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Two-sex life table and host preference studies of *Bactrocera dorsalis* Hendel (Diptera: Tephritidae)

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ABSTRACT: Oriental fruit fly, *Bactrocera dorsalis*, is a serious invasive pest in tropical and subtropical countries. The stage-specific two-sex pooled life table of *B. dorsalis* on four different fruits (guava, water apple, rose apple and mango) were studied during 2018-2020. The life table showed that the survivorship of *B. dorsalis* falls in Type III with about 41.394-33.827per cent of the eggs successfully reached adult stage. The highest mortality recorded was in the egg and adult emergence stages with k_x of 0.045-0.113 and 0.032-0.192, respectively. The average potential fecundity (Pf) was 223-362 eggs female^{-1}. The intrinsic rate of natural increase (r_m) was 0.021-0.035 female^{-1} day^{-1} with mean generation time (T_c) of 194.058-148.710 days. The net reproductive rate (R_o) was 61.504-176.006 female offspring per female and the population doubling time (DT) was within 32.719-19.946 days. The population dynamics of *B. dorsalis* were significantly influenced by the host fruits due to their respective phytoconstituents in terms of host suitability or susceptibility (guava> water apple> rose apple> mango). Host preference of *B. dorsalis* was in the order of guava> water apple> rose apple. © 2021 Association for Advancement of Entomology

KEY WORDS: Oriental fruit fly, phytoconstituents, population dynamics, host preference

INTRODUCTION

Globally, fruit flies in the genus *Bactrocera* (Diptera: Tephritidae) are economically important pests of agricultural crops including fruits, vegetables and nuts (Drew and Raghu, 2002; Jiang *et al*., 2017; Liu *et al*., 2013, 2019). They have been reported to potentially infest more than 173 kinds of fruits and vegetables (White and Elson-Harris, 1992; Ekesi *et al*., 2016), where internal feeding by larvae causes premature abscission of fruit (Liu *et al*., 2013; Shinwari *et al*., 2015; Gu *et al*., 2019). The Oriental fruit fly, *B. dorsalis* (formerly known as *B. papayae*) infests more than 70 species of tropical and subtropical fruits and melons, representing 35 plant families, such as guava, water apple, rose apple, mango, cashew, cherry, orange, banana, etc. (Wee and Tan, 2005; Kunprom *et al*., 2015; Jiang *et al*., 2017; Zeng *et al*., 2019). In India, damage rates caused by *B. dorsalis* can reach 80 per cent, ranking it as the country's most serious fruit fly pest (Jalaluddin *et al*., 1999; Qin *et al*., 2015). Even today, management of such notorious pest, *B. dorsalis*, by applying broad-spectrum synthetic pesticide sand some bio-pesticides are the chief control strategy (Jiji *et al*., 2005; Carvalho, 2017; Rashmi *et al*., 2020). These result into secondary pest outbreak, pest resurgence and development of pesticide resistance as well as emergence of pest biotypes, which ultimately leads

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to both top down and bottom up regulatory complications in the agro ecosystem (Kim *et al*., 2017; Roy, 2019b, 2020).

In integrated pest management (IPM) programs, it is necessary to understand the basic and detailed information of pests can be derived through life table modelling (Yang *et al*., 1994; Chen *et al*.. 2017; Roy 2019b, 2020). Life table is a powerful tool for analysing and understanding the effect of different hosts on feeding, growth, survival and reproduction of an insect pest for their management (Southwood, 1978; Carey, 1993, 2001; Kakde *et al*., 2014; Roy, 2019b). The age-stage, two-sex life table can eliminate many of the inherent error characteristics of female-based traditional life tables (Chen *et al*.,2017; Mobarak *et al*., 2019; Roy, 2020). In other instances, host quality influences larval growth and development which are the key determinant of adult longevity, fertility, fecundity and survivability (Schoonhoven *et al*., 2005; Roy and Barik, 2012, 2013; Roy, 2017, 2018, 2020). Host primary metabolites (PMs) are used only for general vitality, growth and reproduction of the herbivores (Slansky and Scriber, 1985; Turunen, 1990; Roy and Barik, 2013) whereas, the secondary metabolites (SMs) have defensive role (Dicke, 2000; Howe and Jander, 2008; War *et al.*, 2012). Moreover, host plant utilization is also influenced by the ability of insect to ingest, assimilate and convert food into their body tissues according to their metabolic as well as genomic regulations (Slansky and Scriber, 1985; Roy and Barik, 2013; Roy, 2019b). There is a range of innet reproductive capacity for individual of a population (Carey, 1993; Southwood, 1978; Roy, 2020) but the variation in available food quality always influence the growth, reproduction, longevity and survival of that population (Shobana *et al*., 2010; Roy and Barik, 2012; Roy, 2017). The effect of different food sources on population growth were observed in *Diacrisia casignetum* (Roy and Barik, 2013), *S. obliqua* (Mobarak *et al*., 2019), *Podontia quatuordecimpunctata* (Roy, 2015), *Epilachna vigintioctopunctata* (Roy, 2017), *Leptocorisaacuta* (Dutta and Roy, 2016) and many more on different host plants. Variation between the results of these studies could be attributed due to differences among nutritional (PMs) and anti-nutritional (SMs) factors present in their respective host plants (Awmack and Leather, 2002; Roy and Barik, 2013; Roy, 2014). Similarly, few biological studies have been reported on *B. dorsalis* with different pattern of development and growth depending on different artificial diets or natural hosts (Jaleel *et al*., 2017; Mohamed *et al*., 2019). Life table analysis is a solid theory to describe in details the survival, stage differentiation and reproduction of insects including fruit flies in order to develop a complete management system (Maia *et al*., 2000; Huang and Chi, 2013).

