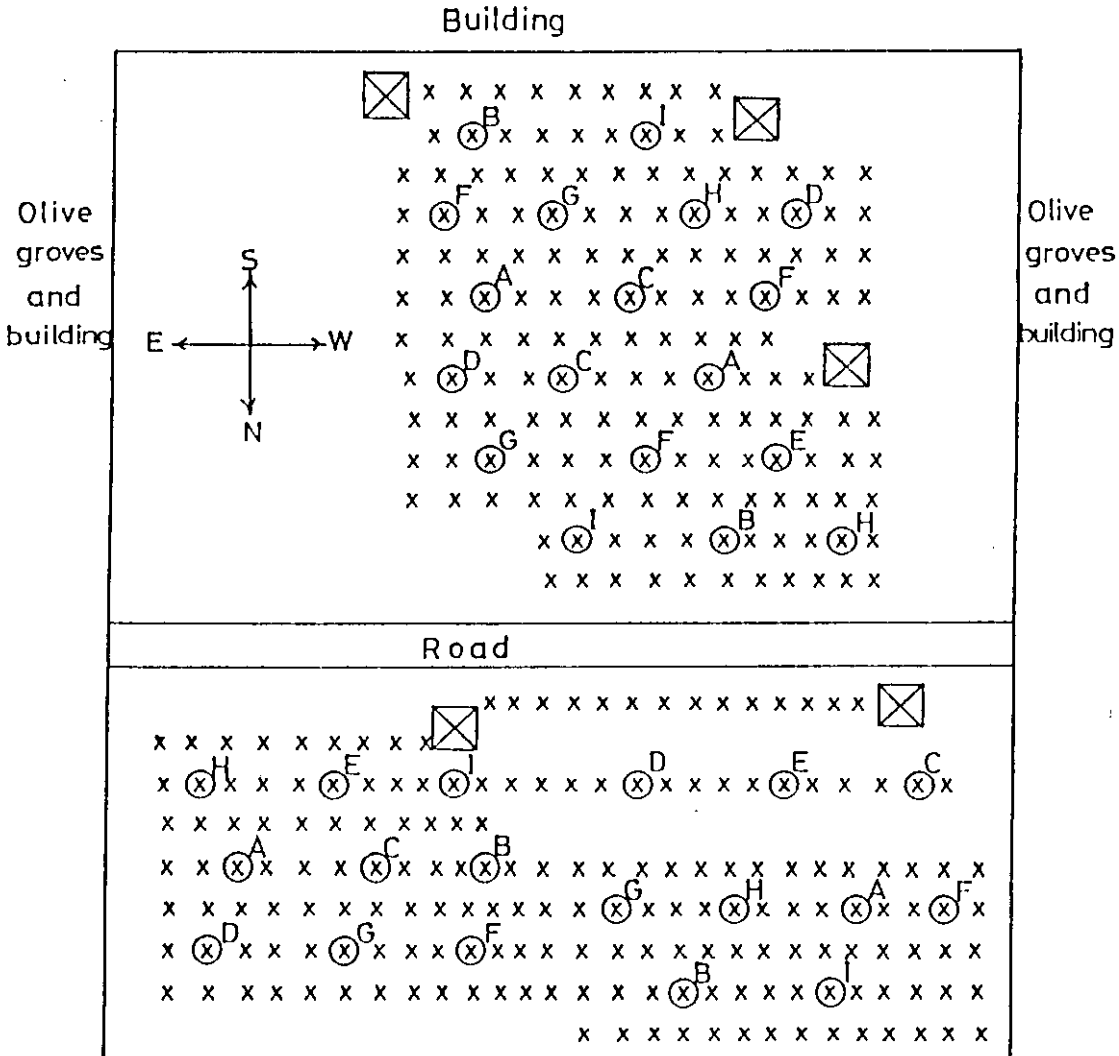

Fig.2 : Diagram of Salt grove

A : Vertical yellow trap
B : Vertical yellow trap with diammonium phosphate
C : Vertical yellow trap with 10 mg pheromone
D : Vertical yellow trap with 20 mg pheromone
E : Mcphail trap with diammonium phosphate and yeast
F : Mcphail trap with protein hydrolysate and borax
G : Mcphail trap with protein hydrolysate,soluble pheromone and borax
H : Ovoid yellow trap
I : Ovoid yellow trap with thick yoghurt
⊠ : House
x : Olive tree

about 3 hectars planted with 15 - 50 years old trees, Nabali and Souri for milling to extract olive oil. The trees are planted in rows 10 m along and 10 m between rows . In addition , there are some grape , peach , apricot and fig trees between some rows .

The grove is bordered to the East , West and North by olive orchards and buidlings , and to the South by a road and buildings . This grove was chosen to conduct experiments on traps evaluation , fruit infestation , parasite occurence and females dissection . No insecticidal sprays were applied during the period of study. However , the other agricultral practices were carried out as normally .

III.2. Field Work :

II.2.1. The traps used :

Nine types of traps were used in each of the Baqa'a and Salt groves , to evaluate the flight activity of olive fruit fly and the distribution of captured males and females on each of the traps .

An experiment was set up in Baqa'a grove between the beginning of March, 1991 and the end of February, 1992 with eight traps (treatments) in a complete randomized design . There were four replicates for each treatment . An other trap treatment was added in mid of July, 1991 . A second experiment was set up in Salt grove between beginning of June, 1991 and end of May, 1992 in randomizely complete block design with eight traps (treatments) . There were four replicates in each treatment . An other trap treatment was added in the mid of July , 1991 .

In all treatments , the traps were hanged about 30 m apart on the periphery of the southern side of the tree .

III.2.1.a. Vertical yellow sticky trap :

This trap (plate 2) consists of yellow plastic sheet 20 cm long and 19 cm wide coated on both sides with banding grease . This sheet was hanged onto the tree in a vertical position by a wire hanger at 1.5 - 2 m height on the periphery of the tree . The sticky sheet was changed monthly . A band of sticky grease material was added to the sheet every 2 weeks . The olive fruit fly on the trap was removed weekly and identified by (10 x) hand lens in the field . Numbers of males and females on both sides of the sheet were counted .

III .2.1.b. Vertical yellow sticky trap with diammonium phosphate :

This trap (plate 3) is similar to that described previously in III.2.1.a. In addition , a small hayaline plastic pocket 8 cm long and 6 cm wide containing 50 gm diammonium phosphate ($NH_4)_2 HPO_4$ as lure was added to it (Delrio , 1981). This pocket was placed on the sticky grease material on the middle of the upper side of the sheet by stables toward the grove . Fine punctures were made on the pocket to help in releasing ammonia . The lure pocket was changed every month . Numbers of males and females of olive fruit fly were removed weekly , identified and counted .

Plate .2 : Vertical yellow sticky trap .

Plate.3 : Vertical yellow sticky trap with diammonium phosphate

III.2.1.c. Vertical yellow sticky trap with 10 mg pheromone capsule:

This trap (plate 4) is similar to that described previously in III.2.1.a. In addition , a polyethylene capsule 3 cm long and 0.9cm diameter containing 10 mg pheromone was added to it . The major component of the pheromone is spiroacetal (Baker *et al.*, 1980) . It was imported from Biological Control System , Agrisense - BCS Ltd . UK. The pheromone was kept in a refrigerator at less than 5°C to prevent degredation .

The capsule was placed on the sticky grease material on the middle of upper side of the sheet toward the grove . The capsule was changed monthly as recommended by Jones (Jones *et al.*, 1983) . Olive fruit fly males and females caught by this trap were removed weekly , identified and counted .

III.2.1.d. Vertical yellow sticky trap with 20 mg pheromone capsule:

This trap (plate 5) was similar to that described previously in III.2.1.a. In addition , a polyethylene capsule 3 cm long and 1.5 cm diameter containing 20 mg pheromone was added to it . The major component of the pheromone is spiroacetal (Baker *et al.*, 1980) . It was synthesized at the University of Southampton and imported from the United Kingdom. The pheromone was kept in a refrigerator at less than 5°C to prevent degredation .

The capsule was placed on the sticky grease material on the middle of

Plate.4 : Vertical yellow sticky trap with 10 mg pheromone capsule

Plate.5 : Vertical yellow sticky trap with 20 mg pheromone capsule

upper side of the sticky sheet toward the grove . The capsule was changed monthly as recommended by Jones (Jones *et al.*, 1983) . Numbers of males and females of olive fruit fly were removed weekly , identified and counted .

III.2.1.e. Mcphail trap with diammonium phosphate and yeast :

This trap (plate 6) consists of a bottle of clear glass . It has two openings from the top and the bottom . The trap has a concave in the center of the bottom to the interior side in order to hold the lure solution , it is elongated toward the top with groove on the nick to tie a wire to hold it on the tree at 1.5-2 m height on the periphery of the southern side of the tree .

Each trap contains 200 ml of the lure solution . The lure consists of 50 gm of diammonium phosphate ($NH_4)_2 HPO_4$ and 5 gm of bakers yeast dissolved in one liter of water (Abu-Yaman 1963) .

The solution lure was replaced weekly by filtering through a peice of muslin in order to count the number of males and females of olive fruit fly .

III.2.1.f. Mcphail trap with protein hydrolysate and borax:

This trap is similar to that described previously in III.2.1.e. However ,

Plate. 6 : Mcphail trap

a solution lure of 3% protein hydrolysate bait and 1.5% borax (sodium borate) for better preservation of the insect (Economopoulos 1986 ; Haniotakis & Skyrianos , 1981 ; Neuenschwander *et al.*, 1981 a) was added . The protein hydrolysate (Protein Bait N°10) was imported from SIAPA (Societa Italio - Americana Prodotti Antiparassitari) , Italy .

The lure solution was replaced weekly by flitering through a peice of muslin . Numbers of olive fruit fly males and females were identified and counted .

III.2.1.g. Mcphail trap with protein hydrolysate , soluble pheromone and borax :

This trap is similar to that described previously in III.2.1.e. To it was added a solution lure of 3% protein hydrolysate bait , 1.5 % borax and 0.5 % polycor SKL that contains 2 % of the active olive fruit fly pheromone . Polycor SKL was developed by Biological Control System Limited in the United Kingdom . The lure solution was changed every week by filtering through a peice of muslin . Numbers of oilve fruit fly males and females were identified and counted .

II.2.1.h. Ovoid yellow sticky trap :

This trap was designed for the first time during the course of this study at the University of Jordan . The trap (plate 7) consists of two plastic dishes attached together from the top by adhesive material to form ovoid shape with two bottoms up

Plate.7 : Ovoid yellow sticky trap

and down . The diameter of each dish is 12.5 cm from the top and 6.4 cm from the bottom . This trap was painted yellow using TOA Spray (41 Suzuki yellow , Thailand) and coated with sticky grease material .

The trap was hanged on the periphery of the southern side of the tree by a wire hanger at 1.5 - 2 m height . The sticky grease material was replaced every 4 -5 weeks . Adults of olive fruit fly caught by this trap were removed every week and identified . Number of males and females were counted .

III.2.1.I. Ovoid yellow sticky trap with labaneh (concentrated yoghurt) :

This trap was designed for the first time during the course of this study in the University of Jordan . The trap (plate 8) is similar to that described previously in III.2.1.h . In addition , an opening was made in the bottom to which a tip containing 50 gm of labaneh was placed . The trap has 30-40 small holes about 1 mm diameter on the upper side of the second bottoms to allow slow release of gases. The lure labaneh was replaced weekly by removing the tip and washing it with water . Before use, labaneh was kept in a growth chamber at 22 $\pm$ 1 °C for 3 days (Personal communication, Dr. M. Yamani , Faculty of Agriculture , University of Jordan) . Males and females of olive fruit fly caught by this trap were removed , identified and counted weekly .

Plate.8 : Ovoid yellow sticky trap with labaneh

III.2.2. Fruit Infestation :

Fruit infestation was recorded in the field from the beginning of June up to mid -November, 1991 . The fruits were chosen randomly in all directions at different heights by walking around the tree . The number of infested fruits from each grove were recorded in the field every two weeks .

The presence of punctures made by females of olive fruit fly or holes made by the larvae were considered as infestation .

III.2.2.a. In Baqa'a grove :

Fruit infestation was studied in 4 cultivars , Ascolano , Shami and Nasohe for pickling , Rase'e for milling and pickling. Four trees from each cultivar were chosen and 25 fruits per tree were examined in the field . The number of infested fruits were recorded as percentage of infestation for each cultivar .

II.2.2.b. In Salt grove :

Fruit infestation was studied in 2 cultivars Nabali and Souri for milling to extract olive oil . Five trees from each cultivar were chosen and 50 fruits per tree were examined in the field as described previously . The number of infested fruits were recorded and converted to percentage of infestation for each cultivar .

III.3. Lab Work :

The lab work was an extention to the field work . Parasite occurrence in the field and female dissection for assessing sexual activity was studied .

III.3.1. Cages :

The cage (plate 9) consisted of clear plastic jar 1000 ml. The cover of the jar was replaced by a peice of metal network 2 mm mesh . The jar bottom was removed and replaced with a peice of muslin . Under the network , a deep side of a Petri dishe was placed in order to collect the parasite. The Petri dish was painted black .

III.3.2. Growth chamber :

Cages contained infested fruits were kept in a growth chamber (model 3744 S/ N 37553 , Forma Scientific , USA) for one month at 22 ± 1 °C . The photoperiod was maintained at 12 : 12 hours light : dark regime .

III.3.3. Female dissection :

To study sexual activity , females caught by Mcphail traps contained solution of diammonium phosphate and yeast ; protein hydrolysate and borax were transferred to a small jar contained alcohol 70% . Samples for dissection were taken from Salt orchard only . In the lab , random samples of 20 females were

Plate.9 : A cage contains infested fruits

chosen from the jar . These chosen females were dissected under the binocular microscope in microdishes contained solution of 45 ml water and 5 ml safranin (counter stain) to improve examining the eggs . This solution was used for the first time for this purpose . Numbers of mature eggs (plate 10) per female were counted every week from July to November, 1991 .

III.3.4. Parasitoid monitoring :

Samples of 200 fruits with punctures made by females of olive fruit fly were collected from Baqa'a and Salt grove every two weeks from July to mid November, 1991 to monitor parasitoid status in olive groves . These infested fruits were collected from trees other than those chosen for fruit infestation study .

For parasitoid (plate 11) study , cages contained the infested fruits (100 fruit per cage) were placed in the growth chamber for one month . The emerged parasitoids were collected from the Petri dishes under the cages , transferred to a vail contained alcohol 70 % for identification .

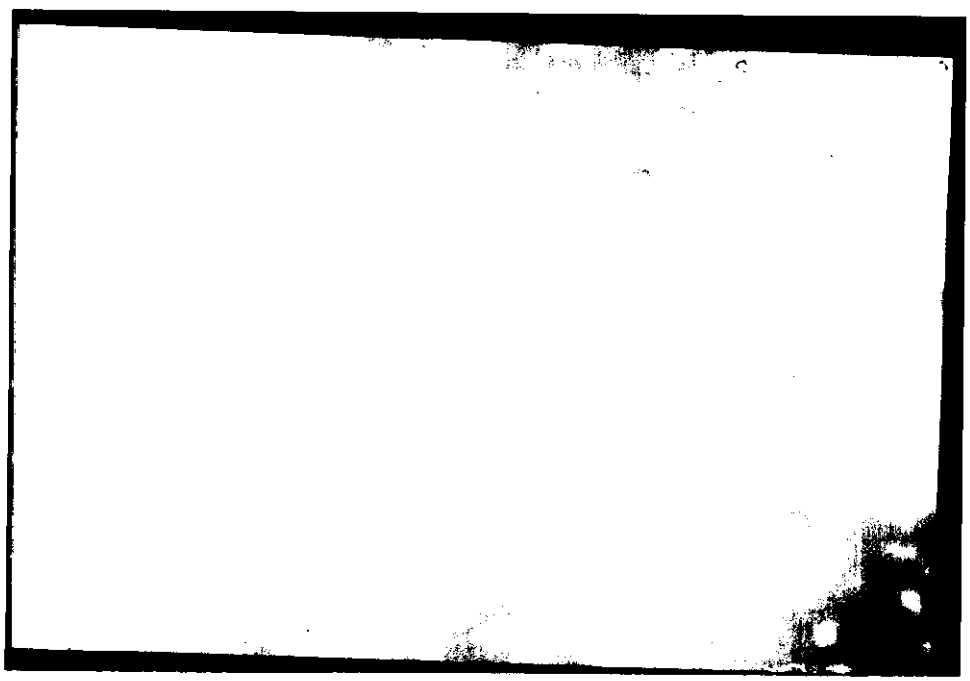

Plate 10 : A mature egg

Plate 11 : Adult of *Opius concolor*

IV. RESULTS

IV.I. Distribution Of Olive Fruit Fly On The Different Traps

IV.I.1. Vertical yellow sticky trap :

Distribution of olive fruit fly caught on vertical yellow sticky trap at Baqa'a grove , from March , 1991 to February , 1992 is shown in Fig.3. Results of this trap showed very low trapped olive fruit fly from March to end of July . Two small flight activity periods were recorded; first , was between mid-April and late May . The second was between early June and the end of July . However, the three main flight activity peaks were recorded from August to end of December . The first peak was at mid-September . The second peak was at mid-October . The third peak was at late November . No trapped olive fruit fly was recorded during January and February .

Distribution of olive fruit fly caught on vertical yellow sticky trap at Salt grove from June , 1991 to May , 1992 is shown in Fig.4. Results of this trap showed four main flight activity peaks , recorded between June and December . The first peak was in early July . The second peak was in mid-August. The third peak was in early October. The fourth peak was in mid-November. No olive fruit fly was trapped from January to end of March , whereas small flight activity periods were recorded between mid-April and late May.

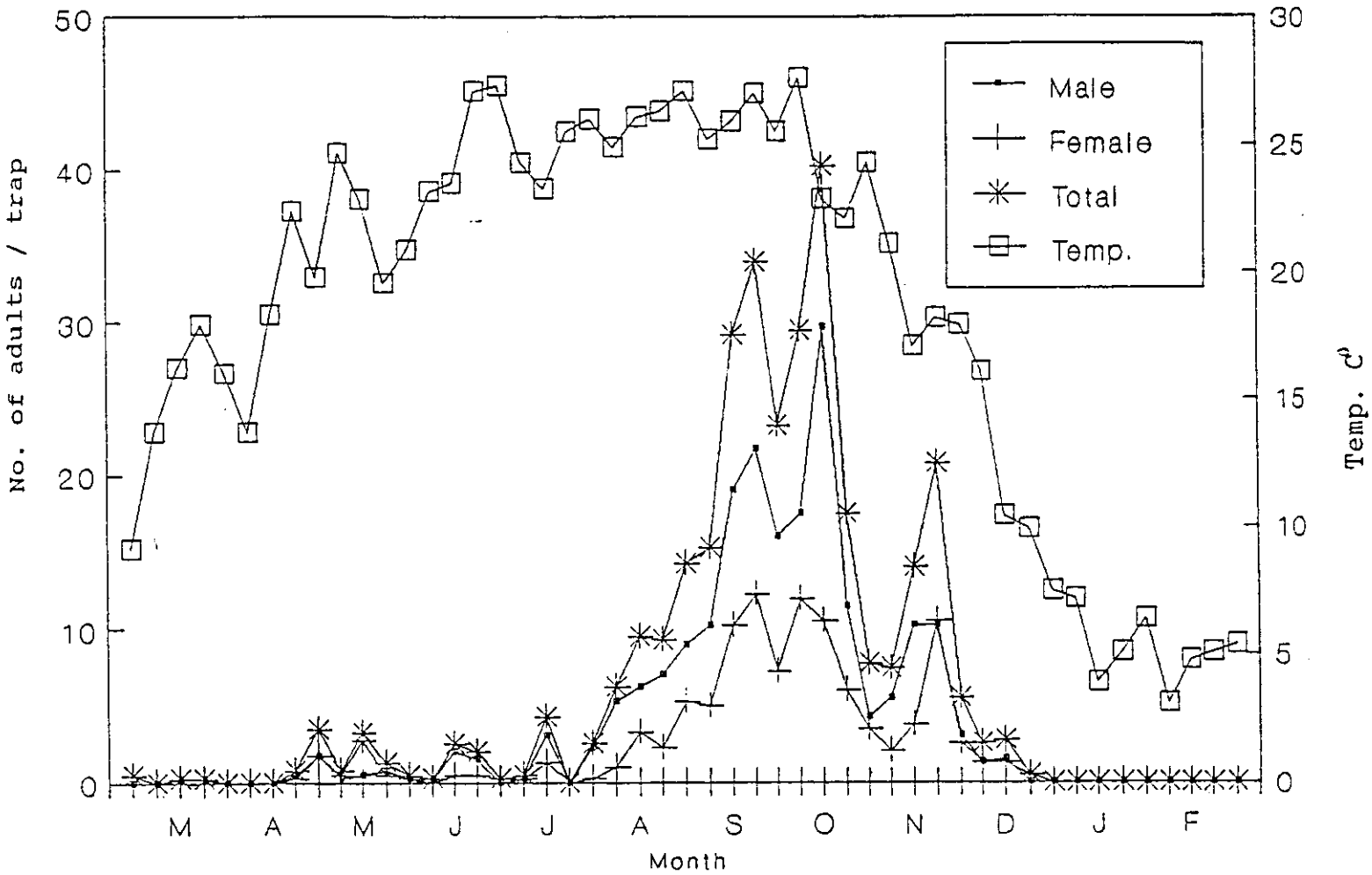

Fig.3: Distribution of olive fruit fly caught on vertical yellow sticky trap at Baqaa grove from March,1991 to end of February,1992.