In other instances, trap cropping is an attractive remedy for pest management by natural enemies over artificial bio-control or other conventional means of pest control (Midega *et al*., 2011; Roy, 2018). Generally, crop polyculture always lead to less damage from pests and can enhance biological control by offering greater host capacity for natural enemies than monoculture within a given area (Shelton *et al*., 2006; Holden *et al*., 2012; Rhino *et al*., 2016). Trap cropping potentially attract pest natural enemies and reduce pest disperse into the main crop through predation and parasitism (Hokkanen, 1991). Considerable research has been conducted on different trap crops to develop improved pest management strategies and resulting in a substantial reduction in pesticides use throughout the world (Holden *et al*., 2012; Rhino *et al*., 2016). But, till date none of the studies has been performed with *B. dorsalis* on different fruit plants using age-stage, two sex life table or trap crop designing for climate smart agriculture (CSA). Therefore studies on basic information on the life stages and demographic parameters of *B. dorsalis* on different fruits were undertaken. Objectives are to find out the detailed information on biochemical basis of host preference of *B. dorsalis* and unfold the impact of different host plants on their population growth parameters.

MATERIALS AND METHODS

Host plants: Four well known economic fruit crops [guava (*Pisidium guajava* L.; Myrtaceae), water apple (*Syzygium aqueum*; Myrtaceae), rose apple (*Syzygium jambos* L.; Myrtaceae) and mango(*Mangifera indica* L.; Anacardiaceae)] were selected in a field situated near Chinsurah Rice Research Center (CRRC), Chinsurah, 22°53' N, 88°23' E, 13m above sea level, Hooghly, West Bengal, India, in their growing season during 2018-2020. Intact mature fruits were collected separately for phytochemical analysis as well as provided as food for *B. dorsalis*. The plants were also identified and voucher specimens (Voucher No. ERU24-27) were kept in Department of Zoology, Ecology Research Unit, M.U.C. Women's College, Burdwan, West Bengal, India.

Phytochemical analysis: Intact mature ripen fruits (guava, water apple, rose apple and mango) were freshly collected from the selected plants. The fruits were initially rinsed with distilled water and dried under shade separately for phytochemical analysis as in Roy (2019b, 2020). Different primary and secondary metabolites (PMs and SMs) were extracted and estimated by various standard biochemical analysis protocols (Harborne, 1973) as in Roy (2019b, 2020). Determination of each biochemical analysis was repeated for three times and expressed in dry weight basis accordingly.

Insect collection, culture and rearing: The initial populations of *B. dorsalis* adults were collected from each fruit (guava, water apple, rose apple and mango) crop separately by special type of baited traps from the cultivated fields near CRRC, Chinsurah, Hooghly, West Bengal, India during summer season (June-August) in 2018-2020. The traps were suspended at a height of 1-1.5 m above the ground. Within one hour the flies was capture from the field then transfer carefully in laboratory condition (28± 2°C temperature and 70±5% relative humidity with 14:10 [L: D] photoperiod) for rearing. The selected fruits in slices were placed in the rearing cages (40×30×30 cm^3) separately for egg laying. The culture was maintained until adult emergence as described by Jaleel *et al.* (2019).