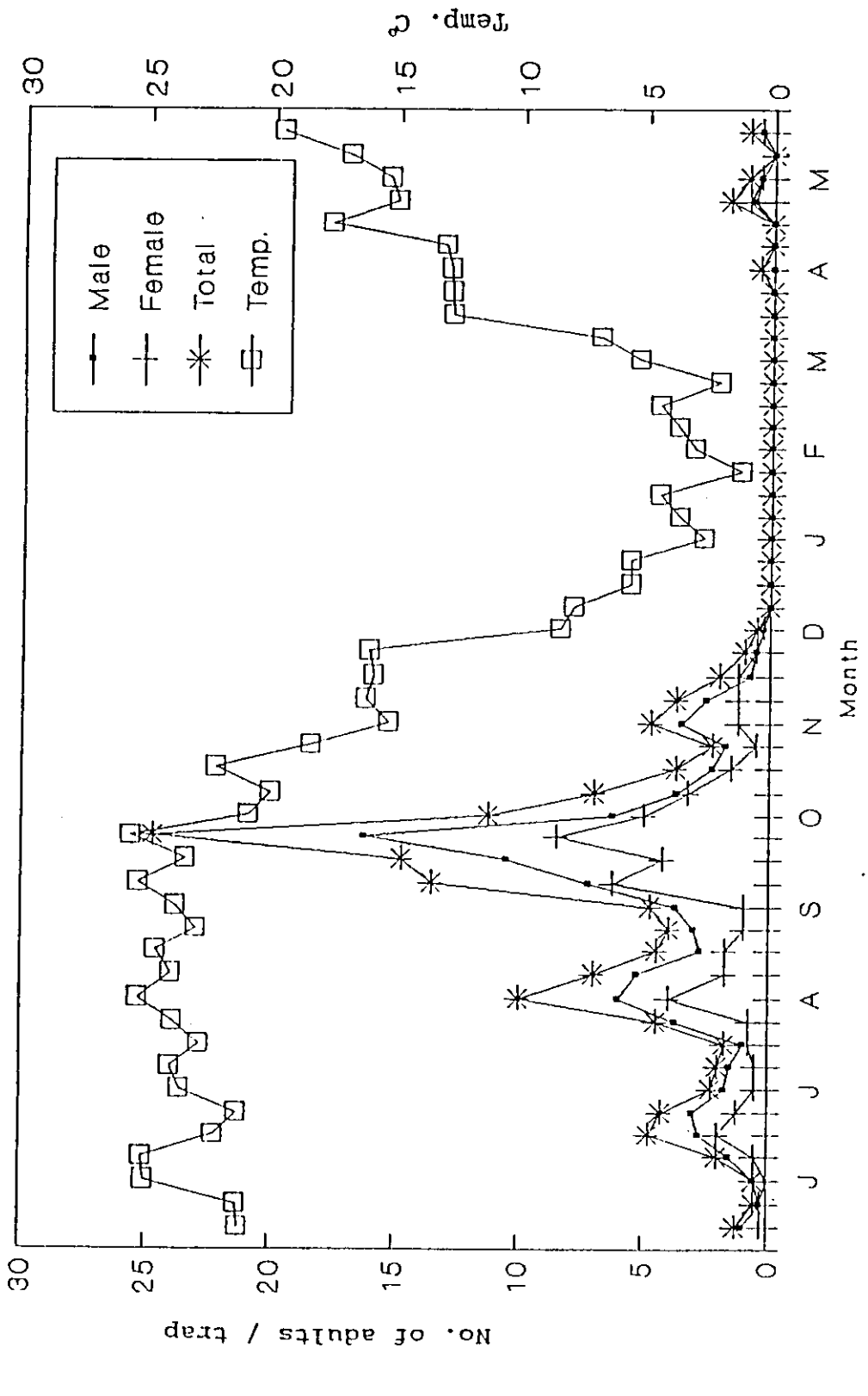

Fig.4: Distribution of olive fruit fly caught on vertical yellow sticky trap at Salt grove from June,1991 to end of May, 1992.

IV.I.2. Vertical yellow sticky trap with diammonium phosphate:

Distribution of olive fruit fly caught on vertical yellow sticky trap with di-ammonium phosphate at Baqa'a grove , from March , 1991 to February, 1992 is shown in Fig.5. Low catch from March to end of July was recorded as low numbers of olive fruit fly were trapped . However , three main flight activity peaks were recorded from August to end of December . The first peak was in early August . The second peak was in mid-October . The third peak was in late of November . No trapped flies were recorded during January and February .

Distribution of olive fruit fly caught on vertical yellow sticky trap with di-ammonium phosphate at Salt grove , from June , 1991 to May , 1992 is shown in Fig. 6. Four main flight activity peaks were recorded between June to end of December . The first peak was in late June . The second peak was in early July . The third peak was at mid-August . The fourth peak was in early October . No flies were trapped from January to end of March , while few numbers were caught between mid-April and mid-May .

IV.I.3. Vertical yellow sticky trap with 10 mg pheromone capsule:

Distribution of olive fruit fly caught on vertical yellow sticky trap with 10 mg pheromone capsule at Baqa'a grove , from March, 1991 to February , 1992 is shown in Fig. 7. Low numbers of flies were trapped between March and

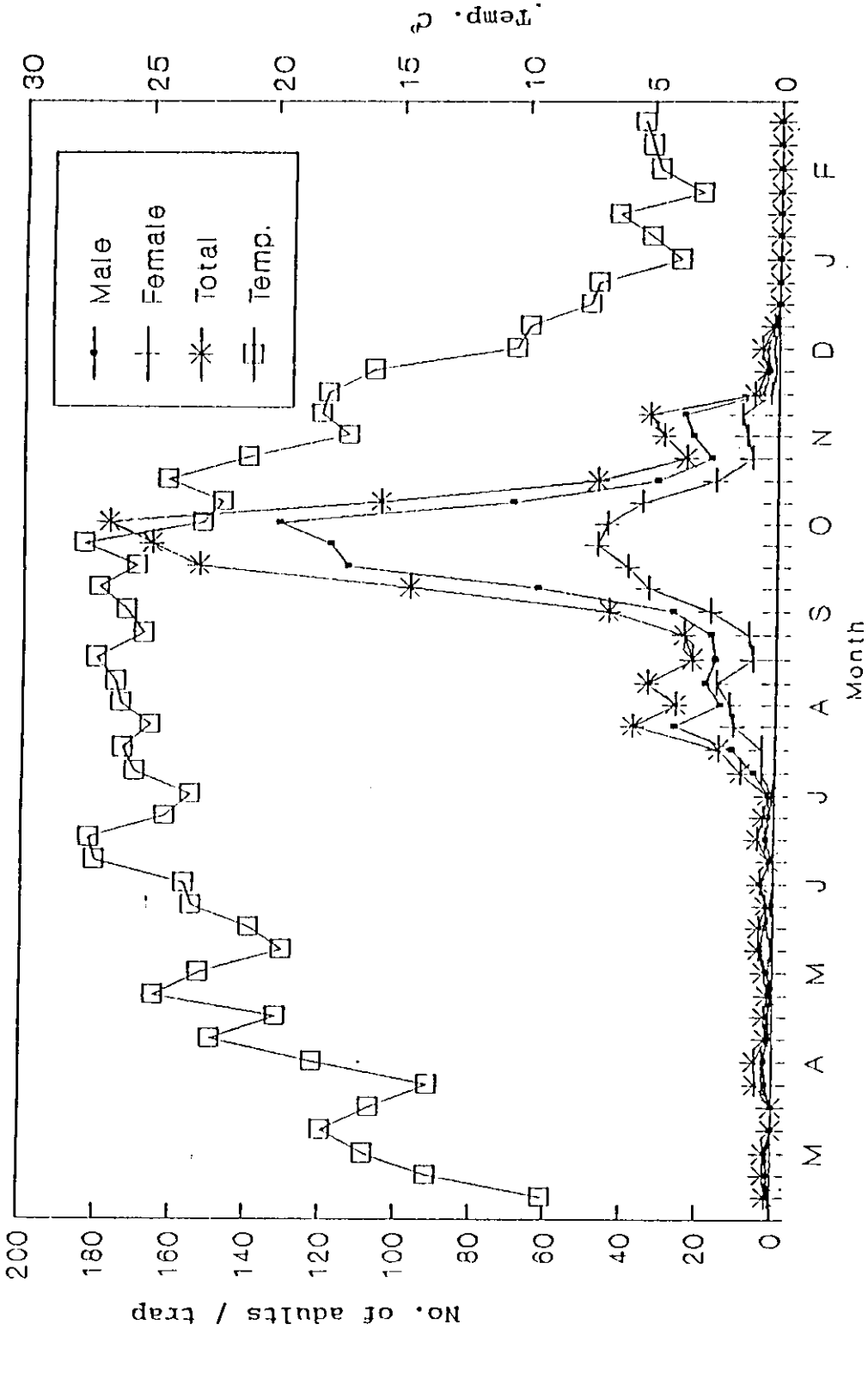

Fig.5: Distribution of olive fruit fly caught on vertical yellow sticky trap with diammonium phosphate at Baqaa grove from March,1991 to end of February,1992.

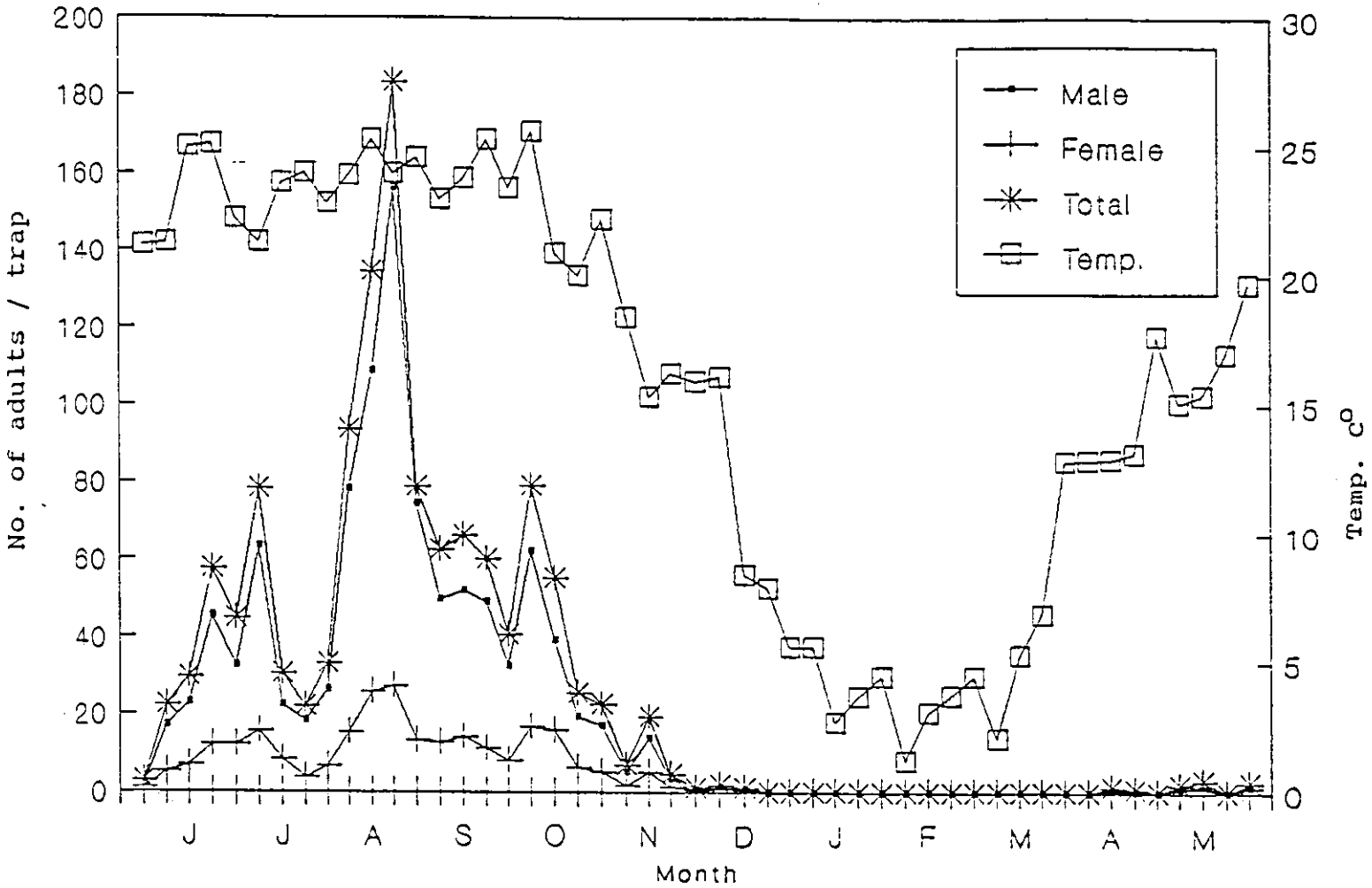

Fig.6: Distribution of olive fruit fly caught on vertical yellow sticky trap with diammonium phosphate at Salt grove from June,1991 to end of May,1992.

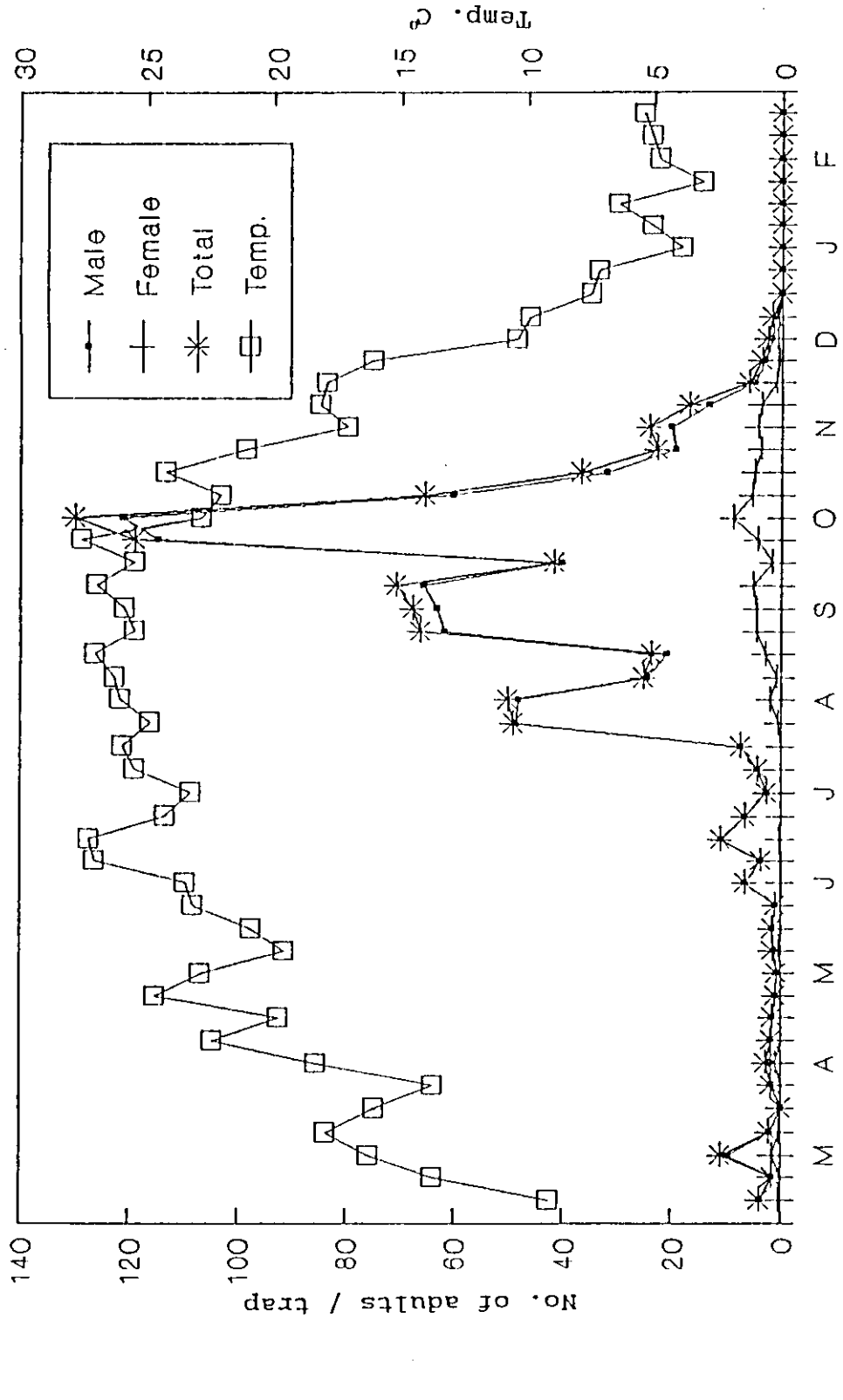

Fig.7: Distribution of olive fruit fly caught on vertical yellow sticky trap with 10 mg pheromone capsule at Baqaa grove from March,1991 to end of February,1992.

July. These are illusterated in small peaks recorded in mid-march and from mid-June to mid-July . However, the tree three main flight activity peaks were recorded from August to end of December . The first peak was in mid-August . The second peak was in mid-September . The third peak was in late October . Flight activity of males was only obvious in the case of using pheromone trap . No flies were trapped during January and February .

Distribution of olive fruit fly caught on vertical yellow sticky trap with 10 mg pheromone capsule at Salt grove , from June , 1991 to May , 1992 is shown in Fig.8. Four main flight activity peaks were recorded from June to end of December . The first peak was at the end of June . The second peak was in mid-August . The third peak was in early September . The fourth peak was in mid-October . No flies were trapped from January to end of March, while few numbers were caught between mid-April and mid-May . Flight activity of males was only obvious in the case of using pheromone trap .

IV.I.4. Vertical yellow sticky trap with 20 mg pheromone capsule :

Distribution of olive fruit fly caught on vertical yellow sticky trap with 20 mg pheromone capsule at Baqa'a grove , from mid-July , 1991 to February , 1992 is shown in Fig. 9. Four main flight activity peaks were recorded between mid-July to end of December . The first peak was in late of August . The second peak was in mid-September. The third peak was in mid-October. The fourth peak was in late of November. Flight activity of males was only obvious in the case of using

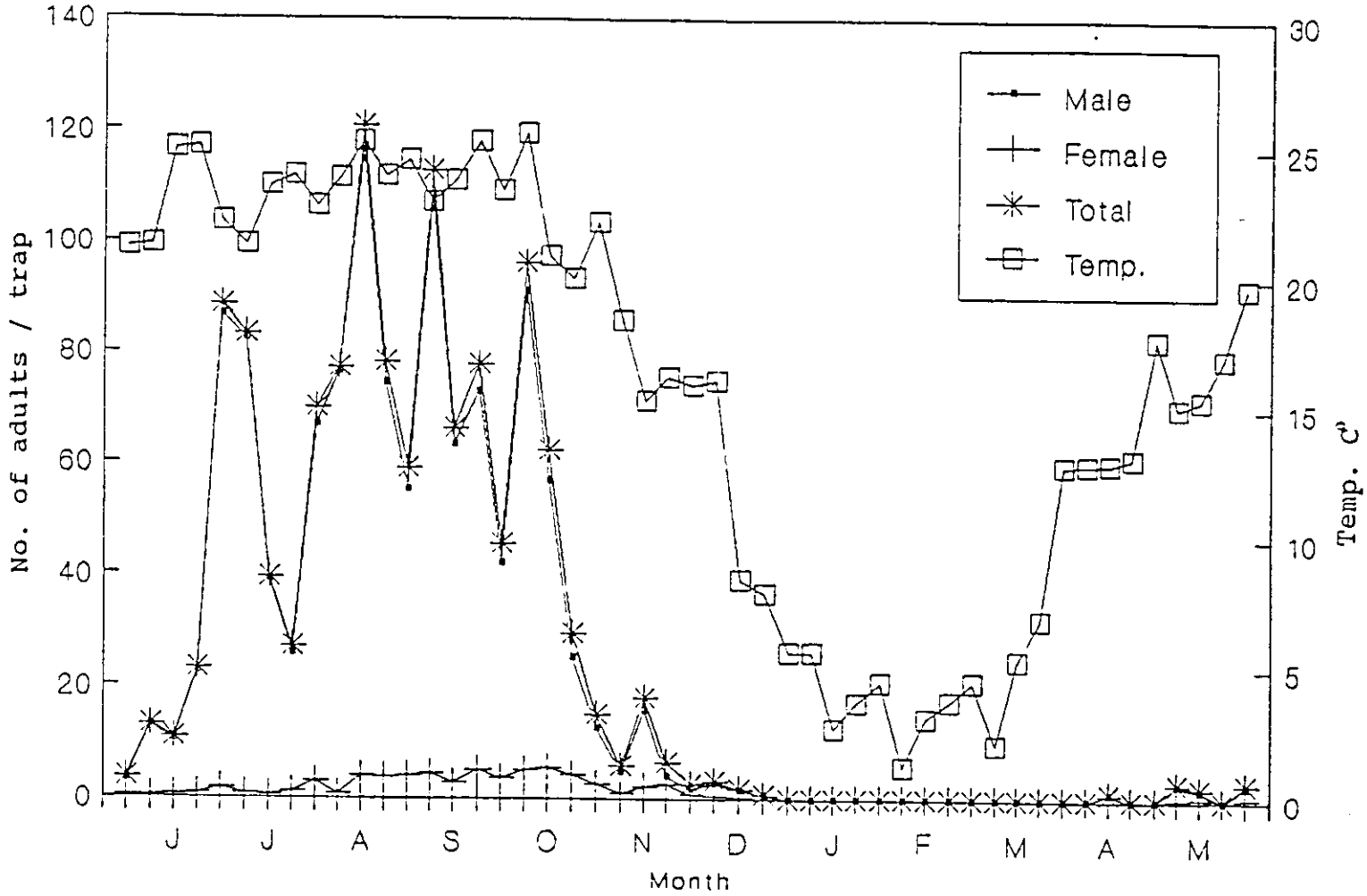

Fig.8: Distribution of olive fruit fly caught on vertical yellow sticky trap with 10 mg pheromone capsule at Salt grove from June,1991 to end of May,1992.