Fecundity, developmental duration and survivorship determination: Five pairs of newly emerged *B. dorsalis* adults from the stock culture were sexed and released into a new adult rearing cage (40×30×30 cm^3). The adults were fed with mixture of yeast extract and sugar in water at ratio 3:1. The eggs of *B. dorsalis* were collected when the age of adult flies from above cultures reached 3 weeks old. Fruit domes were used as egg collection device by cutting the fruits in thin slices leaving little flesh as possible on the skin and placed in Petri dishes (15 cm diameter). The outer skin of domes was pierced 30- 50 times with an entomological pin as oviposition holes. The fruit domes were placed inside the cage and the flies were allowed to oviposit for 24 hours and new fresh fruits slices were supplied every day for oviposition. After 24 hrs of exposure, the eggs were collected using fine hair brush and counted daily under a stereo microscope (Olympus-i20) with micro-photographic attachment. Eggs laid by each female were counted and recorded daily until the death of all individuals. The pre-oviposition periods (POPs), oviposition periods (OVPs) and fecundity of females and adult longevity of females and males of *B. dorsalis* adults were recorded. For each cohort (n=100), the eggs were then divided into 10 groups with 10 eggs per group for survivorship observation. Each group of eggs was placed on 20 g of each fruit pulp diet (in Petri dish 6 cm in diameter). To ensure the eggs remain moist, the Petri dish was covered and sealed with parafilm for the first 3 days. After egg hatching, the larval developmental time was measured as time in days within each stage. The larvae of *B. dorsalis* were reared on the selected fruits as pulp diet instead of the whole fruit to facilitate the daily calculation of survival and mortality of larvae. The eggs and early instar larvae were observed under the stereo microscope to record egg hatch and the survival of the first instar larvae until they reached the third larval instar. The third instar larvae which can be identified by their jumping behaviour were transferred from rearing Petri dish using a fine pair of forceps to plastic cups containing 0.5 cm sterilized fine sand as pupation medium. After 3 days of incubation, the pupae were sieved from sand and placed individually in small plastic cups (3.5 cm height, 6 cm diameter) layered with moistened tissue paper for adult emergence. The developmental durations (days), survival (%), accumulate survival (AS %) and mortality (%) of eggs, larvae, pupae and adults were observed and recorded.

Life table study: The data on survival, developmental duration and oviposition of all individuals on the selected four fruits (guava, water apple, rose apple and mango) were analyzed separately based on age-stage, two-sex life table (Chen *et al*., 2017; Mobarak *et al*., 2019). It includes several parameters, which were calculated with the formulae of Carey (1993, 2001) and Southwood (1978). These parameters include probability of survival from birth to age x (l_x), proportion of dying (d_x), mortality rate (q_x) and survival rate (s_x) per day per age class from egg to adult stages. Using these parameters, the following statistics like total individuals at age x and beyond k (T_x), average population alive in each stage (L_x), life expectancy (e_x), exponential mortality or killing power (k_x), total generation mortality (K or GM), generation survival (GS), gross reproductive rate (GRR or m_x), net reproductive rate (NRR or R_0), mean generation time (T_c), doubling time (DT), intrinsic rate of population increase (r_m), Euler's corrected r (r_c), finite rate of population increase (λ), weekly multiplication rate (λ^7), increase rate per generation (λ^{Tc}), were also computed, using Carey's formulae (1993). Some other population parameters like potential fecundity (Pf), total fertility rate (F_x), mortality coefficient (MC), population growth rate (PGR), population momentum factor of increase (PMF), expected population size in 2nd generation (PF_2), Hypothetical females in 2nd generation (HFF_2), expected females in 2nd generation (RFF_2), general fertility rate (GFR), crude birth rate (CBR), reproductive value (RV), vital index (VI) and trend index (TI) were also determined by using well defined formulae (Carey, 1993; Southwood, 1978; Roy, 2019b, 2020).

Statistical Analysis: Experimental data of different phytoconstituents of the selected fruits (guava, water apple, rose apple and mango) and the pest (*B. dorsalis*) population parameters were subjected to one-way analysis of variance (ANOVA) and Tukey's (HSD) test (Zar, 1999). All the statistical analysis was performed by using SPSS, version 16.0 (Roy, 2019a, 2019b, 2020).

RESULTS

Host phytochemicals: The chemical constituents of the selected fruits (guava, water apple, rose apple and mango), all the PMs and SMS, varied significantly ($F_{3,8} \geq 3.821$, $P \leq 0.024$) in the fruits and they were present in reverse order with each other with few deviations (Fig.1). Among the PMs, total carbohydrate and protein contents were 86.573±1.161, 34.286±1.581, 60.506±1.477, 72.361±1.257 and 12.822±0.561, 8.128±0.448, 9.344±0.501, 11.777±0.212 μg/mg dry weight, respectively, in the selected fruits. Total lipids and amino acids in guava, water apple, rose apple and mango were 2.473±0.960, 1.292±0.316, 1.868±0.525, 2.256±0.167 and 5.705±0.360, 2.037±0.183, 3.594±0.549, 4.696±0.123μg/mg dry weight, respectively. From the SMs, total phenol and flavonoid were11.206±0.561, 12.271±0.560, 14.596±0.487,17.129±0.251 and 10.070±0.524, 13.432±0.452, 13.115±0.504, 15.393±0.214μg/mg dry weight, respectively, in the selected fruits (guava, water apple, rose apple and mango), respectively. Total tannin and alkaloid content in guava, water apple, rose apple and mango were 5.571±0.486, 4.106±0.344, 7.246±0.521, 8.514±0.177 and 7.209±0.412, 5.317±0.195, 9.383±0.546, 11.019±0.126μg/mg dry weight, respectively. Ultimately, the ratio of PMs to SMs was significantly ($F_{3,8} \geq 5.772$, $P<0.022$) varied in the selected fruits and they can be arranged in the order of guava> rose apple> water apple>mango (Fig 1).

Population dynamics: The stage-specific two-sex pooled life tables of *B. dorsalis* were investigated in the laboratory with three replications on ripen fruits (guava, water apple, rose apple and mango) and showed four distinct stages (i.e., egg, larva, pupa and adult) with three larval instars. The population parameters like, l_x, L_x, T_x and e_x of *B. dorsalis* were gradually decreased throughout their developmental stages on the selected fruits and they always produce type-III survivorship curve like most of the insects. Whereas, the q_x and k_x were varied in different developmental stages and comparatively higher in

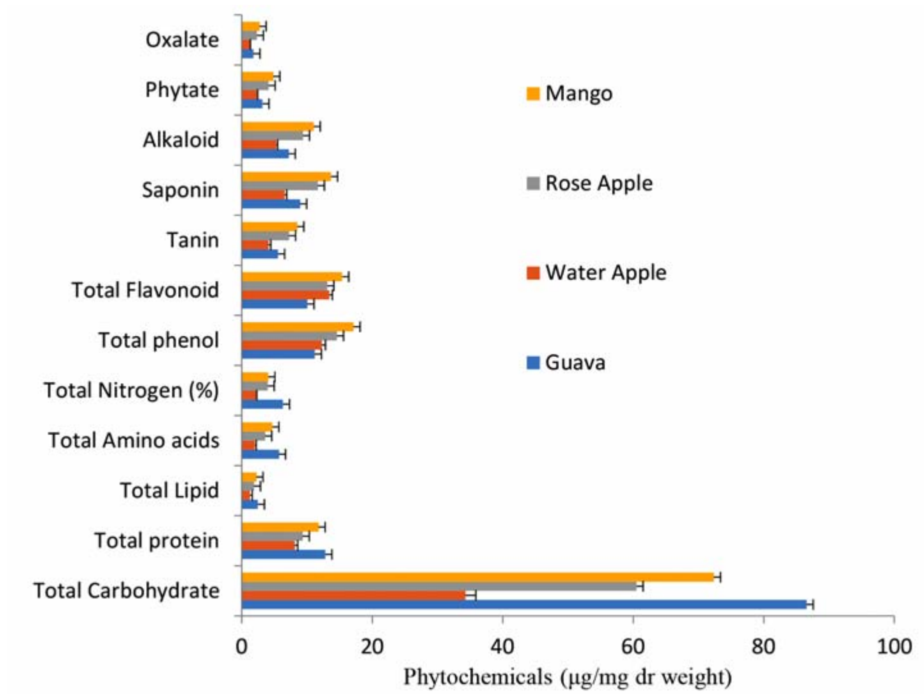

Fig. 1. Phytochemical variations (Mean ± SE, n=3) of four selected fruits (guava, water apple, rose apple and mango) observed during summer season in 2018-2020. All the estimated chemicals were significantly different at P<0.05 by Tukey (HSD) test

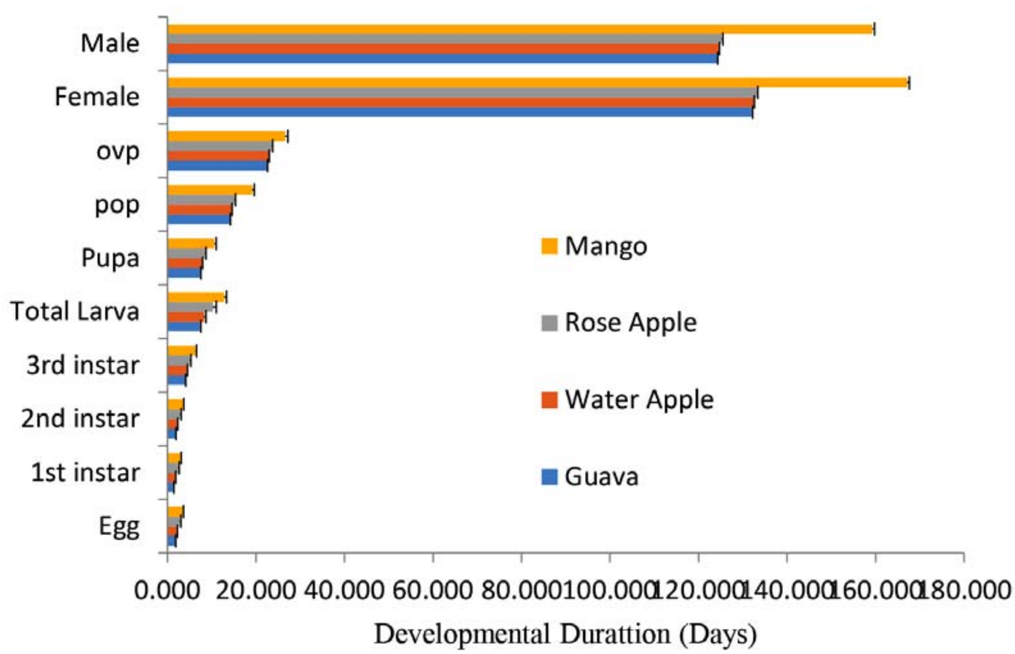

Fig. 2. Developmental duration (Mean ± SE, n=3) of *B. dorsalis* on four selected fruits (guava, water apple, rose apple and mango) observed during summer season in 2018-2020. All the estimated developmental durations were differed at P<0.001 by Tukey (HSD) test