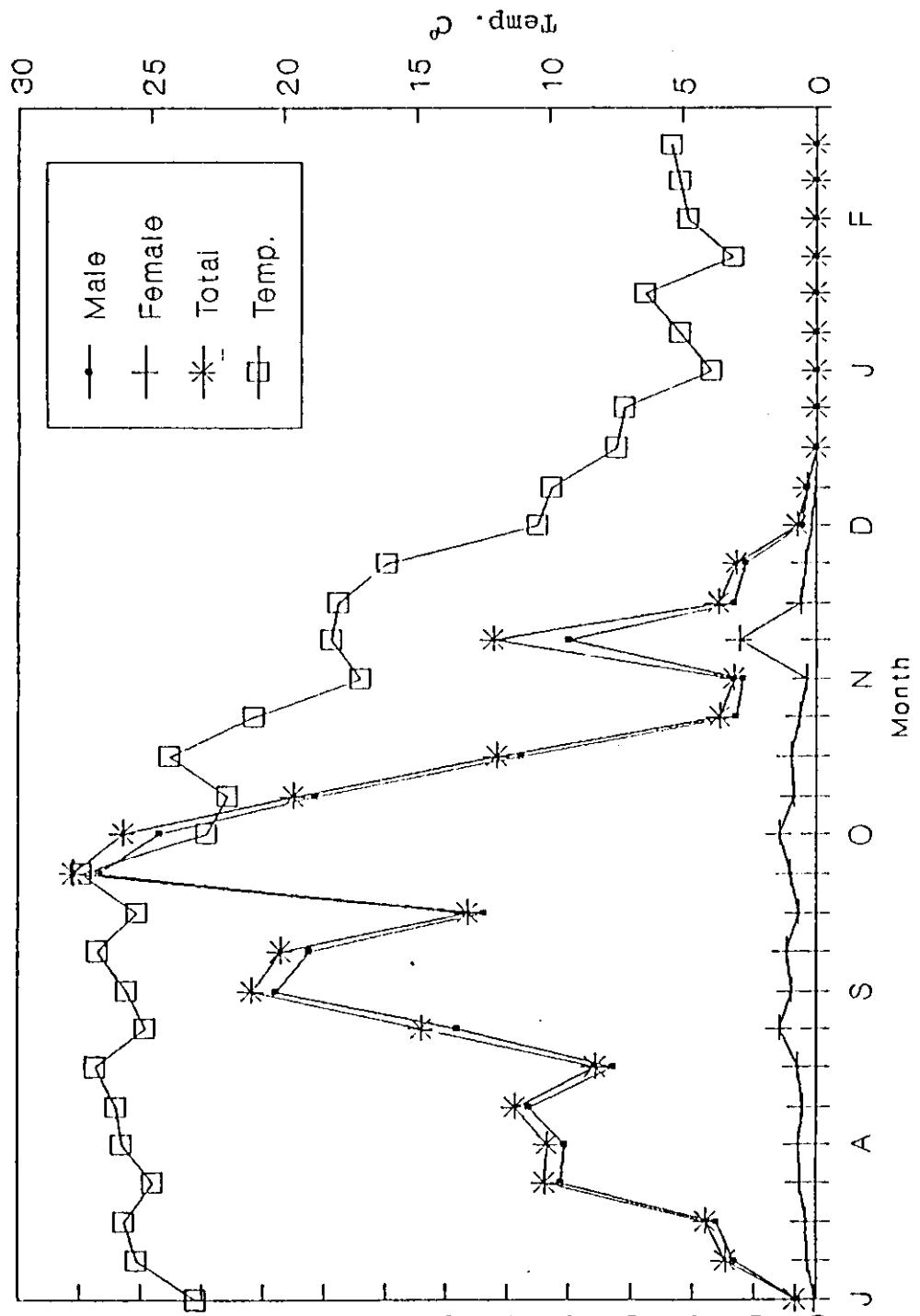

Fig.9: Distribution of olive fruit fly caught on vertical yellow sticky trap with 20 mg pheromone capsule at Baqaa grove from mid-July,1991 to end of February,1992.

pheromone trap . No flies were trapped between January and February .

Distribution of olive fruit fly caught on vertical yellow sticky trap with 20 mg pheromone capsule at Salt grove from mid-July , 1991 to February , 1992 is shown in Fig. 10. Four main flight activity peaks were recorded from mid-July to end of December . The first peak was at mid-July . The second peak was at mid-August . The third peak was at mid-October . The fourth peak was at late of November . No trapped olive fruit fly was recorded from January to end of March , while few numbers were caught in April and May . Flight activity of males was only obvious in the case of using pheromone trap .

IV.I.5. Mcphail trap with diammonium phosphate and yeast:

Distribution of olive fruit fly caught on Mcphail trap with diammonium phosphate and yeast at Baqa'a grove , from March , 1991 to February , 1992 is shown in Fig. 11. Low numbers of trapped olive fruit fly were recorded from March to end of July . These are illusterated in two small flight activity peaks appeared in April and May and then in June and July . Three main flight activity peaks were recorded from August to end of December . The first peak was in early September. The second peak was at early October. The third peak was at late October. No flies were trapped during January and February .

Distribution of olive fruit fly caught on Mcphail trap with diammonium phosphate and yeast at Salt grove , from June , 1991 to May , 1992 is shown in

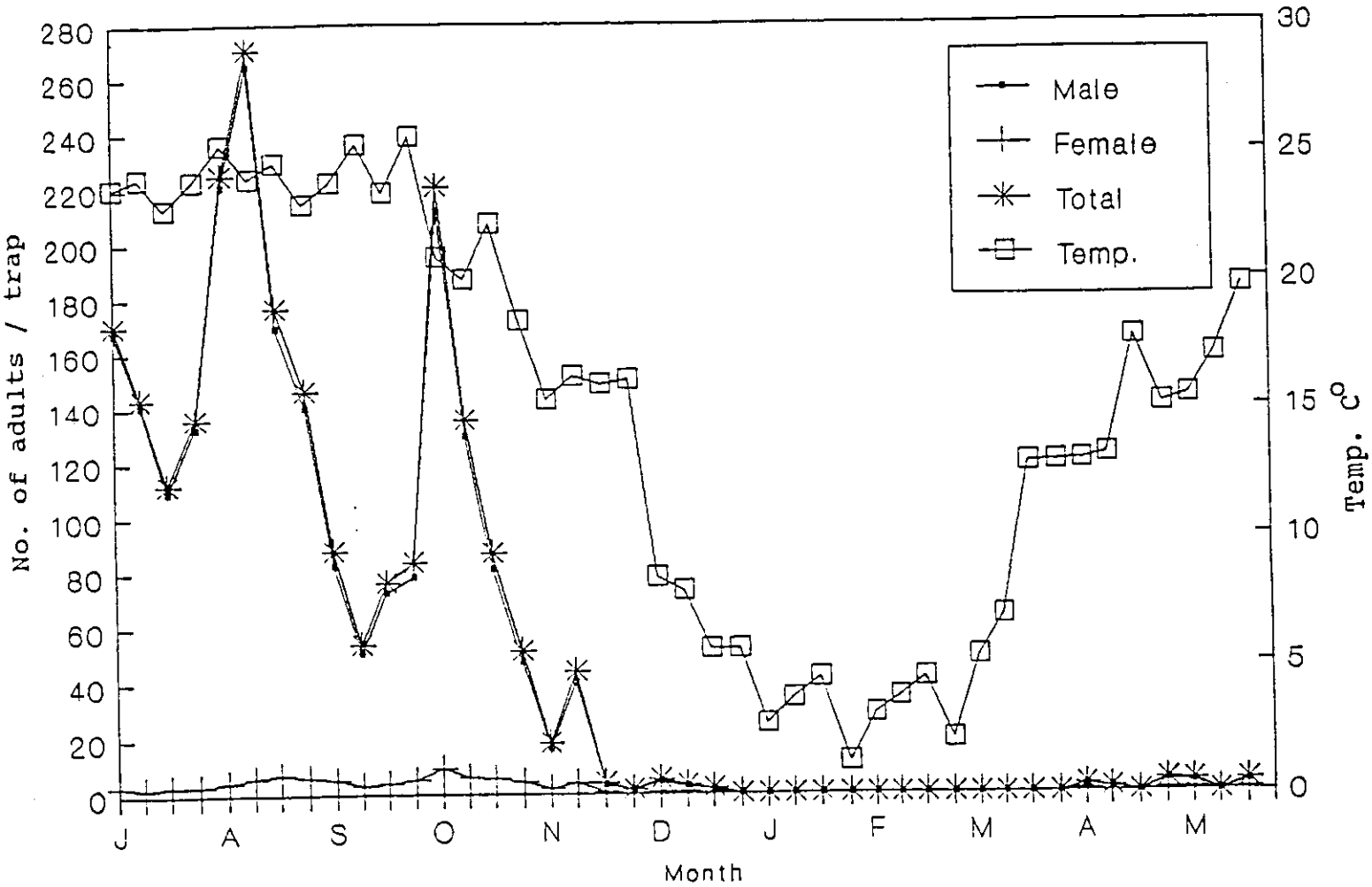

Fig.10: Distribution of olive fruit fly caught on vertical yellow sticky trap with 20 mg pheromone capsule at Salt grove from mid-July,1991 to end of May,1992.

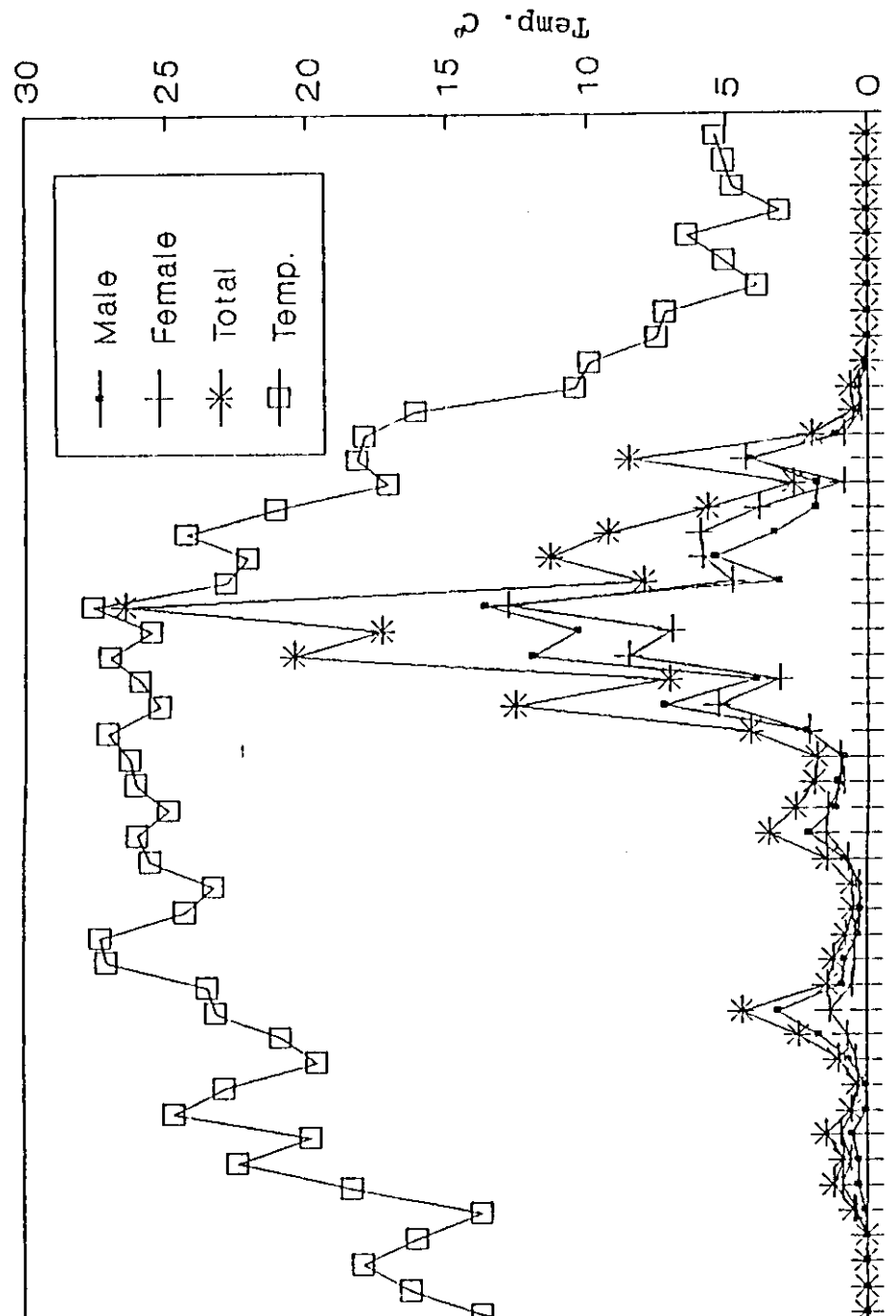

Fig.11: Distribution of olive fruit fly caught on Mcphail trap with diammonium phosphate and yeast at Baqaa grove from March,1991 to end of February,1992.

Fig. 12 . Four main flight activity peaks were recorded from June to end of December . The first peak was at late June . The second peak was at mid-August . The third peak was at mid-September . The fourth peak was at early October .No flies were trapped from January to end March , while few numbers were caught in April and May .

IV.I.6. Mcphail trap with protein hydrolysate and borax:

Distribution of olive fruit fly caught on Mcphail trap with protein hydrolysate and borax at Baqa'a grove , from March , 1991 to February , 1992 is shown in Fig. 13 . Low numbers of flies were trapped from March to end of July . However, the three main flight activity peaks were recorded from August to end of December . The first peak was in mid-August . The second peak was at early October . The third peak was at the end of October . No flies were trapped during January and February .

Distribution of olive fruit fly caught on Mcphail trap with protein hydrolysate and borax at Salt grove from June , 1991 to May , 1992 is shown in Fig. 14 . Four main flight activity peaks were recorded from June to end of December . The first peak was at mid-June . The second peak was at mid-August . The third peak was at late September . The fourth peak was at early October . No flies were trapped from January to end of March , while few numbers were caught in April and May .

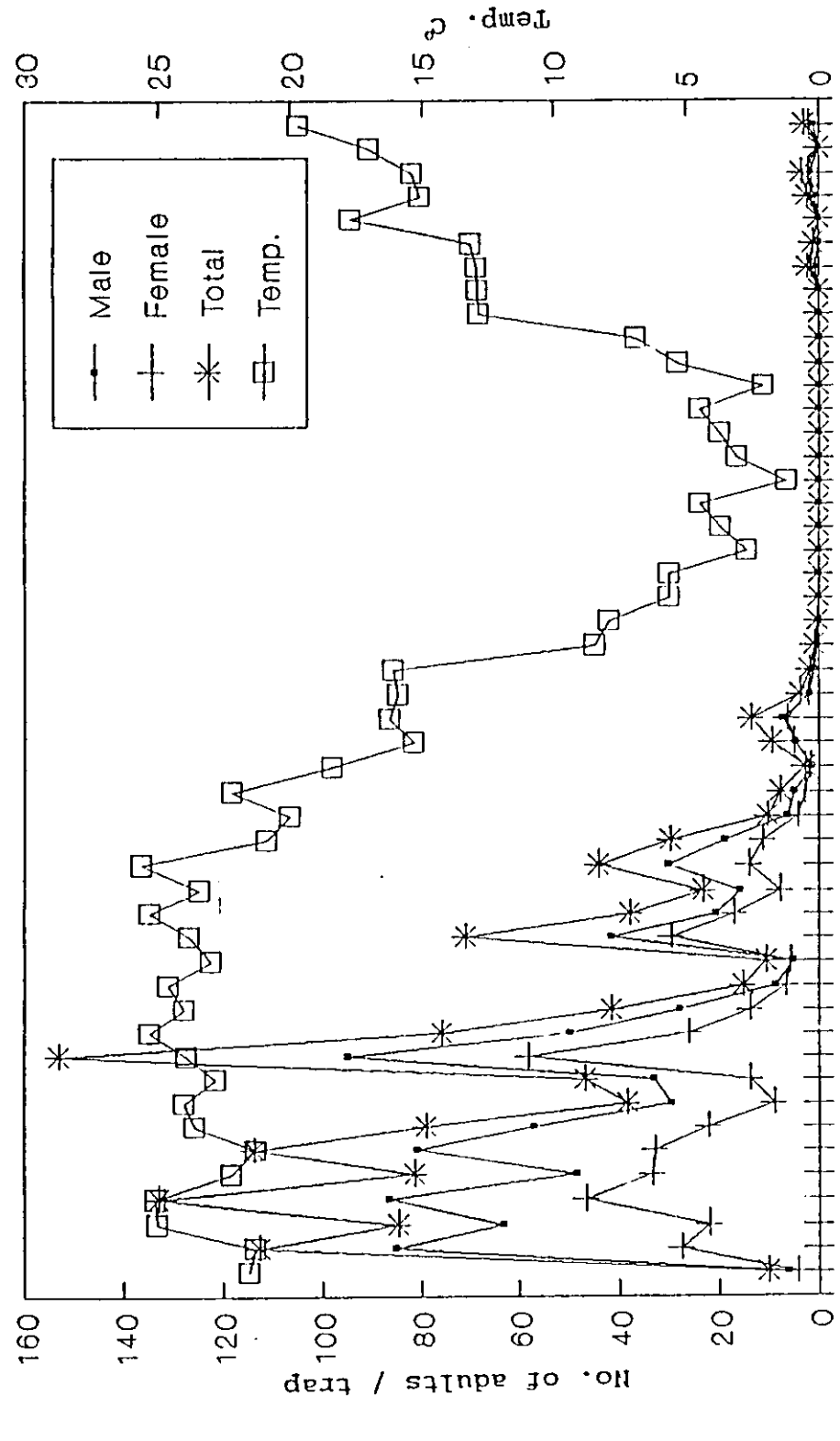

Fig.12: Distribution of olive fruit fly caught on Mcphail trap with diammonium phosphate and yeast at Salt grove from June,1991 to end of May,1992.

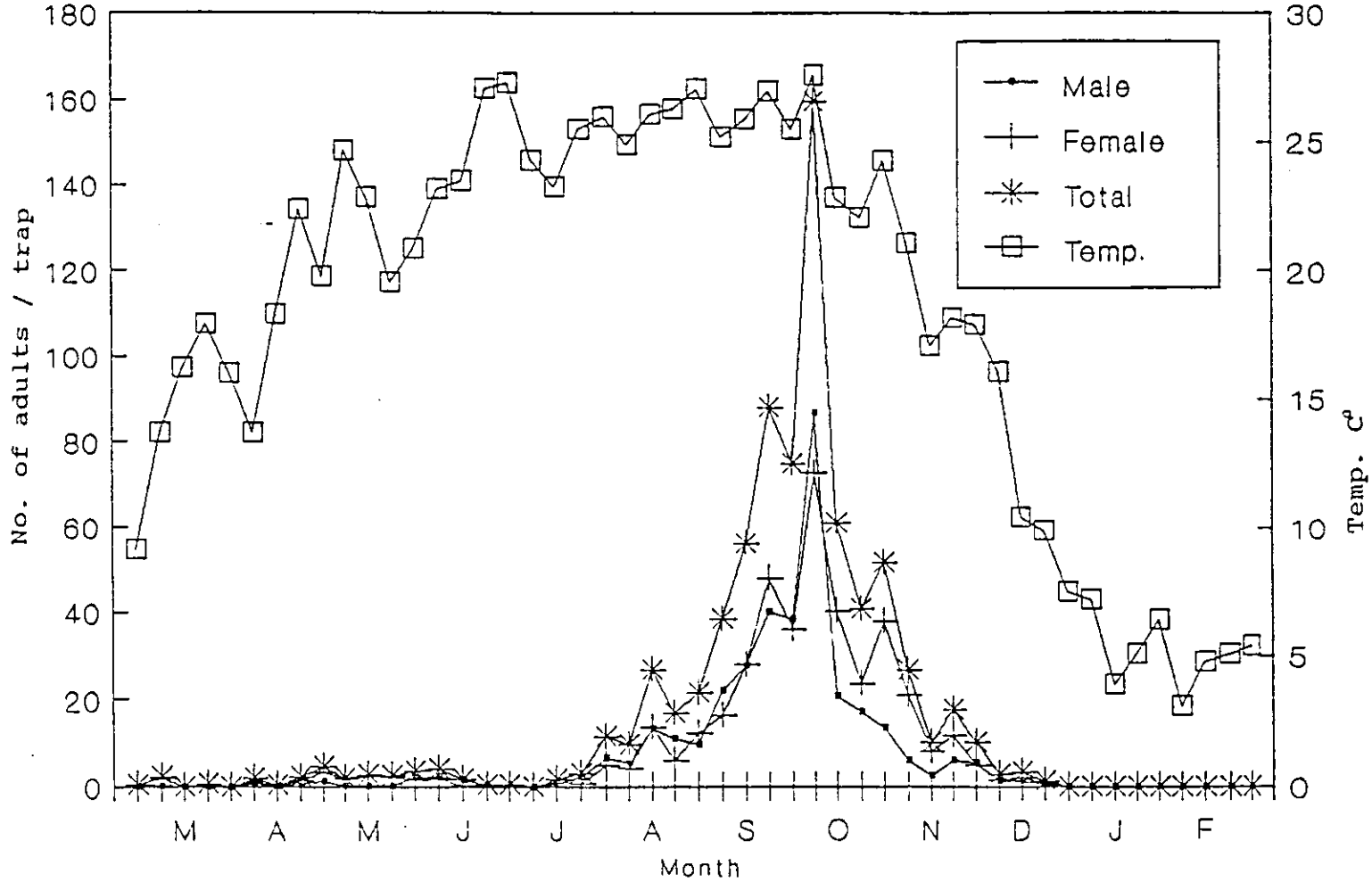

Fig.13: Distribution of olive fruit fly caught on Mcphail trap with protein hydrolysate and borax at Baqaa grove from Marh,1991 to end of Febr.uary,1992.