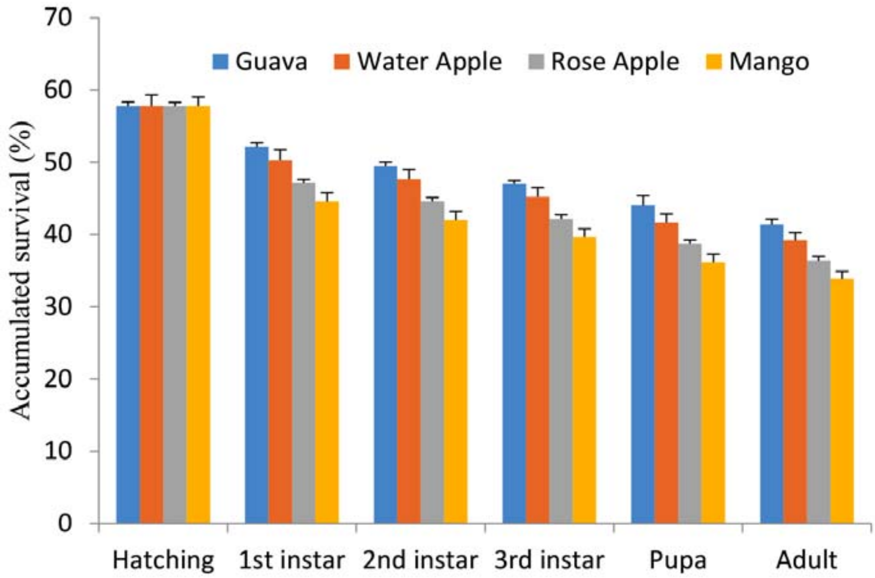

Fig. 3. Accumulated survival (Mean ± SE, n=3) of *B. dorsalis* on four selected fruits (guava, water apple, rose apple and mango) observed during summer season in 2018-2020. All the estimated accumulated survival values were different at P<0.001 by Tukey (HSD) test.

egg and 1st instar larval stage with a rapid surge during adult stage on the selected fruits. The l_x and k_x of adult *B. dorsalis* were 0.716±0.008, 0.679±0.011, 0.630±0.006, 0.585±0.011and 0.032±0.008, 0.074±0.010, 0.131±0.012, 0.192±0.012 individual^{-1}, respectively on guava, water apple, rose apple and mango the adult e_x of *B. dorsalis* on guava, water apple, rose apple and mango were 1.430±0.017, 1.343±0.020, 1.240±0.021, 1.143±0.019 day^{-1}, respectively (Table 1). ANOVA results of the life table parameters on the selected crop cultivars were showed more or less same pattern (guava>water apple>rose apple>mango)with significant ($F_{5,18}$=77.148-641.86; P<0.0001) variations(Table 2) due to host phytoconstituents as well as their metabolic utility by the pest.

The average Pf were 362.000±12.530, 320.667±8.988, 273.000±12.490 and 223.000±9.866 eggs/female, respectively on the selected fruits (guava> water apple> rose apple> mango) with significant ($F_{3,8}$=29.363; *P*<0.001) variations. The F_x, GRR and NRR or R_0 of *B. dorsalis* were also significantly ($F_{3,8} \geq$ 33.316; *P*<0.001) differed on the fruits in the order of guava> water apple> rose apple> mango. Average T_c for the fruits (guava, water apple, rose apple and mango) were 148.710±0.433, 150.614±0.882, 154.627±1.512 and 194.058±7.452 days, respectively (Table 3) with significant ($F_{3,8}$=31.489; *P*<0.001) variations. Similarly, the average DT were 19.946±0.208, 21.332±0.342, 23.692±0.603 and 32.719±1.236 days, respectively on the selected fruits (guava< water apple< rose apple< mango) with significant ($F_{3,8}$=64.326, *P*<0.001) variations. The r_m and ë of *B. dorsalis*were0.035±0.001, 0.033±0.001, 0.029±0.001, 0.021±0.001 and 1.035±0.001, 1.033±0.001, 1.030±0.001, 1.021±0.001 individuals female^{-1}day^{-1}, respectively on the selected fruits (guava> water apple> rose apple> mango) with significant ($F_{3,8}$≥83.214; *P*<0.001) variations. The average GS, PGR, PMF, CBR, RV, VI and TI of *B. dorsalis* were also significantly ($F_{3,8}$=5.402-33.316; *P*≤0.025-0.001) differed on the fruits in the order of guava> water apple> rose apple> mango. All the vital parameters like, GRR, NRR or R_0, r_m, T_c, DT and ë including other dependent parameters such as PGR, PF2, HF2, RF2, RV, VI and TI were higher on guava followed by water apple, rose apple

Table 1. Stage-specific pooled life table (Mean ± SE, n=3) for 3 cohorts (n=100) of *B. dorsalis* on four selected fruits (guava, water apple, rose apple and mango) observed during summer season in 2018-2020

Host: Guava						
Stage	l_x	q_x	L_x	T_x	e_x	k_x
Egg-0	1.000±0.000	0.098±0.005	0.951±0.003	4.883±0.030	4.883±0.030	0.045±0.003
lnst- I -1	0.902±0.005	0.051±0.001[a]	0.880±0.005	4.265±0.026	4.726±0.003	0.023±0.001[b]
lnst- II-2	0.857±0.005	0.050±0.001[a]	0.835±0.005	3.385±0.021	3.951±0.004	0.022±0.001[b]
lnst- III-3	0.814±0.005	0.064±0.012	0.787±0.009	2.550±0.016	3.134±0.004	0.029±0.006[c]
Pup-4	0.761±0.014	0.059±0.018	0.739±0.008	1.763±0.007	2.316±0.032	0.027±0.008[c]
Adult-5	0.716±0.008	0.070±0.017	0.691±0.001	1.024±0.002	1.430±0.017	0.032±0.008
Host: Water Apple						
Stage	l_x	q_x	L_x	T_x	e_x	k_x
Egg-0	1.000±0.000	0.130±0.015	0.935±0.007	4.663±0.072	4.663±0.072	0.061±0.007
lnst- I -1	0.870±0.015	0.052±0.001[d]	0.847±0.014	4.014±0.074	4.613±0.016	0.023±0.001[e]
lnst- II-2	0.825±0.013	0.051±0.001[d]	0.804±0.013	3.167±0.060	3.840±0.017	0.023±0.001[e]
lnst- III-3	0.782±0.013	0.079±0.001	0.752±0.012	2.363±0.047	3.020±0.018	0.036±0.001
Pup-4	0.721±0.012	0.059±0.001	0.700±0.011	1.611±0.035	2.235±0.019	0.026±0.001
Adult-5	0.679±0.011	0.157±0.020	0.626±0.015	0.912±0.025	1.343±0.020	0.074±0.010
Host: Rose Apple						
Stage	l_x	q_x	L_x	T_x	e_x	k_x
Egg-0	1.000±0.000	0.185±0.005	0.908±0.003	4.350±0.035	4.350±0.035	0.089±0.003
lnst- I -1	0.815±0.005	0.054±0.001[f]	0.793±0.005	3.675±0.041	4.506±0.024	0.024±0.001[g]
lnst- II-2	0.771±0.005	0.054±0.001[f]	0.751±0.005	2.881±0.036	3.735±0.022	0.024±0.001[g]
lnst- III-3	0.730±0.005	0.082±0.001	0.700±0.005	2.131±0.031	2.918±0.022	0.037±0.001
Pup-4	0.670±0.005	0.061±0.001	0.650±0.006	1.431±0.026	2.135±0.021	0.027±0.001
Adult-5	0.630±0.006	0.260±0.021	0.548±0.012	0.781±0.020	1.240±0.021	0.131±0.012
Host: Mango						
Stage	l_x	q_x	L_x	T_x	e_x	k_x
Egg-0	1.000±0.000	0.229±0.012	0.886±0.006	4.083±0.062	4.083±0.062	0.113±0.007
lnst- I -1	0.771±0.012	0.057±0.001[h]	0.749±0.012	3.386±0.062	4.391±0.019	0.026±0.001[i]
lnst- II-2	0.727±0.012	0.057±0.001[h]	0.706±0.012	2.637±0.050	3.626±0.018	0.025±0.001[i]
lnst- III-3	0.686±0.012	0.087±0.001	0.656±0.011	1.930±0.039	2.815±0.018	0.040±0.001
Pup-4	0.626±0.011	0.065±0.001	0.605±0.011	1.275±0.028	2.037±0.018	0.029±0.001
Adult-5	0.585±0.011	0.357±0.019	0.481±0.011	0.669±0.018	1.143±0.019	0.192±0.012

Within the column means followed by same letter(s) are not significantly different at $P<0.05$ by Tukey (HSD) test.