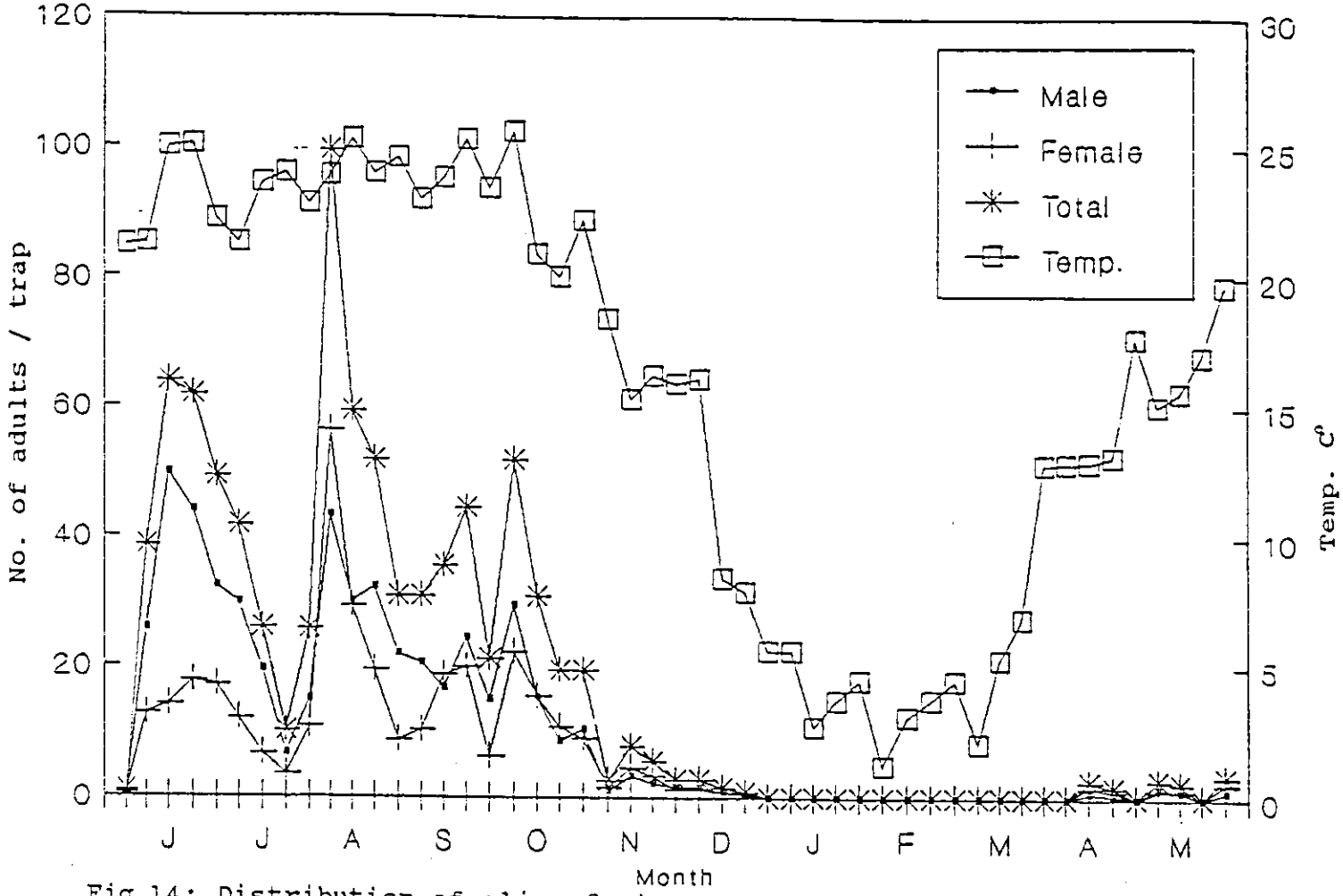

Fig.14: Distribution of olive fruit fly caught on Mcphail trap with protein hydrolysate and borax at Salt grove from June,1991 to end of May,1992.

IV.I.7. Mcphail trap with protein hydrolysate , soluble pheromone and borax :

Distribution of olive fruit fly caught on Mcphail trap with protein hydrolysate , soluble pheromone and borax at Baqa'a grove from March , 1991 to February , 1992 is shown in Fig. 15 . Low numbers of flies were trapped from March to end of July .However, few numbers were caught during this period . Three main flight activity peaks were recorded from August to end of December . The first peak was at mid-August . The second peak was in mid-October . The third peak was in late November . No flies were trapped during January and February .

Distribution of olive fruit fly caught on Mcphail trap with protein hydrolysate , soluble pheromone and borax at Salt grove from June , 1991 to May , 1992 is shown in Fig. 16 . Four main flight activity peaks were recorded from June to end of December . The first peak was in late June . The second peak was in early August . The third peak was in early October . The fourth peak was in late November . No flies were trapped from January to end of March , while few numbers were caught in April and May .

IV.I.8. Ovoid yellow sticky trap :

Distribution of olive fruit fly caught on ovoid yellow sticky trap at Baqa'a grove from March , 1991 to February , 1992 is shown in Fig.17. Low numbers of flies were trapped from March to end of July . However, few numbers were caught

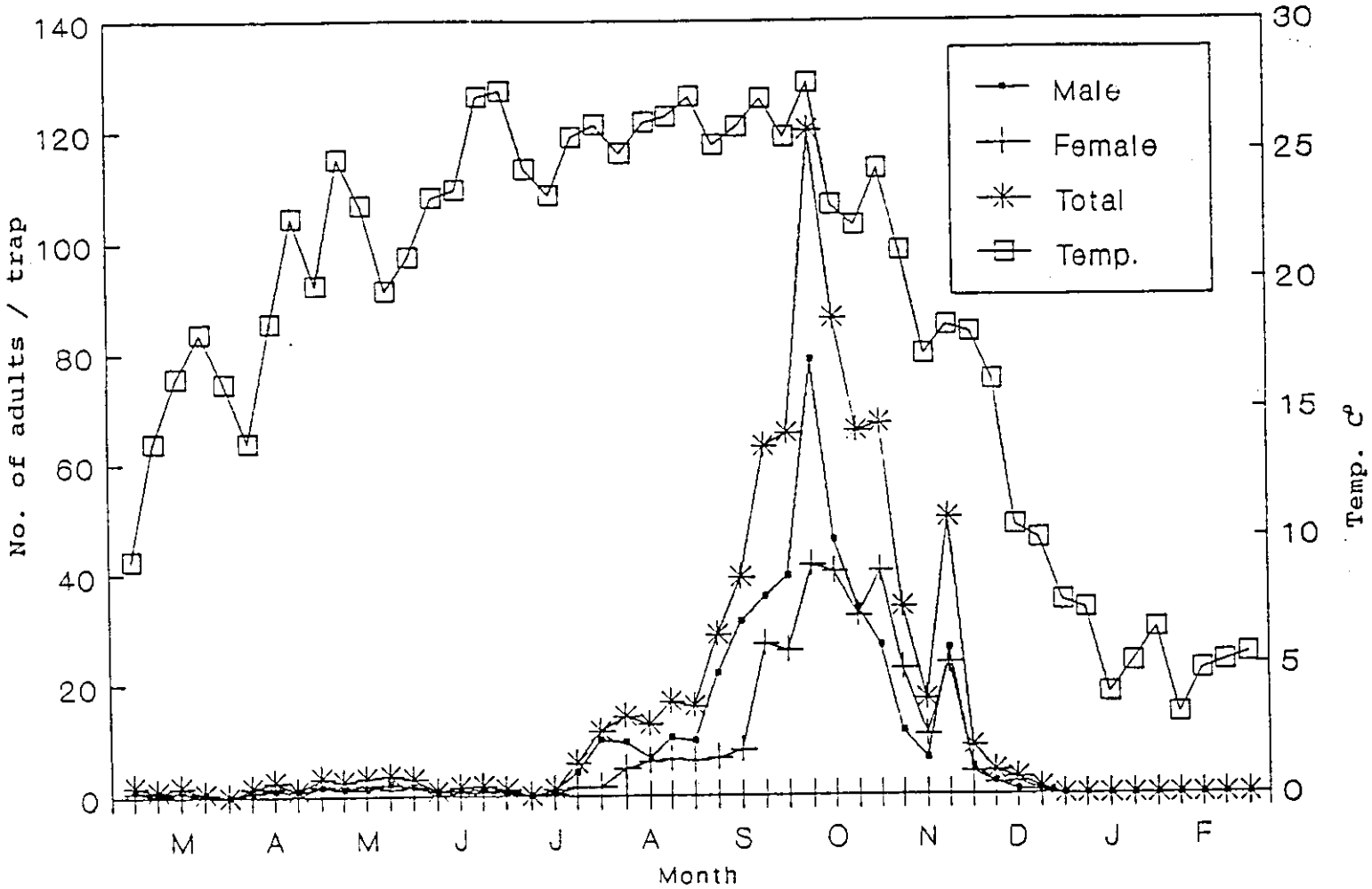

Fig.15: Distribution of olive fruit fly caught on Mcphail trap with protein hydrolysate, soluble pheromone and borax at Baqaa grove from March,1991 to end of February,1992.

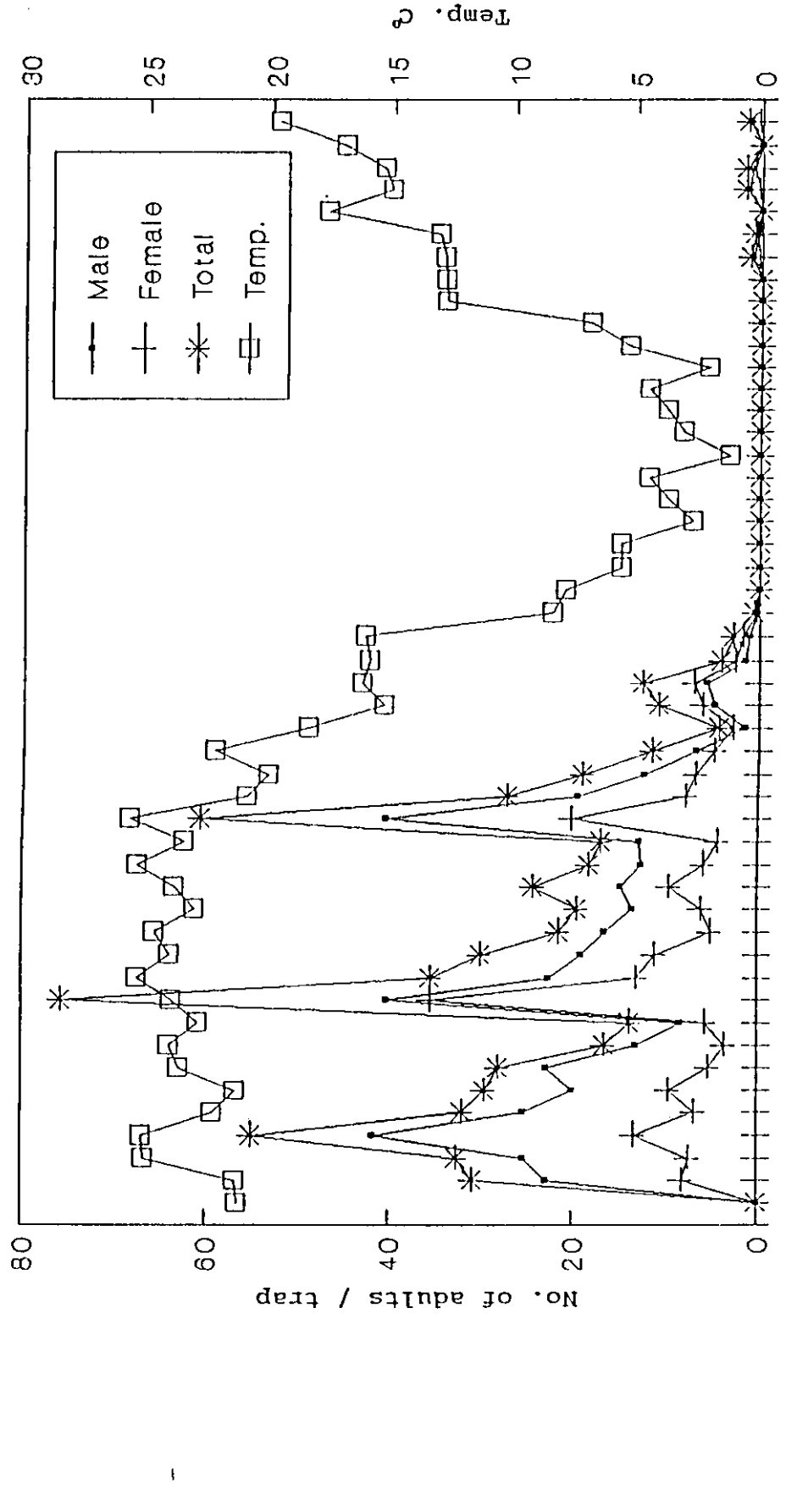

Fig.16: Distribution of olive fruit fly caught on Mcphail trap with protein hydrolysate, soluble pheromone and borax at Salt grove from June,1991 to end of May,1992.

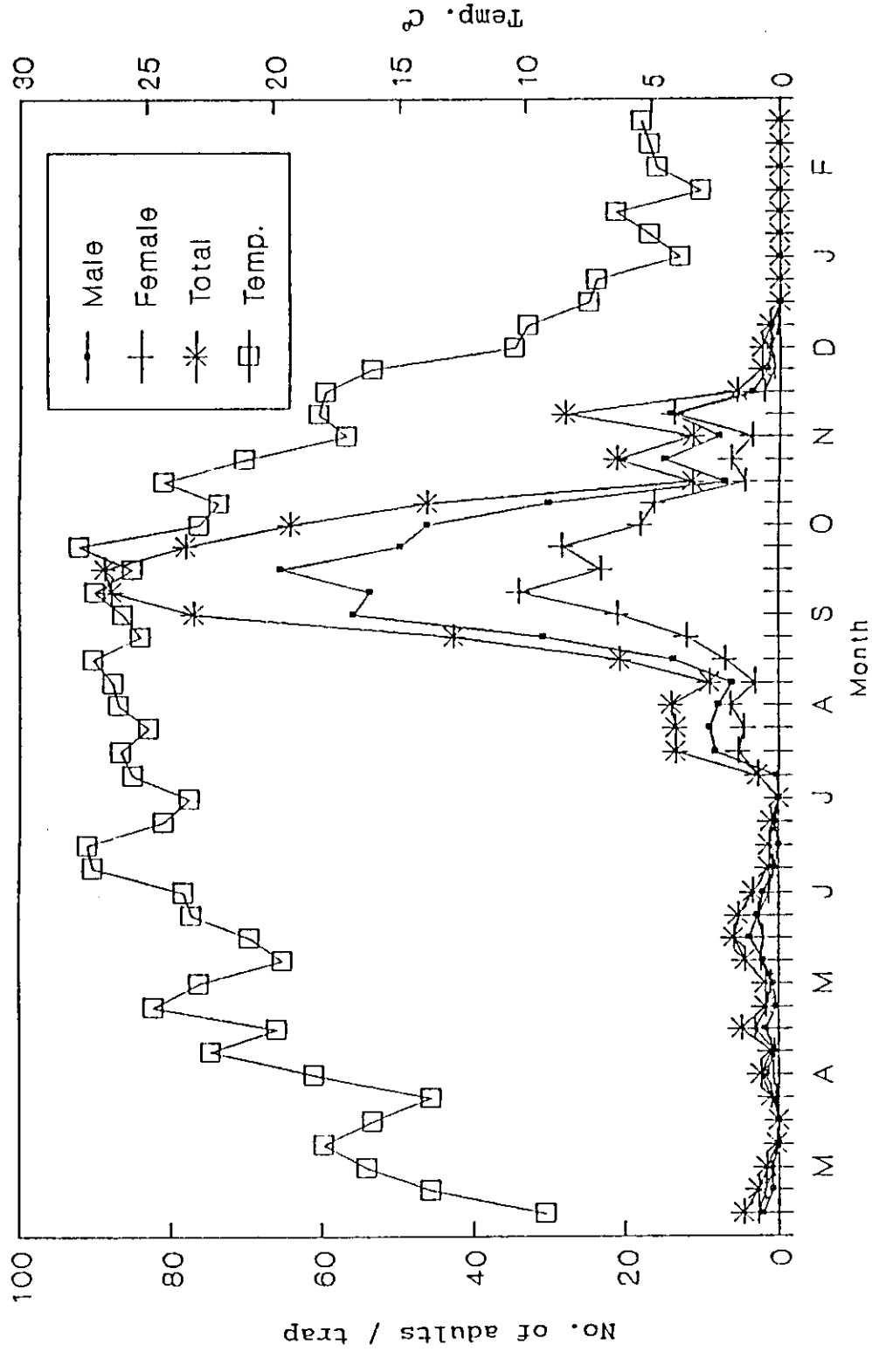

Fig.17: Distribution of olive fruit fly caught on ovoid yellow sticky trap at Baqaa grove from March,1991 to end of February,1992.

during this period . Three main flight activity peaks were recorded from August to end of December . The first peak was in mid-August . The second peak was in early October . The third peak was at late November . No flies were trapped during January and February .

Distribution of olive fruit fly caught on ovoid yellow sticky trap at Salt grove from June , 1991 to May , 1992 is shown in Fig. 18 . Three main flight activity peaks were recorded from June to end of December . The first peak was in mid-August . The second peak was in mid-October . The third peak was in mid-November. However , flight activity peaks were recorded during June and July . No flies were trapped from January to end of March , while few numbers were caught in April and May .

IV.I.9 Ovoid yellow sticky trap with labaneh :

Distribution of olive fruit fly caught on ovoid yellow sticky trap with labaneh at Baqa'a grove from March , 1991 to February , 1992 is shown in Fig. 19 . Low numbers of flies were trapped from March to end of July . However, few numbers were caught during this period . Three main flight activity peaks were recorded from August to end of December . The first peak was in early August . The second peak was in mid-October . The third peak was at late November . No flies were trapped during January and February .

Distribution of olive fruit fly caught on ovoid yellow sticky trap with labaneh at Salt grove from June , 1991 to May , 1992 is shown in Fig. 20 . Three main

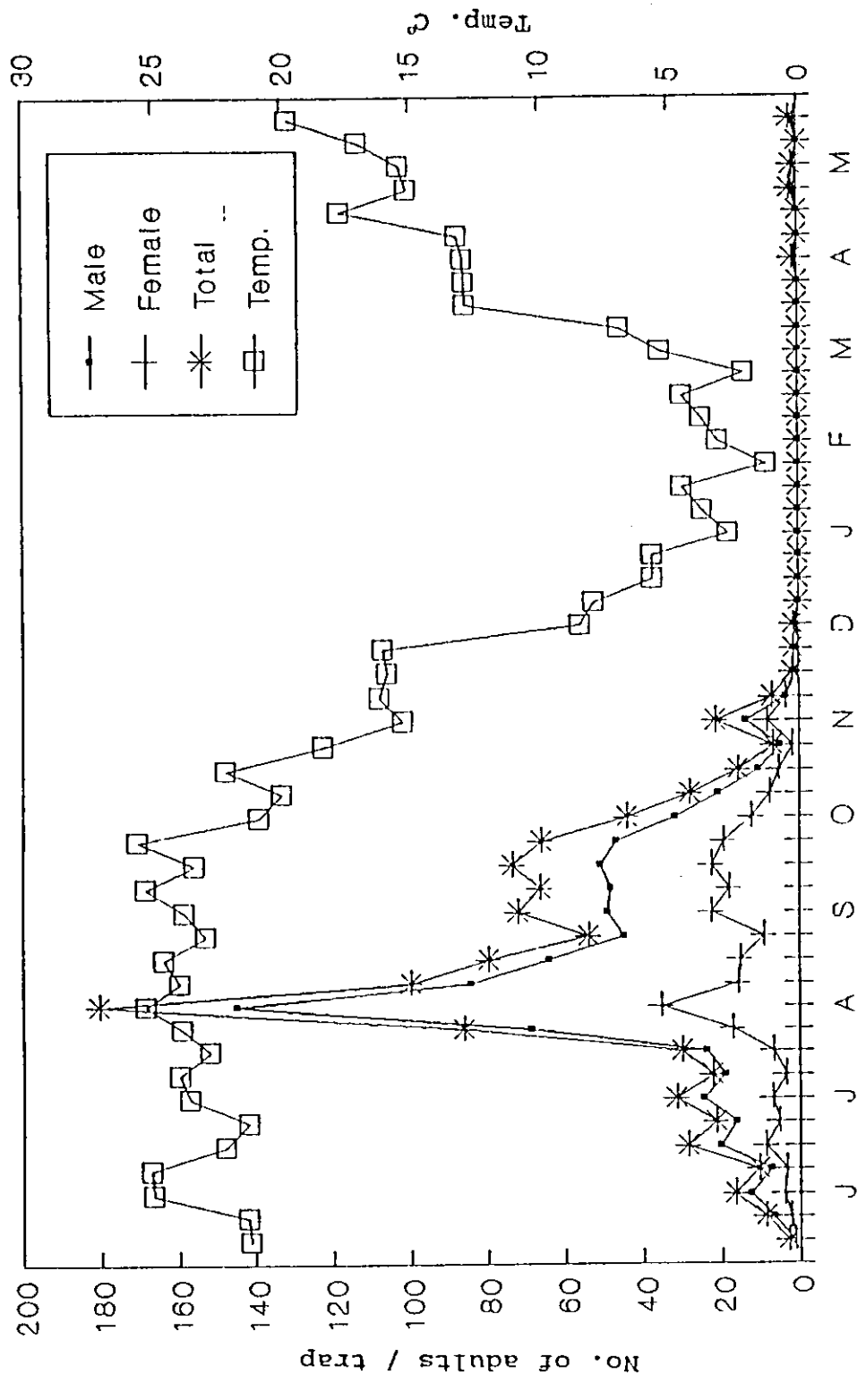

Fig.18: Distribution of olive fruit fly caught on ovoid yellow sticky trap at Salt grove from June,1991 to end of May,1992.

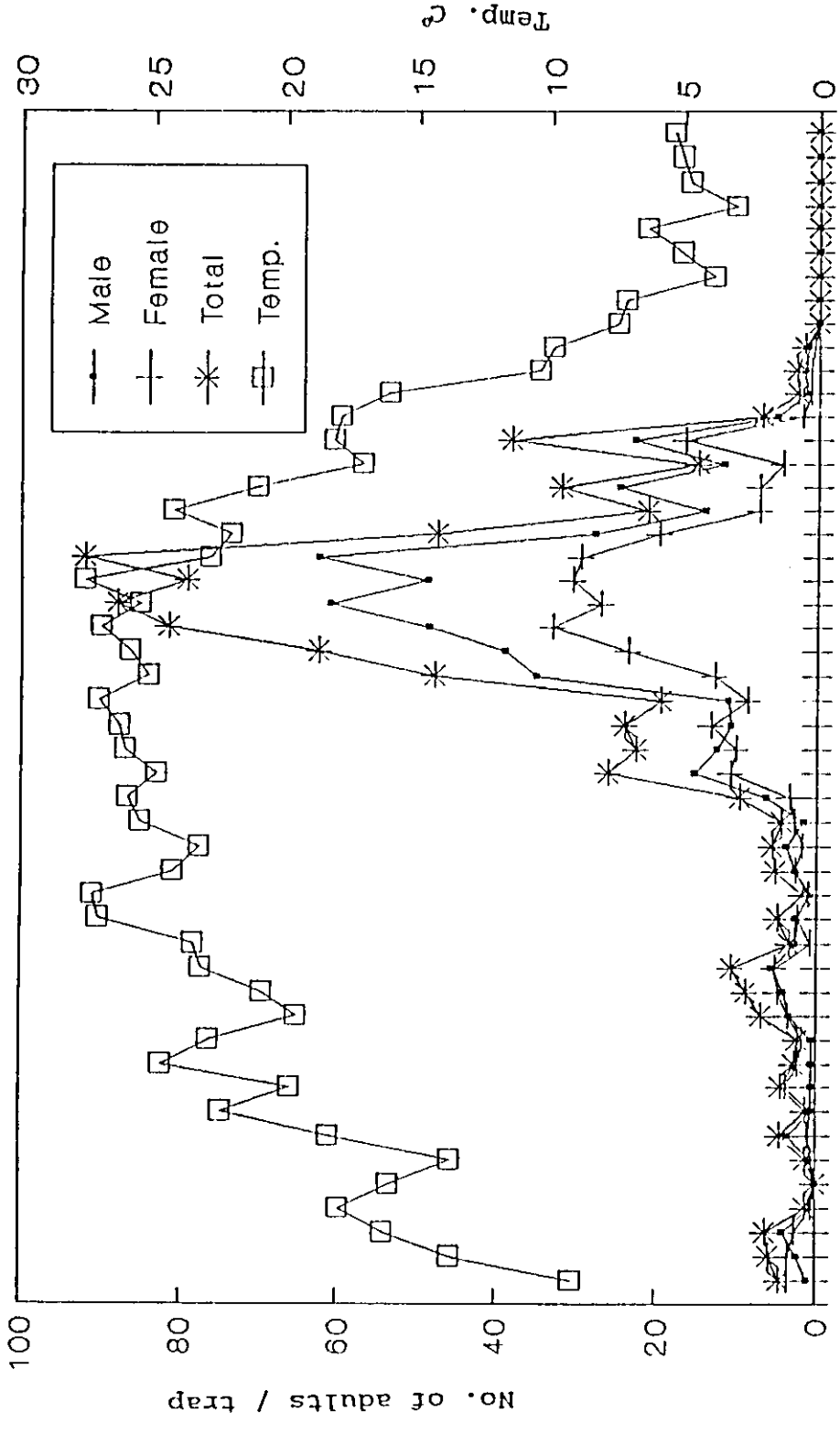

Fig.19: Distribution of olive fruit fly caught on ovoid yellow sticky trap with labaneh at Baqaa grove from March,1991 to end of February,1992.

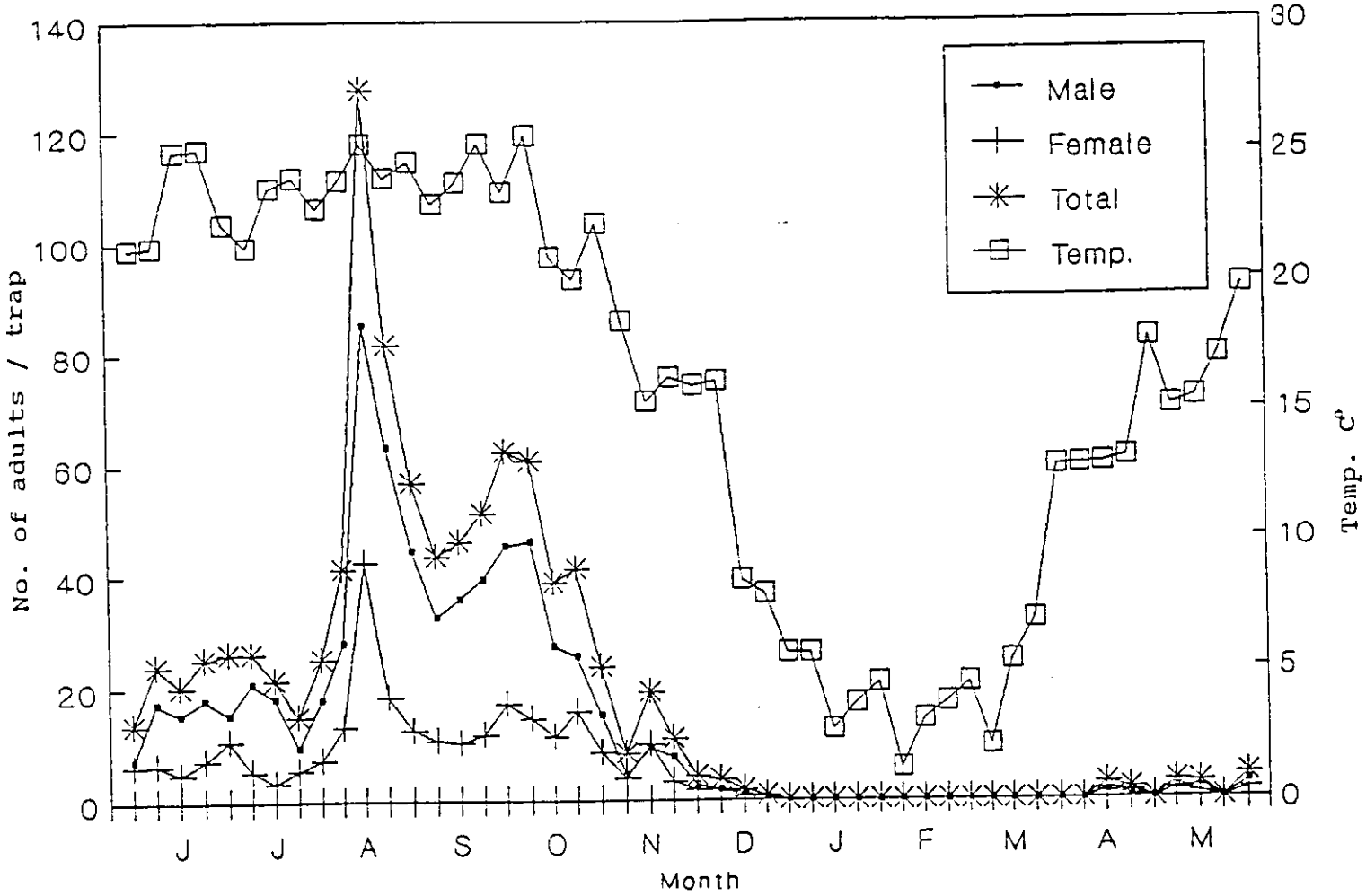

Fig.20: Distribution of olive fruit fly caught on ovoid yellow sticky trap with labaneh at Salt grove from June,1991 to end of May,1992.

flight activity peaks were recorded from June to end of December . The first peak was at mid-August . The second peak was at early October . The third peak was at mid-November . However , flight activity peaks were recorded during June and July . No flies were trapped from January to end of March, while few numbers were caught in April and May .

IV.II.1. Numbers Of Monthly Olive Fruit Fly Caught By The Nine Traps:

Numbers of monthly olive fruit fly caught in Baqa'a grove on the nine traps from March, 1991 to February, 1992 are shown in Table 1. All the traps caught low monthly numbers of flies during March to end of July . The highest catch was 62 adults obtained during June in Mcphail trap with diammonium phosphate and yeast . Also, during this period , Mcphail trap with di-ammonium phosphate and yeast and ovoid trap with labaneh were significantly ($P \leq 0.05$) more efficient than other traps with an exception during March as vertical yellow sticky trap with 10 mg pheromone capsule caught the greatest numbers . However , there were no significant differences between these three treatments in July .

From August to December , vertical yellow sticky trap with 20 mg pheromone capsule gave significantly ($p \leq 0.05$) the greatest caught numbers . Vertical yellow sticky trap was the least in caught numbers during September . While vertical yellow sticky trap with diammonium phosphate was significantly ($P \leq 0.05$) the highest in caught numbers than vertical yellow sticky trap , Mcphail trap with di-ammonium phosphate and yeast , ovoid yellow sticky trap and ovoid yellow sticky trap with labaneh in October . However, all traps did caught high numbers of

Table 1: Numbers of monthly olive fruit fly caught by nine different traps in Baca'a grove from March , 1991 to February , 1992 .

Month	Number of adults /trap									
	Vertical yellow sticky trap	Vertical yellow sticky trap + diammonium phosphate	Vertical yellow sticky trap + 10 mg pheromone	Vertical yellow sticky trap + 20 mg pheromone	Mcphail trap + diammonium phosphate + yeast	Mcphail trap + protein hydrolysate + borax	Mcphail trap + protein hydrolysate + soluble pheromone + borax	Ovoid yellow sticky trap	Ovoid yellow sticky trap + labaneh	LSD
March	1.3 bc .	7.3 bc	19.0 a	____	0.3 c	3.5 bc	6.0 bc	10.8 ab	18.8 a	9.6
April	0.3c	8.8 ab	6.5 abc	____	10.0 a	3.3 bc	4.5 abc	3.5 bc	7.0 ab	6.4
May	8.3 b	7.5 b	5.0 b	____	18.8 a	11.5 ab	10.0 ab	9.3 ab	10.3 ab	9.8
June	6.5 b	14.0 b	14.0 b	____	62.0 a	12.5 b	10.5 b	19.8 b	34.0 ab	34.8
July	5.0 b	17.5 ab	24.3 a	____	18.3 ab	5.3 b	8.3 ab	5.0 b	16.5 ab	17.3
August	41.8 b	135 b	155 b	378 a	82.8 b	67.0 b	71.3 b	71.3 b	101.5 b	118.0
September	99.8 c	319.5 b	245.8 bc	599.0 a	344.0 b	266.3 bc	196.5 bc	296.3 b	279.8 b	170.0
October	95.0 d	496.8 b	350.8 bc	741.3 a	305.0 c	313.3 bc	342.0 bc	199.8 cd	240.0 cd	183.1
November	45.5 c	94.5 bc	69.5 bc	193.0 a	110.3 b	66.3 bc	112.5 b	66.0 bc	93.3 bc	63.0
December	5.8 b	8.8 b	8.3 b	34.5 a	7.0 b	7.3 b	8.5 b	6.3 b	7.0 b	9.9
January	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0
February	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0

Means within rows sharing the same letters are not significantly different at 5 % level using LSD .

olive fruit fly in August , September , October and November .

During November , moderate numbers were caught with a maximum of 193 adults in the vertical yellow sticky trap with 20 mg pheromone capsule , although it did differ significantly ($P \leq 0.05$) than other traps. The vertical yellow sticky trap was significantly the least . However , there were no significant differences between the other traps . There were no trapped insects during January and February , 1992 in all the traps .

Numbers of monthly olive fruit fly caught by all the nine traps in Salt grove from June, 1991 to May, 1992 is shown in Table 2 . During June to end of July , the Mcphail trap with diammonium phosphate and yeast was significantly ($P \leq 0.05$) the highest among other traps . The vertical yellow sticky trap was the least effective . In addition , during July , vertical yellow sticky trap with 10 mg pheromone capsule was significantly ($P \leq 0.05$) the highest in caught numbers than vertical yellow sticky trap , ovoid yellow sticky trap and ovoid yellow sticky trap with labaneh , although the last two traps did catch high numbers .

During August , the highest number was 808 adults caught by vertical yellow sticky trap with 20 mg pheromone capsule . It was significantly ($P \leq 0.05$) caught high numbers than other traps . The vertical yellow sticky trap was the least effective . In addition , the vertical yellow sticky trap with diammonium phosphate was significantly ($P \leq 0.05$) effective than the vertical yellow sticky trap , Mcphail trap with protein hydrolysate + borax and Mcphail trap with protein hydrolysate + soluble pheromone + borax . From August to December , the vertical yellow sticky

Table : 2 Numbers of monthly olive fruit fly caught by nine different traps in Salt grove from June , 1991 to May , 1992 .

Month	Number of adults /trap									LSD
	Vertical yellow sticky trap	Vertical yellow sticky trap + diammonium phosphate	Vertical yellow sticky trap + 10 mg pheromone	Vertical yellow sticky trap + 20 mg pheromone	Mcphail trap + diammonium phosphate + yeast	Mcphail trap + protein hydrolysate + borax	Mcphail trap + protein hydrolysate + soluble pheromone + borax	Ovoid yellow sticky trap	Ovoid yellow sticky trap + labaneh	
June	5.0 c	55.0 bc	26.3 bc	____	216.0 a	104.5 b	66.3 bc	30.5 bc	67.5 bc	86.6
July	15.3 d	233.8 bc	261.5 b	____	447.8 a	188.8 bc	161.0 bc	114.5 cd	114.3 cd	136.9
August	23.3 e	444.5 b	346.5 bc	808.5 a	316.5 bcd	236.3 cd	155.0 ed	410.8 bc	276 bcd	180.0
September	41.0 d	317.3 ab	362.0 ab	448.0 a	157.0 cd	162.8 cd	100.5 d	342.8 ab	260.5 bc	149.7
October	44.8 d	182.0 bc	200.8 b	495.0 a	91.8 cd	121.8 bcd	118.5 bcd	154.5 bc	164.5 bc	95.1
November	12.8 d	31.8 bcd	32.8 bcd	68.0 a	29.5 bcd	18.5 cd	31.5 bcd	36.5 bc	42.8 b	23.4
December	1.5 c	3.0 bc	5.8 abc	10.0 a	2.8 bc	5.0 bc	3.3 bc	3.0 bc	6.0 ab	4.2
January	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0
February	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0
Marcn	0.0 a	0.0a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0a	0
Apnl	0.5 b	2.3 ab	1.3 b	4.3 a	3.3 ab	4.3 a	2.0 ab	1.3 b	4.3 a	2.8
May	3.8 e	7.5 bcd	8.3 bcd	12.3 a	8.8 abc	8.3 bcd	5.0 de	5.5 cde	10.0 ab	3.5

Means within rows sharing the same letters are not significantly different at 5 % level using LSD .

trap with 20 mg pheromone capsule was caught significantly ($P \leq 0.05$) higher numbers than other traps . There were no significant differences between this trap and vertical yellow sticky trap with diammonium phosphate , vertical yellow sticky trap with 10 mg pheromone capsule and ovoid yellow sticky trap in September . However , the ovoid yellow sticky trap with labaneh caught numbers as that of the last mentioned three traps in September . There were no significant differences between numbers caught by other traps in October except vertical yellow sticky trap and Mcphail trap with diammonium phosphate and yeast . There were no significant differences between caught numbers by other traps in November , with exception of ovoid yellow sticky trap and ovoid yellow sticky trap with labaneh, they caught significantly ($P \leq 0.05$) more numbers than vertical yellow sticky trap . However , in December , there were no significant differences between numbers caught by vertical yellow sticky trap with 20 mg pheromone capsule , ovoid yellow sticky trap with labaneh and vertical yellow sticky trap with 10 mg pheromone capsule .

During January to end of March , all traps did not catch olive fruit fly . While from April to end of May , numbers caught by vertical yellow sticky trap with 20 mg pheromone capsule did not differ significantly ($P \leq 0.05$) from numbers caught by ovoid yellow sticky trap with labaneh .

IV.II.2. Olive Fruit Fly Of Both Sexes Caught By The Eight Traps :

Numbers of olive fruit fly male and female caught by the different traps in

Baqa'a grove from beginning of March to end of December, 1991 is presented in (Table 3) .

Vertical yellow sticky trap with 10 mg pheromone capsule caught the greatest number of males , but there was no significant ($P \leq 0.05$) difference between this trap and vertical yellow sticky trap with diammonium phosphate . However , numbers caught by the last mentioned trap did not significantly differ from numbers caught by ovoid yellow sticky trap with labaneh and Mcphail trap with diammonium phosphate + yeast .

Ovoid yellow sticky trap with labaneh was significantly ($P \leq 0.05$) caught similar number of females to those caught by other traps except vertical yellow sticky trap with 10 mg pheromone capsule which caught the least number of females. However, the Mcphail traps were the most efficient in catching female flies.

Numbers of olive fruit fly males and females caught by the different traps from beginning of June to end of November, 1991 in Salt grove is shown in (Table 4) . Vertical yellow sticky trap with 10 mg pheromone capsule caught significantly ($P \leq 0.05$) more males than other traps but it did not significantly differ from vertical yellow sticky trap with diammonium phosphate , Mcphail trap with diammonium phosphate + yeast or ovoid yellow sticky trap . In addition , males caught by the last mentioned trap did not differ significantly ($P \leq 0.05$) from all traps with exception of vertical yellow sticky trap which caught the least numbers of males .

Table 3 :Total numbers of males and females of olive fruit fly caught by eight different traps in Baqa'a grove between beginning of March to end of December , 1991 .

Sex	Number of adults / trap ± SE							
	Vertical yellow sticky trap	Vertical yellow sticky trap + diammonium phosphate	Vertical yellow sticky trap + 10 mg pheromone	Mcphail trap + diammonium phosphate + yeast	Mcphail trap + protein hydrolysate + borax	Mcphail trap + protein hydrolysate + soluble pheromone + borax	Ovoid yellow sticky trap	Ovoid yellow sticky trap + labaneh
Male	200.3 d ± 44.7	769.3 ab ± 127.4	837.8 a ± 58.3	507.3 bc ± 162.6	350.0 cd ± 45.7	438.3 cd ± 70.5	450.3 cd ± 87.7	501.5 bc ± 67
Female	110.8 cd ± 28.9	340.5 ab ± 71.9	61.5 d ± 2.9	478.0 a ± 133.3	412.0 ab ± 73.4	327.0 ab ± 71.9	237.3 bcd ± 57.1	306.5 abc ± 74.5

Means within rows sharing the same letters are not significantly different at 5 % level using LSD .

Table : 4 Total numbers of males and females of olive fruit fly caught by eight different traps in Salt grove between beginning of June to end of November, 1991.

Sex	Number of adults / trap ± SE							
	Vertical yellow sticky trap	Vertical yellow sticky trap + diammonium phosphate	Vertical yellow sticky trap + 10 mg pheromone	Mcphail trap + diammonium phosphate + yeast	Mcphail trap + protein hydrolysate + borax	Mcphail trap + protein hydrolysate + soluble pheromone + borax	Ovoid yellow sticky trap	Ovoid yellow sticky trap + labaneh
Male	95.3 e ± 18.8	1012.3 ab ± 195.4	1173.8 a ± 154.7	831.5 abc ± 116.6	500.3 cd ± 34.3	424.5 de ± 47.1	823.3 abcd ± 205.5	658.0 bcd ± 153.6
Female	49.3 c ± 8.4	252.3 b ± 51.6	61.0 c ± 14.4	424.5 a ± 68.1	332.0 ab ± 72.2	208.3 b ± 28.6	255.0 b ± 64.3	267 b ± 61.4

Means within rows sharing the same letters are not significantly different at 5 % level using LSD.

Mcphail trap with diammonium phosphate + yeast did catch more females than other traps , although it did not significantly ($P \leq 0.05$) differ than Mcphail trap with protein hydrolysate + borax . In addition , the last mentioned trap did not differ significantly ($P \leq 0.05$) in catch females than the other traps except vertical yellow sticky trap with 10 mg pheromone capsule and vertical yellow sticky trap . The last two mentioned traps caught significantly ($P \leq 0.05$) the least number of females .

IV. II.3 Comparison Between Numbers Of Males and Females Of Olive Fruit Fly Caught By The Eight Traps :

The results in Table 5 represents comparison between numbers of males and females caught by eight traps in Baqa'a grove between beginning of March to end of December, 1991 using "paired t " test . Numbers of Males captured by all the traps were more than females except in Mcphail trap with protein hydrolysate + borax .

The first two types of baited Mcphail traps gave no significant ($P \leq 0.05$) differences between numbers of males and females captured . In all other traps males captured were significantly ($P \leq 0.05$) higher than females . In Salt grove Table 6 represents similar comparison among the same traps between beginning of June to end November, 1991 . Numbers of males captured were significantly ($P \leq 0.05$) higher than numbers of females in all the traps .

Taole 5 : Total numbers of males and females of olive fruit fly caught by eight different traps in Baqa'a grove between beginning of March to end of December, 1991 .

Sex	Number of adults / trap ± SE							
	Vertical yellow sticky trap	Vertical yellow sticky trap + diammonium phosphate	Vertical yellow sticky trap + 10 mg pheromone	Mcphail trap + diammonium phosphate + yeast	Mcphail trap + protein hydroiysate + borax	Mcphail trap + protein hydroiy-sate + soluble pheromone + borax	Ovoid yellow sticky trap	Ovoid yellow sticky trap + labanen
Male	200.8 a ± 44.7	769.3 a ± 127.4	837.8 a ± 58.3	507.3 a ± 162.6	350.0 a ± 45.7	438.3 a ± 70.5	450.3 a ± 87.3	501.5 a ± 66.9
Female	110.8 b ± 28.9	340.5 b ± 71.9	61.5 b ± 2.9	478.0 a ± 133.0	412.0 a ± 73.4	327.0 b ± 71.9	237.3 b ± 57.1	306.5 b ± 74.5

Means within columns sharing the same letters are not significantly different at 5 % level using " paired t " test .

Table 6: Total numbers of males and females of olive fruit fly caught by eight different traps in Salt grove between beginning of June to end of November , 1991 .

Sex	Number of adults / trap ± SE							
	Vertical yellow sticky trap	Vertical yellow sticky trap + diammonium phosphate	Vertical yellow sticky trap + 10 mg pheromone	Mcphail trap + di-ammonium phosphate + yeast	Mcphail trap + protein hydrolysate + borax	Mcphail trap + protein hydrolysate + soluble pheromone + borax	Ovoid yellow sticky trap	Ovoid yellow sticky trap + labanen
Male	95.3 a ± 18.8	1012.3 a ± 195.4	1173.8 a ± 154.7	331.5 a ± 116.6	500.3 a ± 94.4	424.5 a ± 47.1	823.3 a ± 205.5	658.0 a ± 153.6
Female	43.3 b ± 8.4	252.3 b ± 51.6	61.0 b ± 14.4	424.8 b ± 68.1	332.0 b ± 72.2	208.3 b ± 28.6	255.0 b ± 64.3	267.0 b ± 61.4

Means within columns sharing the same letters are not significantly different at 5 % level using " paired t " test .

IV.II.4 Comparison Among Traps :

IV.II.4.a. Ovoid yellow sticky trap with and without labaneh :

The results in Table 7 represents comparison between total numbers of olive fruit fly caught by ovoid yellow sticky trap with and without labaneh in Baqa'a grove between beginning of March to end of December, 1991 using paired t " test.

Ovoid yellow sticky trap with labaneh caught higher numbers of both males and females than ovoid yellow sticky trap , but always they did not differ significantly ($P \leq 0.05$) in Baqa'a grove between March and December , 1991 .

Table 8 represents comparison between total numbers of olive fruit fly caught by ovoid yellow sticky trap with and without labaneh in Salt grove between beginning of June to end of November , 1991 .

Ovoid yellow sticky trap with labaneh caught lower numbers of males than ovoid yellow sticky trap , but they did not differ significantly ($P \leq 0.05$) in the period between June and November 1991 .

Ovoid yellow sticky trap with labaneh caught higher numbers of females than ovoid yellow sticky trap but they did not differ significantly ($P \leq 0.05$) in Salt grove during the same previously mentioned period . In case of total catches , ovoid yellow sticky trap caught higher numbers than ovoid yellow sticky trap with labaneh , but also they did not differ significantly ($P \leq 0.05$) in the same grove during the same period .

Table 7: Comparison between total numbers of olive fruit fly caught by ovoid yellow sticky trap with and without labaneh in Baqa'a grove between beginning of March to end of December , 1991 .