Table 2. ANOVA result of stage-specific pooled life table (Mean ± SE, n=3) for the 12 cohorts (n=100) of *B. dorsalis* on four selected fruits (guava, water apple, rose apple and mango) observed during summer season in 2018-2020

Parameters	Sum of Squares	df	Mean Square	F	Sig.
l_x	87.124	5,18	17.425	487.405	<0.001
q_x	80.235	5,18	16.047	641.862	<0.001
L_x	52.005	5,18	10.401	551.773	<0.001
T_x	29.581	5,18	5.916	428.651	<0.001
e_x	14.843	5,18	2.969	303.240	<0.001
k_x	4.174	5,18	0.835	77.148	<0.001

and mango while, GM, GFR and DT were in reverse (guava< water apple< rose apple< mango) order (Table 3).

Their average developmental durations of *B. dorsalis* on the selected fruits were differed significantly ($F_{3,8} \geq 83.214$; $P<0.001$) like T_c with few deviations within the developmental stages. The average POPs and OVPs were 14.135±0.078, 14.455±0.146, 15.122±0.252, 19.181±0.445 and 22.535±0.076, 22.855±0.149, 23.522±0.242, 26.581±0.618 days, respectively on the selected fruits (guava< water apple< rose apple< mango) with significant ($F_{3,8}=5.643$, $P=0.023$) variations (Fig. 2). The AS (%) of *B. dorsalis* in different developmental stages ($F_{5,18}=436.351$; $P<0.001$) on the selected fruits (guava> water apple> rose apple> mango) were varied significantly like l_x (Fig. 3). Thus, the population growth and reproductive parameters of *B. dorsalis* were significantly affected by their hosts (fruits) in respect to their phytoconstituents (Fig. 1) which support the host superiority or susceptibility (guava> water apple> rose apple> mango) to the notorious pest. According to host preference the three fruits (guava> water apple> rose apple) plant can be used in trap cropping for mango as main crop.

DISCUSSION

Modern agriculture includes integrated crop management (ICM) as well as integrated pest management (IPM) for eco-friendly, sustainable and smart agriculture (Cook *et al*., 2007; Chávez *et al*., 2018; Anuga *et al*., 2019). Despite this, it also relies primarily on habitat manipulation through farm scaping, trap cropping and other biological control practices to avoid detrimental effects of chemical insecticides on the total environment (Cook *et al.,* 2007; Holden *et al*., 2012). On the other hand, trap cropping by habitat manipulation is an attractive option to reduce dependency on conventional pest management practices through insecticides (Satarkar *et al*., 2009; Rhino *et al*., 2016). The study of pest population dynamics are widely useful technique in insect pest management (Southwood, 1978; Kakde *et al*., 2014; Roy, 2015, 2018). The development of immature insect pests is known to fluctuate with various abiotic and biotic factors (Roy 2014, 2015; Chen *et al*., 2017). Thus, host plant availability and quality in terms of their phytochemicals play a vital role on pest ecology (Awmack and Leather, 2002; Roy, 2014, 2015). The PMs (carbohydrates, proteins, lipids, amino acids including moisture content) are used for their general growth and reproduction like other animals (Turunen 1990). Whereas, consumption of SMs (phenols, flavonoids, tannin, alkaloids, phytate, etc.) are responsible for reducing their adult longevity, fecundity and retardation of larval growth (Schoonhoven *et al.,* 2005; Roy, 2017, 2019b) due to higher metabolic costs (War *et al.,* 2012). The polyphenols are a common and widespread group of defensive compounds which provide host resistance by antibiosis mechanism against any invading organisms (Bhonwong *et al.,* 2009). Even, oxidation of phenols by polyphenol oxidase or peroxidase produces quinones and it binds covalently with proteins and inhibits its utilization

Table 3. Population dynamics and reproductive table (Mean ± SE, n=3) of the 12 (3 cohorts/host) cohorts (n=100) of *B. dorsalis* on four selected fruits (guava, water apple, rose apple and mango) observed during summer season in 2018-2020