Trap	Number of adults / trap ± SE		
	Male	Female	Total
Ovoid yellow sticky trap with labaneh	501.5 a ± 66.9	306.5 a ± 74.5	808.0 a ± 139.9
Ovoid yellow sticky trap	450.3 a ± 87.8	237.3 a ± 57.1	687.5 a ± 143.8

Means within columns sharing the same letters are not significantly different at 5 % level using " paired t " test .

Table 8: Comparison between total numbers of olive fruit fly caught by ovoid yellow sticky trap with and without labaneh in Salt grove between beginning of June to end of November, 1991 .

Trap	Number of adults / trap ± SE		
	Male	Female	Total
Ovoid yellow sticky trap with labaneh	658.0 a ± 153.8	267.0 a ± 61.4	925.0 a ± 214.8
Ovoid yellow sticky trap	823.3 a ± 205.5	255.0 a ± 64.3	1078.3 a ± 268.4

Means within columns sharing the same letters are not significantly different at 5 % level using " paired t " test

IV.II.4.b. Vertical yellow sticky trap with 10 and 20 mg pheromone capsule :

The results in Table 9 represents comparison between total numbers of olive fruit fly caught by vertical yellow sticky trap with 10 and 20 mg pheromone capsule in Baqa'a grove between mid-July to end of December , 1991 , using " paired t " test .

Vertical yellow sticky trap with 20 mg pheromone capsule caught significantly ($P \leq 0.05$) higher numbers of both males and females than vertical yellow sticky trap with 10 mg pheromone capsule in Baqa'a grove between mid-July and end of December , 1991 .

Table 10 represents comparison between total numbers of olive fruit fly caught by vertical yellow sticky trap with 10 and 20 mg pheromone capsule in Salt grove between mid-July to end of December , 1991 . The Table shows that vertical yellow sticky trap with 20 mg pheromone capsule caught significantly ($P \leq 0.05$) higher numbers of males. Although it caught more numbers of females than the other trap , but they did not differ significantly . However, vertical yellow sticky trap with 20 mg pheromone capsule caught significantly ($P \leq 0.05$) more adults in total than the other trap in Salt grove from mid-July up to end of December , 1991 .

Table 9 : Comparison between total numbers of olive fruit fly caught by vertical yellow sticky trap with 10 and 20 mg pheromone capsule in Baqa'a grove between mid-July to end of December , 1991 .

Trap	Number of adults / trap ± SE		
	Male	Female	Total
Vertical yellow sticky trap with 20 mg pheromone capsule	1842.3 a ± 240.6	139.8 a ± 24.8	1982.0 a ± 264.8
Vertical yellow sticky trap with 10 mg pheromone capsule	785.5 b ± 48.8	58.5 b ± 1.3	844.0 b ± 48.4

Means within columns sharing the same letters are not significantly different at 5 % level using " paired t " test .

Table 10 : Comparison between total numbers of olive fruit fly caught by vertical yellow sticky trap with 10 and 20 mg pheromone capsule in Salt grove between mid-July to end of December , 1991 .

Trap	Number of adults / trap ± SE		
	Male	Female	Total
Vertical yellow sticky trap with 20 mg pheromone capsule	2171.8 a ± 149	85.3 a ± 4.9	2257.0 a ± 149.6
Vertical yellow sticky trap with 10 mg pheromone capsule	1041.8 b ± 145.3	58.3 a ± 13.9	1100.0 b ± 157

Means within columns sharing the same letters are not significantly different at 5 % level using " paired t " test .

IV.II.4.c. Mcphail trap with diammonium phosphate and yeast and Mcphail trap with protein hydrolysate and borax :

Results in Table 11 represents comparison between total numbers of olive fruit fly caught by Mcphail trap with diammonium phosphate and yeast , Mcphail trap with protein hydrolysate and borax in Baqa'a grove between beginning of March to end of December , 1991 . Mcphail trap with diammonium phosphate and yeast caught higher numbers of both males and females than Mcphail trap with protein hydrolysate and borax , although they did not differ significantly ($P \leq 0.05$).

Table 12 represents comparison between total numbers of olive fruit fly caught by Mcphail trap with diammonium phosphate and yeast , Mcphail trap with protein hydrolysate and borax in Salt grove between beginning of June and end of November , 1991 . Mcphail trap with diammonium phosphate and yeast caught higher numbers of both males and females than Mcphail trap with protein hydrolysate and borax in Salt grove between beginning of June and end of November , 1991 , although , the difference between number of adults caught by these two traps is high , but they did not differ significantly .

IV.II.4.d. Mcphail trap with diammonium phosphate and yeast and Mcphail trap with protein hydrolysate , soluble pheromone and borax :

Results in Table13 represents comparison between total numbers of olive fruit fly caught by Mcphail trap with diammonium phosphate and yeast , Mcphail

Table 11 : Comparison between total numbers of olive fruit fly caught by Mcphail trap with diammonium phosphate and yeast , and Mcphail trap with protein hydrolysate and borax in Baqa'a grove between beginning of March to end of December , 1991 .

Trap	Number of adults / trap ± SE		
	Male	Female	Total
Mcphail trap + diammonium phosphate + yeast	507.8 a ± 162.6	478.0 a ± 133.3	985.8 a ± 294.4
Mcphail trap + protein hydrolysate + borax	350.0 a ± 45.7	412.0 a ± 73.4	762.0 a ± 117.5

Means within columns sharing the same letters are not significantly different at 5 % level using " paired t " test .

Table 12 : Comparison between total numbers of olive fruit fly caught by Mcphail trap with diammonium phosphate and yeast , and Mcphail trap with protein hydrolysate and borax in Salt grove between beginning of June to end of November , 1991 .

Trap	Number of adults / trap ± SE		
	Male	Female	Total
Mcphail trap + diammonium phosphate + yeast	831.5 a ± 116.6	424.8 a ± 68.1	1256.3 a ± 177.8
Mcphail trap + protein hydrolysate + borax	500.3 a ± 94.4	332.0 a ± 72.2	832.3 a ± 160.2

Means within columns sharing the same letters are not significantly different at 5 % level using " paired t " test .

Table 13 : Comparison between total numbers of olive fruit fly caught by Mcphail trap with diammonium phosphate and yeast , and Mcphail trap with protein hydrolysate , solubie peheromone and borax in Baqa'a grove between beginning of March to end of December , 1991 .

Trap	Number of adults / trap ± SE		
	Male	Female	Total
Mcphail trap + diammonium phosphate + yeast	507.8 a ± 162.6	478.0 a ± 133.3	985.8 a ± 294.4
Mcphail trap + protein hydrolysate + soluble pheromone + borax	438.3 a ± 70.5	327.0 a ± 71.9	765.3 a ± 139.9

Means within columns sharing the same letters are not significantly different at 5 % level using " paired t " test .

trap with protein hydrolysate , soluble pheromone and borax in Baqa'a grove between beginning of March to end of December , 1991 . Mcphail trap with diammonium phosphate and yeast caught higher numbers of both males and females than Mcphail trap with protein hydrolysate , soluble pheromone and borax , but they did not differ significantly ($P \leq 0.05$) .

Table 14 represents comaprison between total numbers of olive fruit fly caught by Mcphail trap with diammonium phosphate and yeast , Mcphail trap with protein hydrolysate , soluble pheromone and borax in Salt grove between beginning of June to end of November , 1991 . Mcphail trap with diammonium phosphate and yeast caught significantly ($P \leq 0.05$) higher numbers of both males and females than Mcphail trap with protein hydrolysate , soluble pheromone and borax in Salt grove between June and November , 1991 .

IV.II.4.e. Mcphail trap with protein hydrolysate and borax and Mcphail trap with protein hydrolysate , soluble pheromone and borax :

Results in Table 15 represents comparison between total numbers of olive fruit fly caught by Mcphail trap with protein hydrolysate and borax , Mcphail trap with protein hydrolysate , soluble pheromone and borax between beginning of March to end of December , 1991 .

Mcphail trap with protein hydrolysate and borax caught lower numbers of males than Mcphail trap with protein hydrolysate , soluble pheromone and borax, but they did not differ significantly ($P \leq 0.05$) .

Table 14 : Comparison between total numbers of olive fruit fly caught by Mcphail trap with diammonium phosphate and yeast , and Mcphail trap with protein hydrolysate , soluble pheromone and borax in Salt grove between beginning of June to end of November , 1991 .

Trap	Number of adults / trap ± SE		
	Male	Female	Total
Mcphail trap + diammonium phosphate + yeast	831.5 a ± 116.6	424.8 a ± 68.1	1256.3 a ± 177.8
Mcphail trap + protein hydrolysate + soluble pheromone + borax	424.5 b ± 47.1	208.3 b ± 28.6	632.8 b ± 65.1

Means within columns sharing the same letters are not significantly different at 5 % level using " paired t " test .

Table 15 : Comparison between total numbers of olive fruit fly caught by Mcphail trap with protein hydrolysate and borax , and Mcphail trap with protein hydrolysate , soluble pheromone and borax in Baqa'a grove between beginning of March to end of December , 1991 .

Trap	Number of adults / trap ± SE		
	Male	Female	Total
Mcphail trap + protein hydrolysate + borax	350.0 a ± 45.7	412.0 a ± 73.4	762.0 a ± 117.5
Mcphail trap + protein hydrolysate + soluble pheromone + borax	438.3 a ± 70.5	327.0 a ± 71.9	765.3 a ± 139.9

Means within columns sharing the same letters are not significantly different at 5 % level using " paired t " test .

Mcphail trap with protein hydrolysate and borax caught higher numbers of females than Mcphail trap with protein hydrolysate , soluble pheromone and borax, however, they did not differ significantly . The total numbers of olive fruit fly caught by these two traps were about the same (Table 15) .

Table 16 represents comaprison between total numbers of olive fruit fly caught by Mcphail trap with protein hydrolysate and borax , Mcphail trap with protein hydrolysate , soluble pheromone and borax in Salt grove between beginning of June to end of November , 1991 . Mcphail trap with protein hydrolysate and borax caught higher numbers of both males and females than Mcphail trap with protein hydrolysate , soluble pheromone and borax , although they did not differ significantly ($P \leq 0.05$) .

IV.III.1. Fruit Infestation :

To assess fruit infestation by olive fruit fly from the beginning of June to mid-November 1991, four pickling cultivars namely Ascolano , Nasouhi , Rase'e and Shami were studied in Baqa'a grove . While in Salt grove , two cultivars usually used for milling to extract oil were studied , namely Nabali and Souri .

IV.III.1.a. Ascolano cultivar :

Low infestation occurred during June and July, as it reached 7% . By mid-August , the percentage increased about two times and becomes five fold in mid-September. The peak of infestation occurred in mid-October, reaching 48% , then

Table 16 : Comparison between total numbers of olive fruit fly caught by Mcphail trap with protein hydrolysate and borax , and Mcphail trap with protein hydrolysate , soluble pheromone and borax in Salt grove between beginning of June to end of November , 1991 .

Trap	Number of adults / trap ± SE		
	Male	Female	Total
Mcphail trap + protein hydrolysate + borax	500.3 a ± 94.4	332.0 a ± 72.2	832.3 a ± 160.3
Mcphail trap + protein hydrolysate + soluble pheromone + borax	424.5 a ± 47.1	208.3 a ± 28.6	632.8 a ± 65.1

Means within columns sharing the same letters are not significantly different at 5 % level using " paired t " test .

decreased to 34 % by mid-November (Fig. 21) .

IV.III.1.b. Nasouhl cultivar :

No infestation occurred during June but low infestation percentage was recorded during July and reached 6% by mid-August . It increased about three to four times during mid-September to end of October . The peak of infestation was in mid-November and reached about 29 % (Fig.21) .

IV.III.1.c. Rase'e cultivar :

Infestation was low during June and July . It was 10% in mid-August . It increased to 28 and 36 % in mid - October and mid-November . While the peak of infestation occurred at the end of October ; it reached 43 % (Fig. 21) .

IV.III.1.d. Shami cultivar :

Infestation was low during June , while it was moderate during July. It increased in August , reaching 35 % in mid - October and 38 % in mid-November. The peak of infestation occurred in mid - September; it reached 40 % (Fig. 21) .

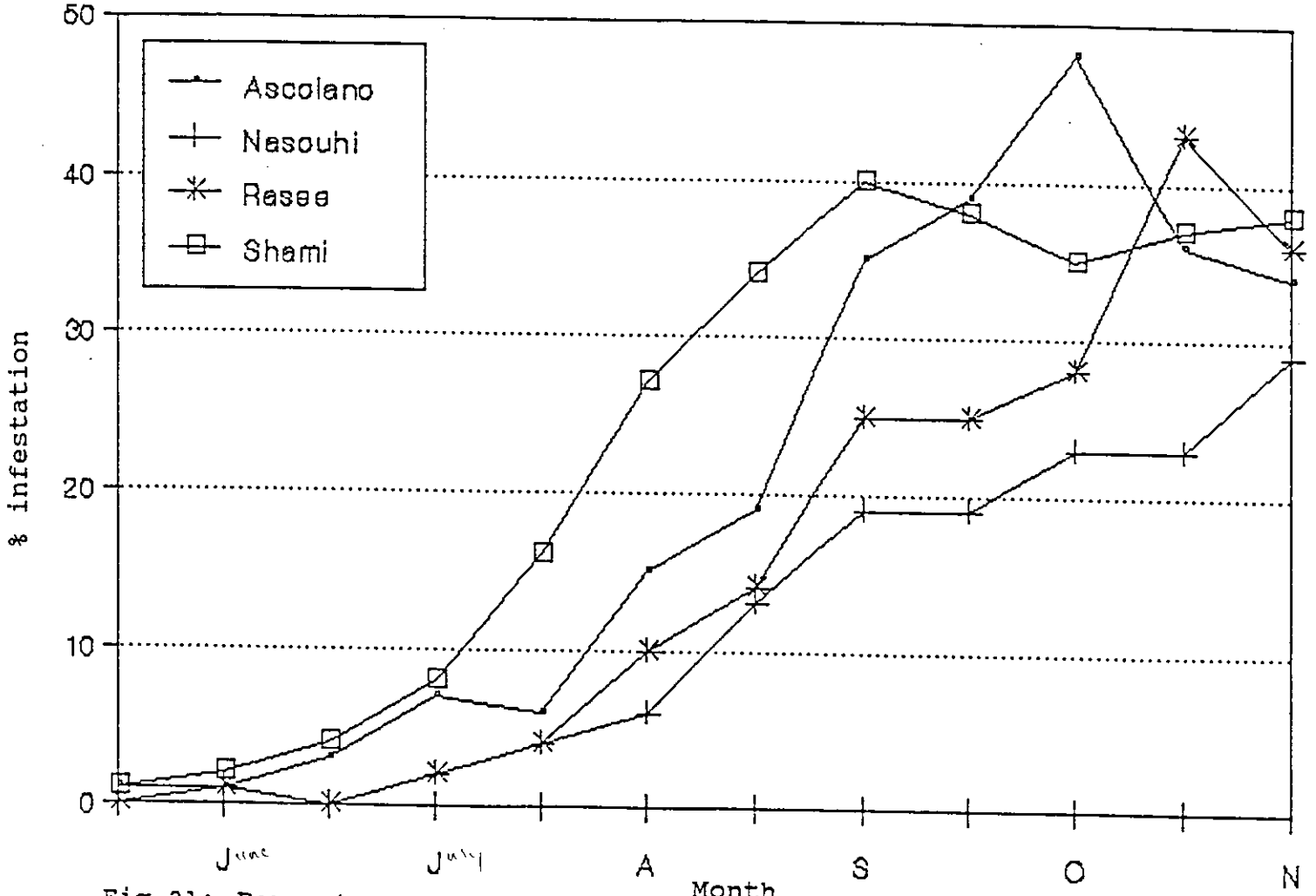

Fig.21: Percentage of infestation of olive fruits of different cultivars by olive fruit fly at Baqaa grove between June to mid-November,1991.

IV.III.1.e. Nabali cultivar:

No infestation occurred during June . It started at low level during July . It increased in August , reaching about 11% at mid - August and 17 % by mid-September . The peak of infestation occurred at the end of October; it reached about 22 % (Fig. 22) .

IV.III.1.f. Souri cultivar:

Infestation was low during June . It increased in July and reached about 7 % in mid-July and 30 % in mid- August . The peak of infestation occurred at the end of August , reaching about 40 % . From mid-September to mid - November , also high infesation occurred , reaching about 34 % at mid - September and 30 % at mid-November (Fig. 22) .

IV.Iv. Mature Eggs In Females:

Results in Fig. 23 represents number of mature eggs per female counted weekly in the ovaries of olive fruit flies trapped from Salt grove between July and November , 1991.

There were three peaks for numbers of mature eggs. The first peak appeared in mid-July; it reached 13 eggs per female. The second peak appeared in late of August; it reached about 9 eggs per female. The third peak appeared in late of October; it reached about 7.5 eggs per female, then decreased gradually .

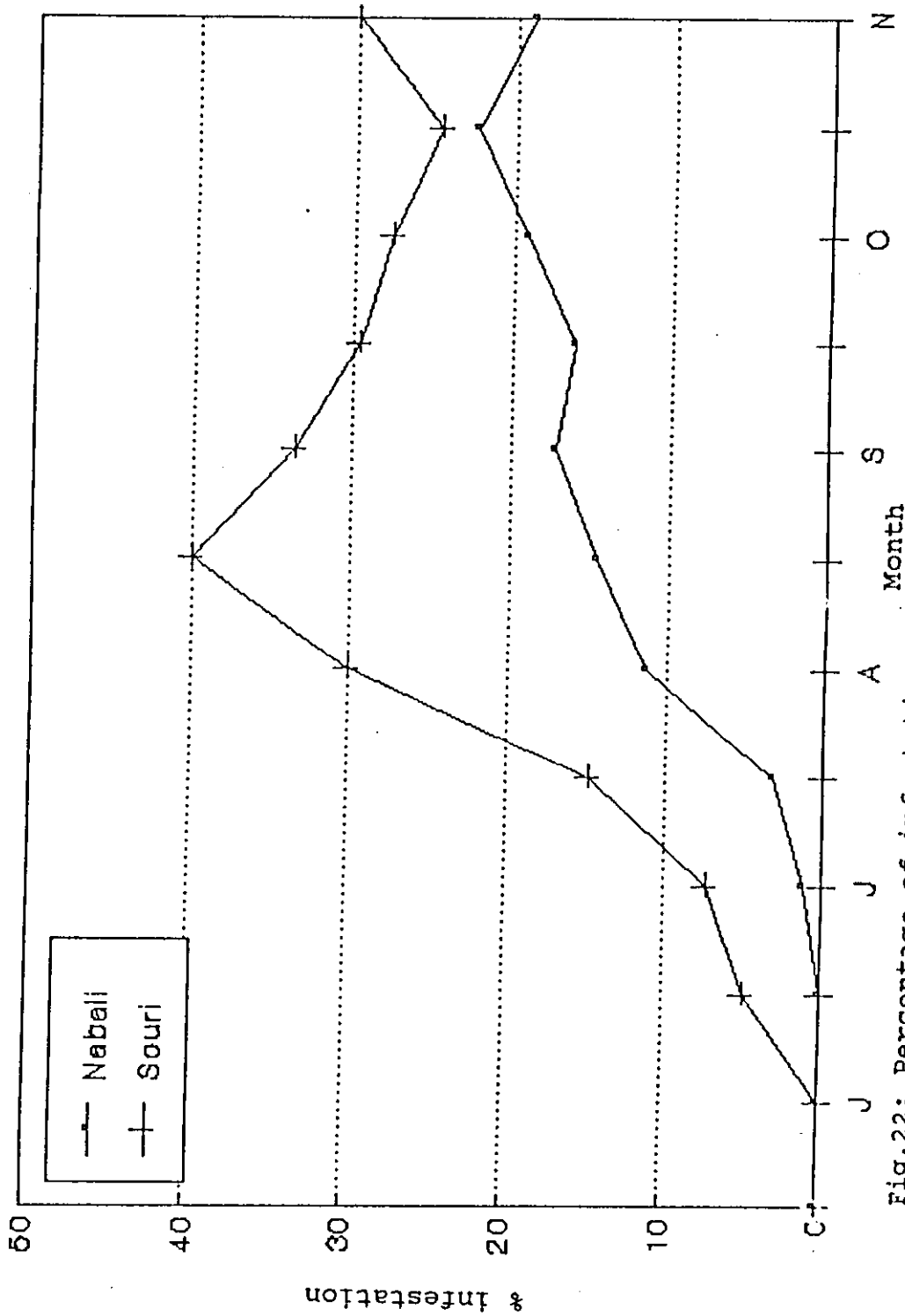

Fig.22: Percentage of infestation of olive fruits of different cultivars by olive fruit fly at Salt grove between June to mid-November,1991.

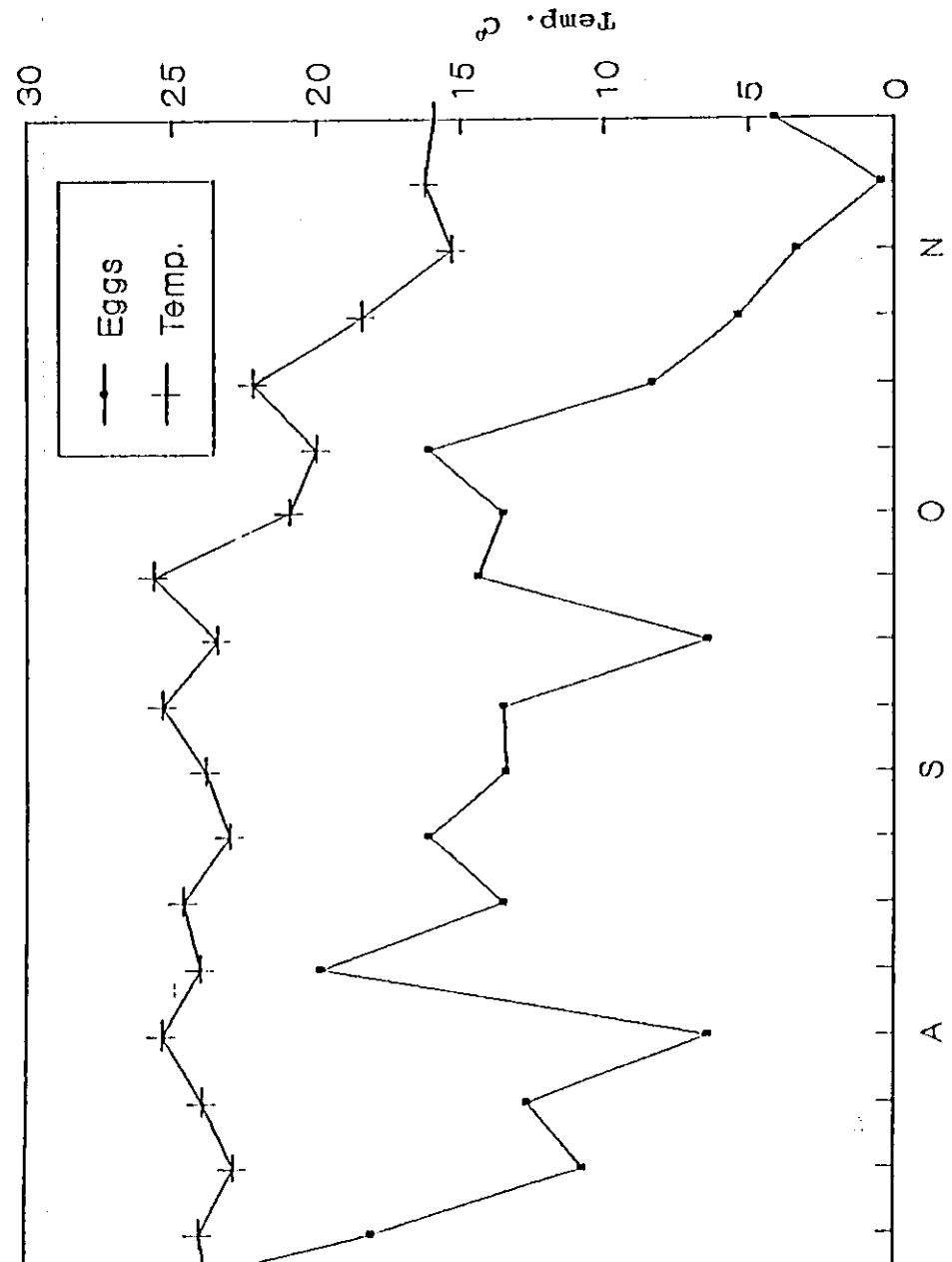

Fig.23: Mean number of mature eggs per 20 females of olive fruit fly caught by Mcphail trap at Salt grove from July to end of November,1991.

IV.v. Parasitoid Occurrence :

Numbers of adult parasite emerged from caged infested fruits collected from Baqa'a and Salt grove between July and mid-November, 1991 were studied.

III.v.1. *Opius concolor* :

Numbers of the adult parasitoid *Opius concolor* emerged from 200 caged infested olive fruits collected from Baqa'a and Salt groves (Fig. 24) were separately recorded under the previously mentioned growth chamber conditions .

At Baqa'a grove , the number of emerged parasitoids was low during July until mid-August . These numbers increased steadily and reached a peak in mid-September , it was 31 adults. Then decreased sharply reaching 9 and 12 adults during October and mid - November , respectively (Fig. 24).

At Salt grove , the number of emerged parasitoids ranged from 5 to 14 adults from the beginning of July to the end of August . The peak was in mid-September ; it was 25 adults . During October to mid- November , the numbers decreased from 17 adults at the beginning of October to 4 adults in mid-November per 200 infested fruits (Fig. 24).

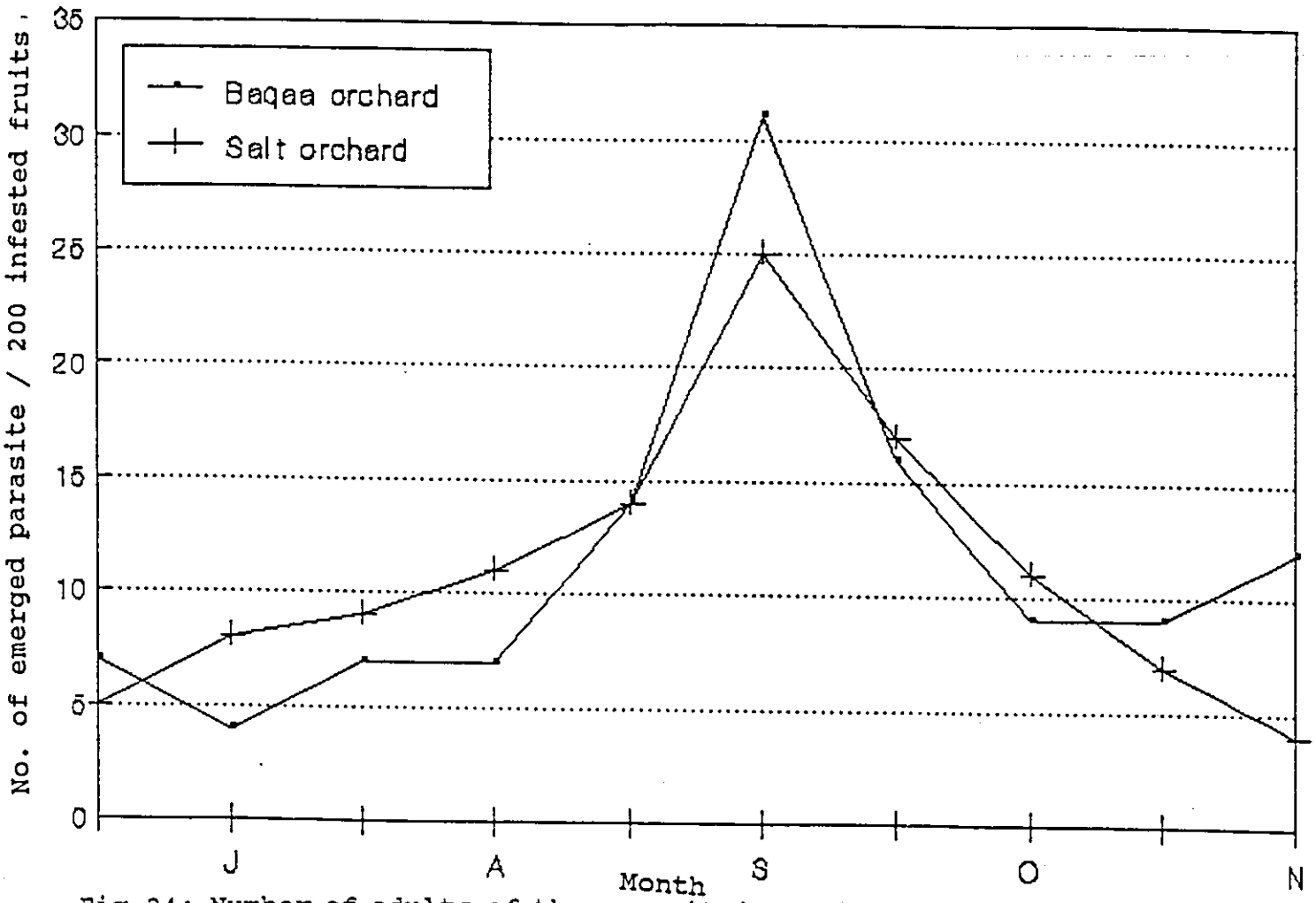

Fig.24: Number of adults of the parasitoid (Opius concolor) emerged from caged infested olive fruits by olive fruit fly collected from Baqaa and Salt groves between July to mid-November,1991.

DISCUSSION

V. DISCUSSION

Trapping technique started at different periods for the two locations . It was at the beginning of March, 1991 for the Baqa'a grove and at the beginning of June of the same year for the Salt grove . The main flight activity periods attained by all the traps at the two locations seemed to be different .

Results obtained on flight activity at Salt grove indicate the presence of three generations .The first flight activity period attained by different traps was between June and July that suggests to be representing the first generation . The second flight activity period was between August and beginning of September that suggests to be representing the second generation . The third flight activity period was from mid-September to the end of October that suggests to be representing the third generation. These results confirmed by Fig. 30 that represents distributiion of total adults of olive fruit fly caught by the nine traps during the same period . Similar results were obtained by Sodah and Abu-Hassan (1985) at Fuhais area , and Al-Zaghal and Mustafa (1986) at Gbeiha area .

The greatest numbers of adults caught by different traps were in mid-August with the exception of the three kind baited Mcphail traps ; they were in early of August , and in vertical yellow trap ; it was in mid - October . This could be because olive fruit fly was strongly attracted to Mcphail traps before sexually maturation . Haniotakis (1982) also reported that male flies were attracted to Mcphail traps before sexually maturation . In addition , number of mature eggs per

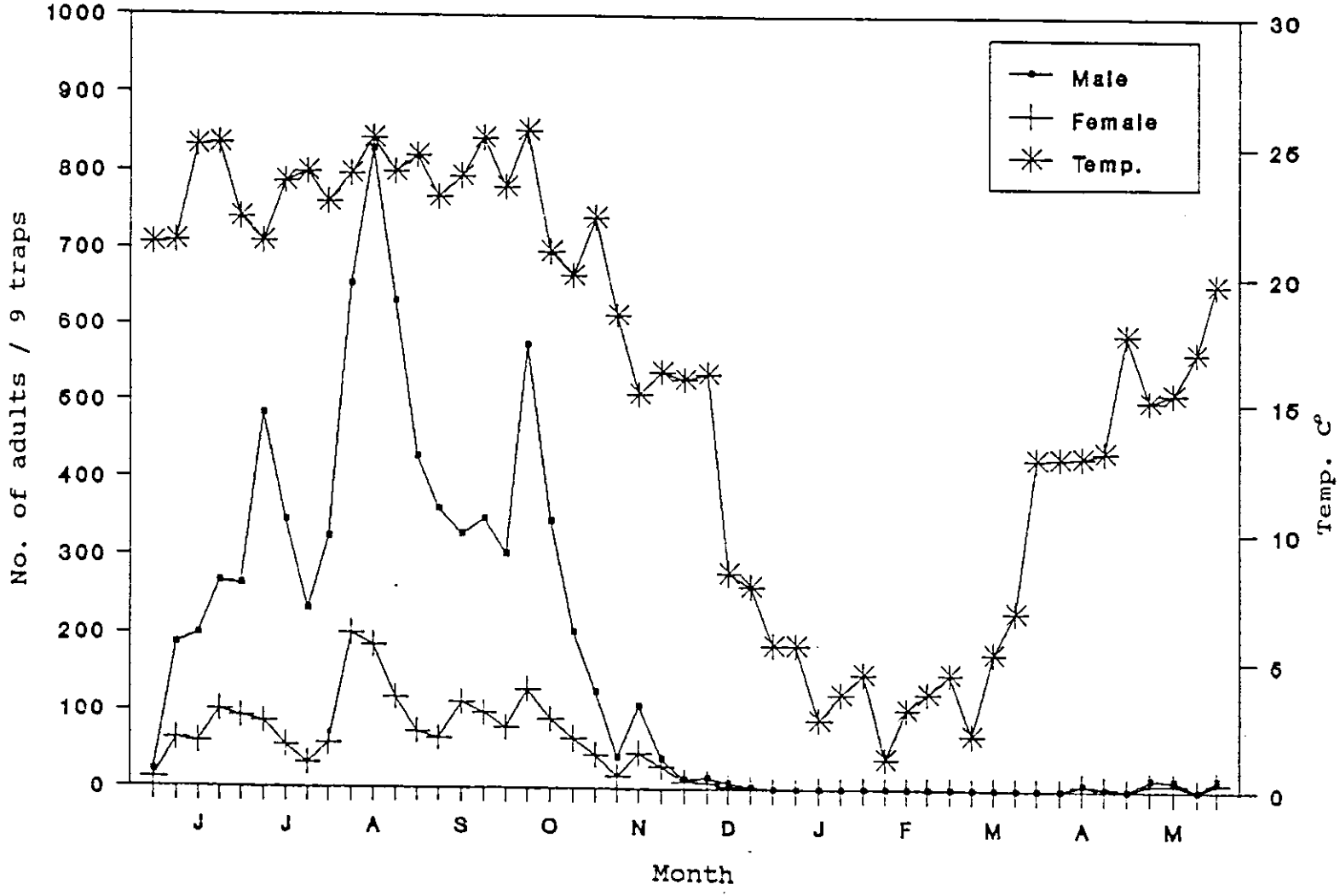

Fig.25: Distribution of total olive fruit fly male and female caught by the nine traps at Salt grove from June,1991 to end of May,1992.

female (Fig. 23) was very low at mid - August then increased the week after .

All the traps caught more males than females during the study periods with the exception of Mcphail traps containing protein hydrolysate as a source of bait during the period in which the greatest numbers were caught . This could be as a result of short distance between pheromone traps and other traps which allowed strong interaction . This is in full agreement with the results of Haniotakis (1982) who found that Mcphail traps captured more males than pheromone traps as a result of strong interaction . Furthermore a high proportion of males has been associated with the beginning of flight activity reported by Neuenschwander and Michelakis (1979) .

The number of fruit flies caught during the 2nd flight activity (2nd generation) was greater than the number of flies caught during the 3rd flight activity (3rd generation) . This is on contrary with the results obtained by (Sodah & Abu Hassan, 1985; Al-Zaghal & Mustafa, 1986). This might be due to the continuous removal of flies by the 36 traps installed in the grove .

At Baqa'a grove , trapping technique started early in the season , from March,1991 to end of February , 1992 . Results obtained on flight activity at Baqa'a grove indicate the presence of three generations also. It appears that the first flight activity period attained by these traps was between late July to end of August that suggests to be representing the first generation . The second flight activity period was between September and October that suggests to be representing the second generation . The third flight activity period was between November and mid -

December that suggests to be representing the third generation . These results confirmed by the results obtained in Fig. 31 that representing distribution of total olive fruit fly males and females caught by the nine traps during the same period . In contrast , Al-Zaghal and Mustafa (1986) at Baqa'a grove ; Sodah and Abu-Hassan (1985) at Jarash grove reported different results . It seems that mass trapping early in the season by using (32 - 36) traps at approximately 3 hectars might eliminate high numbers of overwintering adults before mating and forming the nuclei of infestation . Sharaf (1980) reported that individuals overwintered in the adult stage were considered to be responsible for the first attack at the beginning of June . It might be for this reason we have the late first flight activity period with low population numbers, and hence , overlapping in the generations . Haniotakis (1981) reported that mass trapping early in the season can remove maximum number of adults before mating and that mass trapping after the first spray which takes place at the second half of June can eliminate the additional 2-3 sprays usually required for acceptable control . The greatest number of males and females caught by different traps was during mid-October when the mean temperature was about 27 °C . This gave another evidence that overlapping between the second generation with the first and third generation occurred that gave a rise of higher numbers of the second generation . Male flies were caught in higher numbers than females in all the traps in Baqa'a grove . This could be due to the same reasons previously mentioned .

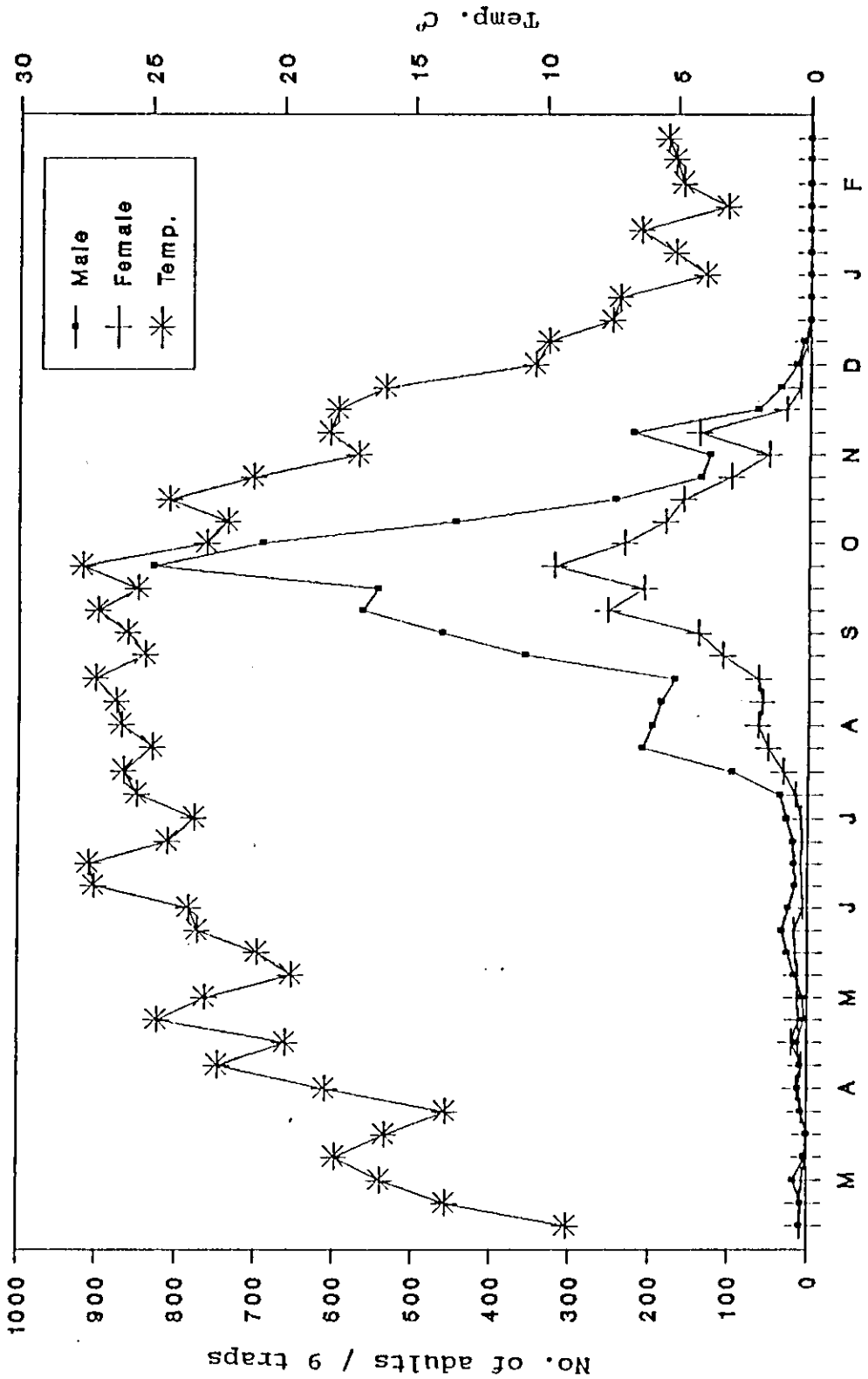

Fig.26: Distribution of total olive fruit fly male and female caught by the nine traps at Baqaa grove from March,1991 to end of February,1992.

Environmental conditions , type of traps , kind of baits and interacting with the biological feature of olive fruit flies might affect fluctuating numbers caught by traps . Haniotakis (1982) reported that population fluctuations were more obvious by pheromone than Mcphail traps . However, the temperature convenience for flight activity in the two locations seems to be between 19 - 27°C . Avidov and Harpaz (1969) reported that when temperature rose above 20 °C and reached 23 °C all the flies began to move about, while activity was greatest at 28°C .

Numbers of adults of olive fruit fly caught monthly by different traps showed that Mcphail trap with diammonium phosphate and yeast was the most effective from April to July at Baqa'a grove (Table . 1) and from June to July at Salt grove (Table. 2) . Adult requirements for food and water sources during this period is high . These periods are characterized with high temperature , low relative humidity and lack of fruit suitable for oviposition . Sharaf (1980) reported that the highest sterile punctures from which the flies imbibes the exuding juice exceeded during the hot summer months. In addition , Haniotakis (1981) stated that during high temperature and low relative humidity , flies aggregated around the water sources of the release jar . The system of diammonium salt releasing ammonia gas slowly was found to be attractive to olive fruit fly (Zervas , 1986) . The pheromone trap was less efficient during this period . This was obvious in case of 10 mg pheromone capsule . In Greece , Zervas (1989) stated that traps baited with olive fruit fly pheromone were inactive during the period of mid-May to end of June . In

addition , Economopoulos (1986) in the same country stated that pheromone traps was inactive for several weeks at the beginning of summer . This point needs more investigation . Vertical yellow sticky trap with 20 mg pheromone capsule was the most efficient trap from August to end of December at Baqa'a and Salt groves (Tables . 1 and 2). These periods were characterized with higher flight activity , as adult insects seeking for mating and oviposition . Haniotakis (1982) reported that pheromone traps only attract males at the reproductively active state and that the reproductively inactive periods of the flies extends from the late of May to August . The two types of ovoid yellow sticky traps catches seems to be as effective as Mcphail traps for most of the periods , and that vertical yellow sticky trap without bait was the least effective . The colour and shape of the ovoid trap was reported to be attractive to the olive fruit fly . Neuenschwander and Michelakis (1979) reported that yellow colour was more attractive than orange , red , green , black and white . Prokopy and Haniotakis (1976) found that females were mostly attracted to the spherical shape of olive fruit model . The combination of yellow trap with odor increased trap effectiveness . Economopoulos (1986) reported that yellow trap was more pronounced with ammonium salt odor lure .

Total olive fruit fly males and females caught by different traps from March to end of December at Baqa'a grove (Table . 3) and from June to end of November at Salt grove (Table . 4) showed that 10 mg pheromone trap was the greatest attractive to male flies . This result is clearly expected since sex pheromone is a

special lure for male flies . Vertical yellow trap with diammonium phosphate seems to be as effective as 10 mg pheromone yellow trap in capturing male flies . Economopoulos (1982) reported that when the yellow trap was combined with odor - lure , its effectiveness increased by several time . The same author (1986) reported that yellow traps were more pronounced with ammonium salt odor - lure . While Economopoulos (1977) concluded that males may be attracted to yellow traps than females . Vertical yellow trap without bait was the least effective in capturing males since no effect of this trap on flies in neihbouring trees . Economopoulos (1982) reported that yellow trap is a short - range attractant affecting flies only in its neighbourhood within the tree that flies have the chance to perceive it . Mcphail traps with different baits were less effective than baited vertical yellow sticky trap in capturing male flies . This is true since effectiveness of Mcphail traps was mainly dependent on environmental conditions . Neuenschwander and Michelakis (1979) reported that the attractiveness of Mcphail trap increased at low relative humidity and high temperature . The results in Tables 1 and 2 indicating that from autumn onward , the effectiveness of Mcphail trap reduced . Ovoid yellow trap without a bait or with labaneh gave encouraging results in catching male flies and seems to be as effective as Mcphail traps , indicating that colour , shape and bait are attractive to olive fruit flies .

Female olive fruit flies was found strongly attracted to Mcphail trap with diammonium phosphate and yeast as will as other baited Mcphail traps (Tables . 3 and 4) . Economopoulos (1977) concluded that preferrence of females to protein

baited Mcphail traps could be the result of greater requirments for protein to maintain oogenesis . This is true also for vertical yellow trap with diammonium phosphate and ovoid yellow trap with labaneh. In addition , colour and shape stimuli in ovoid yellow trap probably indicated host-oviposition substrate availability . Economopoulos (1979) stated that females with eggs and spermatozoa showed tendency to prefer the colour stimuli as probably indicating host - oviposition substrate availability as compared to the odor stimulus which indicating food availability . The least number of females was obtained in case of vertical yellow sticky trap with 10 mg pheromone and the same trap without lure . Haniotakis and Skyrianos (1981) stated that sex pheromone did not increase yellow trap female catches .

Yellow colour is attractive especialy to male flies (Neuenschwander , 1982) and sex pheromone includes a long range male attractant (Haniotakis , 1986 b) . In addition , Economopoulos (1979) reported stronger response of males to both odor and colour traps while odor - lure attracts more females than colour one . It is logical that the results showed significantly higher male flies in almost most trapping systems than females (Tables . 5 and 6) with the exception of Mcphail trap with either protein hydrolysate or diammonium phosphate at Baqa'a grove (Table. 5) . Furthermore , Economopoulos *et al* (1977) reported that regular seasonal changes in the sex ratio have been observed in Mcphail traps .

No significant differences were found among ovoid yellow trap with labaneh as bait and the same trap without bait (Tables . 7 and 8) for male and female

catches . The reason probably that labaneh as bait seems to have no additive effect on male captures , hence , more females were trapped by baited ovoid trap in the two locations .

Vertical yellow trap with 20 mg pheromone gave significantly higher male catches than the same trap with 10 mg pheromone in the two locations (Tables . 9 and 10) . This refers to the release rate of 20 mg pheromone capsule which is higher as well as the half life is longer . Jones *et al* (1983) reported that the half life of the pheromone decreased with time and increasing of temperature .

Mcphail trap with diammonium phosphate and yeast caught higher number of males and females than Mcphail trap with protein hydrolysate and borax (Tables 11 and 12) but no significant difference were found among the two traps in the two locations . The reason could be due to higher variance recorded specially in case of diammonium phosphate baited Mcphail trap . The solution of ammonium salt or protein hydrolysate are slowly ammonia releasing system (Zervas , 1986) . The efficiency of Mcphail traps strongly depends on environmental factors (Neuenschwander & Michelakis , 1979) . Thus effectivness are expected to be varied at different times due to evaporation . Field observations indicated that evaporation of diammonium salt solution is higher than that of protein hydrolysate solution because the last solution is thicker and may produce less ammonia compared to the first bait .

Mcphail trap with diammonium phosphate and yeast caught higher number of males and females than the same trap baited with protein hydrolysate , soluble

pheromone and borax (Tables . 13 and 14) , but the difference was significant only in the Salt grove (Table . 14) . The population of olive fruit fly was higher in Salt grove which might cause the significant difference . In addition , Haniotakis and Skyrianos (1981) reported that Mcphail trap with baits and pheromone dispenser suspended in the interior of the trap do not only show increased attraction but reduces trap efficiency . This phenomena is also confirmed by the results obtained by the two baits Mcphail traps , namely protein hydrolysate and protein hydrolysate plus soluble pheromone (Tables . 15 and 16) .

At Baqa'a grove infestation started at a higher rate in case of the larger fruits of Ascolano and Shami than that of Nasouhi and Rase'e cultivars (Fig.21). Kapatos *et al* (1977 b) reported that early in the season , females choose larger fruit for oviposition . The population of olive fruit fly started to build up and increasing rapidly from end of July (Fig. 26) . An increase in fruit infestation was clearly noticed in all cultivars during this period (Fig . 21) . Bagnoli *et al* (1982) reported that the course of infestation is closely reflected in the traps capture . The fruits of Shami cultivar mature gradually from mid-August toward the end of the season . It seems that for this reason fruit infestation reached a peak earlier than other cultivars . Kapatos *et al* (1977 b) reported that later in the season the preferrence for oviposition and infestation shifts to less ripe fruits . In addition field observations showed highly dropping of infested mature fruits of Shami cultivar that explain reduction of the infestation percentage curve recorded from mid-September onward (Fig. 21) .

Ascolano cultivar was found to be more susceptable to infestation than that of Shami cultivar . Neuenschwander and Michelakis (1978) reported that smoothness of fruit surface favours oviposition . Prokopy and Haniotakis (1976) found that females of olive fruit fly were mostly attracted to spherical shape and very little to cylindrical and rectangular fruit model. Furthermore , Neuenschwander *et al* (1985) reported that green colour was preferred over rose or black fruits .

Nasouhi cultivar (Fig. 21) was found to be the least infested as a result of the cylindrical, date palm fruit shape . This confirmed the finding of Prokopy and Haniotakis (1976).

In Jordan , Mustafa and Al-Zaghal (1987) reported that infestation of olive fruit started in June as eggs were first detected in Shami cultivar in early June . While Al-Zaghal and Mustafa (1987 a) found that the percentage infestation of Ascolano , Shami and Rase'e cultivars was more than 50% , in Nasouhi cultivar was less than 30% . Our findings support the results obtained previously .

At Salt grove infestation started by mid - July in the case of Nabali cultivar , while at Souri cultivar by end of June (Fig.22) . Talhouk (1969) reported that Souri cultivar , the commonest olive grown in Libanon and Syria was suitable for oviposition by mid-July . Bigler (1980) reported that olives became suitable for oviposition when they reach 0.5 gm . The shape and smoothness of fruit surface skin in Souri cultivar make it more suitable for oviposition . Cirio (1971) reported that female flies after oviposition spread olive juice trickling from oviposition wounds over fruit surface which functions as a deterrent to repeat oviposition on

the same fruit . It seems that this juice might spread among the small smooth fruit surface which resulted in the spread of infestation during a period of higher insect population .

In addition to fruit characteristics , shortage of water for irrigation and high infestation rates allowed high dropping of infested fruits . This is the reason for the reduction of infestation curve for Souri cultivar recorded from mid-September onward (Fig. 22) . The infestation of Nabali cultivar was less than that of Souri as a result of fruit shape and irrigular surface skin .

It is concluded from these results that all cultivars studied were susceptable to infestation attack in various degrees , but Nasouhi cultivar at Baqa'a grove and Nabali at Salt grove were the least . It seems that later in the season when insect population is high, the preferrence of infestation for suitable fruits become obscured . This conclusion in confirmed by the results of Pucci and Ambrosi (1982) as cited by Neuenschwander *et al* (1985) that females in the field usually preferred larger and heavier fruits for oviposition , but later in the season , olive fly population were much higher and this preferrence become obscured .

Ovarian maturation and production of mature eggs in females collected from Salt grove (Fig. 23) seems to be coincident with the starting of infestation (Fig. 22) , Fletcher *et al* (1978) reported that ovarian of female olive fruit fly remained immature during June and early July due to hot dry condition and lack of fruits , but start to mature in mid-July if they received a stimulus from developing olive fruits .

The highest three peaks of mature eggs were recorded in mid-July , late August and late October ; it reached 13 , 9 and 7.5 eggs per female , respectively . Different numbers of daily mature eggs production were recorded by several authors . Talhouk (1969) reported 10 eggs as average of numbers . No more than 18 eggs reported in Italy by Fornasari (1985) . 10 - 12 eggs was reported by Christenson and Foote (1960) in Yugoslavia . 7 - 14 eggs as a result of different diets was reported by George and Rhum (1977) . In addition , Economopoulos *et al* (1976) reported that twice mated female produces above 8 eggs daily for a period twice as long as one mated female .

Several factors might affect egg production , such as diet , mating , temperature , humidity and presence of suitable fruits for oviposition . Number of mature eggs per female was highest during the first peak as a result of unsuitability of fruits for oviposition . Sharaf (1980) reported that only one egg was deposited in a small fruit . In some cases 5 -6 eggs were found in a fruit , but this number was laid by an identical number of females (Sharaf , 1980) . The insect population reached the highest peak in mid-August (Fig. 25) , while number of mature eggs was low during the same period , then increased sharply a week later . Neuenschwander and Michelakis (1979) stated that reproductive females are more attracted to protein bait than juvenile females . In addition, Haniotakis (1982) stated that pheromone traps only attract males at the reproductive active state . This explains the negative relation between number of mature eggs and insect population during mid-August . In addition , Fornasari (1985) reported that

females begin to make sterile bites when they are about 5 days old . This explains the increase in number of mature eggs one week later . The results in Fig. 23 showed that mean temperature between 20 - 25 °C is suitable for ovarian maturation and egg production in the field . Fletcher *et al* (1978) reported that at 23 °C all females are able to complete ovarian maturation. The three peaks of mature eggs obatined in this study confirmed by the three peaks of eggs found in dissected fruits of almost all cultivars at Baqa'a grove reported by Mustafa and Al-Zaghal (1987) .

The parasitoid *Opius concolor* was most abundant during September in the two locations (Fig. 24) . In Greece , Kapatos *et al* (1977 a) reported high mortality of third larval instar during September due to parasitism . In Jordan , Mustafa and Al-Zaghal (1987) reported that between August and October , the parasitoid *O. concolor* was mostly caught . Larvae of olive fruit fly normally migrated and pupated in the soil after being parasitized by *O. concolor* (Canard *et al.*, 1979 a) . In addition several authors reported soil pupation from autumn onward (Talhouk , 1969 ; Sharaf , 1980 ; Mustafa & Al-momani , 1990) . Since this parasite developed normally in the 3 rd larval instar (Liaropoulos *et al.*, 1977) , it is logically to have a reduction in the parasitism curve from mid-September onward as a result of soil pupation of parasitized larvae and dropping of infested fruits . In fact , in the Mediterranean regions specially Greece , several authors (Michelakis, 1986 ; Neuenschwander *et al.*, 1983) reported that *O. concolor* population

gradually increased from August onward . Data from field observations confirmed these findings in Greece . Trapping adults of *O. concolor* by vertical yellow trap which allow clear observation of trapped insects showed increasing in the population density from autumn onward . It reached 37 and 19 adults of *O. concolor* per trap per week by the end of November at Baqa'a and Salt grove , respectively .

In Jordan , the periods without olive fruits is long and the reliance on a single host may explain the lower population density of this parasite during early summer. In Corfu , olive fruits remain in the trees up to the following spring as it falls naturally . This allows high population density of *O. concolor* in spring and early summer (McFadden *et al.*, 1977) . In addition , Manikas and Tsiroyannis (1982) reported that *O. concolor* can reinforce or replace chemical control where population of olive fruit fly are very high in early summer and olive fruits remain on the tree up to the following spring .

Fruit infestation was clearly noticed by early July in the two locations (Figs. 21 and 22). This coincides with the build up of olive fruit fly population (Figs. 25 and 26) . For this reason , it is logically to conclude that future release of *O. concolor* as a method of integrated pest management should be done during this period . In addition , the temperature is normally high during July which allow higher rates of parasitism . Pucci (1982) reported that parasites were active at high temperature , for exmple at 36 °C the expected percentage of parasitized larvae of second and third instar was about 50 % .

CONCLUSIONS

VI. CONCLUSIONS

1. The main flight activity periods for the olive fruit fly extended from late July to mid-December, 1991 at Baqa'a grove , and from June to end of November, 1991 at Salt grove.

2. The peak of the first main flight activity period was between late July and end of August at Baqa'a grove , and between June and July at Salt grove .

3. The peak of the second main flight activity period was between September and October at Baqa'a grove , and between August and ealry September at Salt grove .

4. The peak of the third main flight activity period was between November and mid-December at Baqa'a grove , and between mid-September and end of October at Salt grove .

5. The highest number of caught olive fruit fly was during October at Baqa'a grove , and during August at Salt grove .

6. All the cultivars studied were highly infested by olive fruit fly. Naball and Nasouhi were the least infested cultivars.

7. The highest mean number of mature eggs per dissected female obtained in this study was found to be about 13 eggs. Mean number during the activity period was about 6 eggs.

8. There were three peaks of mature eggs in dissected females appeared during the whole season.

9. The activity of the parasite *Opius concolor* was from September toward the end of the season .

10. Vertical yellow trap caught few flies in summer when population density of the olive fruit fly was low and higher number in fall when the population was high. This trap was the least efficient.

11. Vertical yellow trap was more pronounced with diammonium salt odor lure. It was as active as the same trap baited 10 mg pheromone in male flies catches and Mcphail trap baited protein hydrolysate in female flies catches.

12. Vertical yellow trap baited 20 mg pheromone caught males more than double caught of the same trap baited 10 mg pheromone .

13. Protein hydrolysate or diammonium phosphate odor-lure water solution baited Mcphail trap caught more olive fruit flies in summer than in fall. This trap, however, varied in its effectiveness at different times of the year according to environmental conditions .

14. Diammonium phosphate and yeast solution odor-lure baited Mcphail trap was the most efficient for catching adult females .

15. Soluble pheromone did not improve catching of olive fruit fly males by baited Mcphail trap with protein hydrolysate solution .

16. The new designed trap, ovoid yellow trap with and without labaneh as bait gave encouraging results. It was as active as Mcphail trap baited protein hydrolysate .

RECOMMENDATIONS

VII. RECOMMENDATIONS

The study suggests a pest management programme involving the following practices :

1. Encouragement of the planting of Nabali cultivar for extracting olive oil and Nasouhi cultivar for olive fruit pickling .
2. Collecting of dropped infested fruits as soon as possible.
3. Plowing the ground under the olive trees twice, particularly in autumn after fruit collection and in early spring .
4. Using 5-6 ovoid traps per dunum of olive grove (10-12 olive trees) or any other effective trap should be try as mass trapping to decrease the olive fruit fly population . This system can be used also to monitor the population level of the olive fruit fly and for timing control application.
5. Encouragement of biological agents especially the parasitoid *Opius concolor* by preventing application of systemic insecticides in June and July. Future work on controlling this pest should emphesis on laboratory culturing and releasing this biological agent in June and July .
6. Then, as a last solution the use of insecticide to suppress the population of olive fruit fly but not killing the biological agents. Bait spray consisting of a mixture of protein hydrolysate with a contact, short residual effect insecticides is recommended.

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ملخص بالعربية

تقييم طرق صيد ذبابة ثمار الزيتون ودراسة احد طفيلياتها

إجريت تجربتان حقليتان في موقعين مختلفين لتحديد كفاءة المصائد في جذب واصطياد ذبابة ثمار الزيتون . كما اجريت محاولة لتصميم مصيدة جديدة . لقد اختير حقل زيتون في منطقة البقعه مساحته ثلاثة هكتارات لدراسة تسعة معاملات من المصائد بواقع اربعة مكررات لكل معاملة باستخدام نظام التصميم العشوائي الكامل . طبقت نفس المعاملات والمكررات على مساحة حقل زيتون مماثلة في منطقة السلط واستخدم نظام تصميم القطاعات العشوائية الكاملة . وتم مراقبة نشاط طيران ذبابة ثمار الزيتون لكل مصيدة على حده في كلا الموقعين .

تم فحص الثمار المصابة حقلياً . وكانت الاصناف المفحوصة في حقل البقعة هي في الاغلب لاغراض التخليل . أما الاصناف المفحوصة في حقل السلط هي في الاغلب لاغراض استخلاص الزيت . استعملت مصيدة مكفيل المحتوية على محلول البروتين هيدروليزيت او على محلول فوسفات ثنائي الامونيوم لدراسة اعداد البيوض الناضجة في الاناث المشرحه والتي اخذت من تلك المصائد . درست اعداد وتوزيع المتطفل *Opius concolor* خلال الموسم على الثمار المصابة في كلا الحقلين.

من خلال النتائج الشهرية لاعداد ذبابة ثمار الزيتون المنجذبة للمصائد المختلفة ، كانت مصيدة مكفيل المحتوية على محلول فوسفات ثنائي الامونيوم والخميرة الاكثر فعالية في جذب واصطياد الذبابة خلال الفترة الممتدة من شهر نيسان حتى شهر تموز في حقل البقعه ، ومن شهر حزيران حتى تموز في حقل السلط . خلال الفترات المشار اليها سابقاً كانت المصيدة الجنسية اقل كفاءة . يتضح ذلك من نتائج

المصيدة العمودية الصفراء المحتوية على ١٠ ملغم جاذب جنسي على هيئة كبسولة . لم تتضمن الفترات المشار اليها سابقاً المعاملة الخاصة بالمصيدة العمودية الصفراء المحتوية على ٢٠ ملغم جاذب جنسي على هيئة كبسولة .

اظهرت المصيدة العمودية الصفراء المحتوية على ٢٠ ملغم جاذب جنسي تفوقاً معنوياً في اجتذاب ذبابة ثمار الزيتون في الفترة الواقعة بين شهر آب ولغاية نهاية كانون اول لكلا الحقلين . النموذجان من المصيدة البيضاوية اظهرا نتائج مشابهة لمصيدة مكفيل المحتوية على الطعوم المختلفة خلال اغلب فترات النتائج الشهرية . المصيدة العمودية الصفراء غير المعاملة بالطعوم هي الاقل كفاءة في جذب واصطياد ذبابة ثمار الزيتون .

المصيدة العمودية الصفراء المعاملة بالجاذب الجنسي ذو التركيز ١٠ ملغم او املاح الفوسفات ثنائي الامونيوم هي الاكثر كفاءة في اصطياد ذكور ذبابة ثمار الزيتون ، وتتضح النتائج من خلال المجموع الكلي . مصيدة مكفيل المعاملة باحد الطعوم المختلفة هي الاكثر كفاءة في اصطياد اناث ذبابة ثمار الزيتون، وتتضح النتائج من المجموع الكلي . المصيدة العمودية الصفراء المعاملة باملاح الفوسفات ثنائي الامونيوم ذات كفاءة مماثلة لمصيدة مكفيل المحتوية على بروتين هيدروليزيت كمصدر للطعم وذلك من نتائج المجموع الكلي للاناث المصطادة . المصيدة البيضاوية الصفراء المعاملة وغير المعاملة بالطعوم ادت الى نتائج مشجعة وذلك من خلال المجموع الكلي لذكور او اناث ذبابة ثمار الزيتون المصطادة والتي كانت ذات كفاءة مماثلة لمصيدة مكفيل المحتوية على بروتين هيدروليزيت كمصدر للطعم . المصيدة العمودية الصفراء غير المعاملة هي الاقل كفاءة في الاصطياد من حيث المجموع الكلي لكل من الذكور والاناث .

في معظم المعاملات كانت اعداد ذكور ذبابة ثمار الزيتون المصطادة هي الاعلى مقارنة بالاناث في كلا الموقعين باستثناء مصيدة مكفيل المحتوية على بروتين هيدروليزيت او فوسفات ثنائي الامونيوم في حقل زيتون البقعه .

لم توجد فروق معنوية بين المجموع الكلي لاعداد الذكور او الاناث المنجذبة الى كل من المصيدة البيضاوية الصفراء ونفس المصيدة المحتوية على اللبنه كطعم . المصيدة العمودية الصفراء المحتوية على ٢٠ ملغم جاذب جنسي على شكل كبسولة اصطادت اكثر من ضعفي معدل الذكور المصطادة على نفس المصيدة المحتوية على ١٠ ملغم جاذب جنسي على شكل كبسولة .

مصيدة مكفيل المحتوية على فوسفات ثنائي الامونيوم وخميرة اصطادت اعداداً اعلى من الذكور والاناث مقارنة بنفس المصيدة المحتوية على بروتين هيدروليزيت او مزيج من البروتين هيدروليزيت والجاذب الجنسي السائل في كلا الموقعين ، حيث كانت الفروق معنوية في حالة المزيج من البروتين والجاذب السائل في حقل زيتون السلط فقط . مصيدة مكفيل المحتوية على بروتين هيدروليزيت اصطادت اعداداً اعلى من الذكور والاناث من نفس المصيدة المحتوية على مزيج من البروتين والجاذب الجنسي السائل في كلا الموقعين الا ان الفروق غير معنوية .

لقد وجد ان فترات نشاط الطيران الرئيسية لذبابة ثمار الزيتون تمتد من اواخر تموز ولغاية منتصف شهر كانون اول في حقل البقعه ، ومن شهر حزيران الى نهاية شهر تشرين ثاني في حقل السلط . وظهرت ثلاثة فترات نشاط طيران رئيسية لذبابة ثمار الزيتون تمثل ثلاثة اجيال في كل من الموقعين . في حقل زيتون البقعه امتد النشاط الاول للطيران من الفترة الواقعه بين نهاية شهر تموز حتى نهاية آب ، وفترة النشاط الثاني في الفترة الواقعه بين شهري ايلول وتشرين اول . وكانت فترة

النشاط الثالثة في الفترة الواقعه بين تشرين ثاني ومنتصف كانون اول . كان اعلى رقم لاعداد الذكور والاناث المصطادة خلال شهر تشرين اول.

في حقل السلط كان النشاط الاول للطيران خلال شهري حزيران وتموز ، وفترة النشاط الثاني في الفترة الواقعة بين اب واوائل شهر ايلول . وكانت فترة النشاط الثالثة في الفترة الواقعه بين منتصف شهر ايلول حتى نهاية تشرين اول . كان اعلى رقم لاعداد الذكور والاناث المصطادة خلال شهر اب .

اظهرت الدراسة ان جميع الاصناف المدروسة كانت حساسة للاصابة بذبابة ثمار الزيتون ، الا ان الصنف بصوحي في حقل البقعه والصنف نبالي في حقل السلط كانا الاقل اصابة ، حيث بلغت نسبة اصابتهما ٢٩ و ٢٢٪ على التوالي . أما الاصناف اسكولانو ، رصيعي ، شامي والسوري فكانت اكثر عرضة للاصابة حيث بلغت نسبة الاصابة ٤٨ ، ٤٣ ، ٤٠ ، ٤٠ ٪ على التوالي .

اظهرت نتائج تشريح الاناث ان هناك ثلاث قمم لاعداد البيوض الناضجة خلال الفترة الواقعه بين تموز ولغاية نهاية تشرين ثاني ، الاولى في منتصف شهر تموز ، الثانية في اواخر آب ، والثالثة في اواخر تشرين اول . كان معدل اعداد البيوض الناضجة خلال تلك الفترات ١٣ ، ٩ ، ٥ر٧ على التوالي.

تم تسجيل التواجد الاكثر للطفيل *Opius concolor* خلال شهر ايلول في كلا الموقعين . اظهرت قراءات الملاحظات الحقلية ان نشاط الطفيل استمر من شهر ايلول حتى نهاية الموسم ، ولكن هذا النشاط لم يكن واضحاً بسبب تعذر اليرقات المتطفل عليها في التربة .