Population parameters	Guava	Water Apple	Rose Apple	Mango	$F_{3,8}$	Sig.
Potential fecundity (Pf)	362.000±12.530	320.667±8.988	273.000±12.490	223.000±9.866	29.363	<0.001
Total fertility rate (F_x)	17600.571± 735.166	13426.596± 834.302	9319.930± 782.561	6150.441498.946	47.182	<0.001
Gross reproductive rate (GRR)	246.025±12.698	197.679±10.315	147.854±11.023	104.986±7.674	33.316	<0.001
Net reproductive rate (NRR or R_0)	176.006±7.352	134.266±8.343	93.199±7.826	61.504±4.989	47.182	<0.001
Generation time (T_c)	148.710±0.433	150.614±0.882	154.627±1.512	194.058±7.452	31.489	<0.001
Doubling time (DT)	19.946±0.208	21.332±0.342	23.692±0.603	32.719±1.236	64.326	<0.001
Intrinsic rate of increase (r_m)	0.035±0.001^{a}	0.033±0.001^{a}	0.029±0.001	0.021±0.001	83.161	<0.001
Finite rate of increase (ë)	1.035±0.001^{b}	1.033±0.001^{bc}	1.030±0.001^{c}	1.021±0.001	83.214	<0.001
Weelkly multipli-cation rate ($ë^{7}$)	1.275±0.003	1.256±0.005	1.228±0.007	1.160±0.007	83.423	<0.001
Increase rate per generation ($ë^{Tc}$)	176.005±7.352	134.266±8.343	93.199±7.826	61.504±4.989	47.182	<0.001
Generation mortality (GM)	0.177±0.003	0.243±0.016	0.332±0.016	0.425±0.016	59.556	<0.001
Mortality coefficient (MC)	0.135±0.004	0.130±0.002	0.125±0.001^{d}	0.123±0.001^{d}	5.402	0.025
Generation survival (GS)	0.794±0.007	0.780±0.001	0.772±0.002	0.759±0.002	12.581	0.002
Population growth rate (PGR)	2.314±0.041	1.863±0.094	1.368±0.087	0.801±0.049	83.016	<0.001
Population momentum factor of increase (PMF)	31.744±1.449	26.893±1.120	21.703±1.203	16.710±0.854	30.493	<0.001
Population size in 2nd generation (PF_2)	2114.773± 113.351	1543.615± 115.045	1015.707± 95.324	631.437± 54.830	43.594	<0.001
Hypothetical F_2 females (HFF_2)	31086.103± 2641.626	18166.561± 2223.198	8808.591± 1504.924	3832.582± 616.075	39.449	<0.001
Realised F_2 females (RFF_2)	1543.784±82.746	1126.839±83.983	741.466±69.587	460.949±40.026	43.594	<0.001
General fertility rate (GFR)	7.446±0.209	7.678±0.105	8.019±0.070	8.108±0.085	5.641	0.023
Crude birth rate (CBR)	4.451±0.177	4.098±0.095	3.738±0.145	3.252±0.128	13.530	0.002
Reproductive value (RV)	492.049±25.395	395.358±20.629	295.708±22.046	209.972±15.349	33.316	<0.001
Vital Index (VI)	0.184±0.005	0.178±0.002	0.171±0.001^{e}	0.169±0.002^{e}	5.402	0.025
Trend index (TI)	216.405±11.337	177.101±8.142	139.918±10.030	103.323±7.385	27.000	<0.001

Within the rows means followed by same letter(s) are not significantly different at P<0.05 by Tukey (HSD) test along with *F* values (ANOVA) by the herbivores (Howe and Jander, 2008). The complex mixture of other SMs in many plants may provide effects in defence against a range of pests (Dicke, 2000; Schoonhoven *et al*., 2005). Never the less feeding on nutritionally poor host plants causes lower fecundity and survivability (Roy, 2014, 2017, 2020). Thus, phytoconstituents of the host plants would help to understand the mechanisms of host suitability or susceptibility as it affects larval survival, fecundity, growth and development (Awmack and Leather, 2002; Mobarak *et al.,* 2019). In this study, host suitability or susceptibility (guava> water apple> rose apple> mango) of *B. dorsalis* was also affected by the phytoconstituents (PMs and SMs) in their population parameters.

Several studies have described the biology of *Bactrocera* species on different artificial diets (Ekesi *et al*., 2007, 2016, Waseem *et al*., 2012; Mir *et al*., 2014; Aslam *et al*., 2019). Jaleel *et al*. (2019) described the two-sex life table parameters of four species in the genus *Bactrocera* e.g., *B. correcta, B. dorsalis, B. cucurbitae* and *B. tau* fed on semi-artificial diet. Only a few studies having focused on the two sex life table traits of *B. cucurbitae* on cucumber and *B. dorsalis* on mango as a natural host plant (Huang and Chi, 2014; Mohamed *et al*., 2019). The suitability of a host for larval development was determined by the nutritional elements, texture of the fruit pulp and chemical composition (Jaleel *et al*., 2019). According to Gomina et al. (2014), the differences of fecundity observed in *Bactrocera* species mainly affected by the diet provided to the larvae. In this instance, the larval development, survival and fecundity of *B. dorsalis* was also affected by the selected fruit diets. The development time of their immature stages and pre-oviposition period of their females was also varied with food resource like *B. cucurbitae* (Waseem *et al*., 2012; Huang and Chi, 2012). *B. dorsalis* was showed almost similar life-history attributes like *B. cucurbitae* and *B. correcta*on the selected fruit diets (Liu *et al*., 2013; Mir *et al*., 2014; Gu *et al*., 2019). The GRR, NRR or R_0, r_m, T_c, DT and λ are fundamental ecological parameters to predict the pest population growth to evaluate the performance of an insect on different host plants as well as their resistance (Roy, 2017, 2019b; Mobarak *et al*., 2019). Further, these are influenced by several factors like development time, survivorship and fecundity rate of an insect which states the physiological status of an insect in relation to its capacity to increase (War *et al*., 2012; Roy, 2019b, 2020). The r_m is an important population parameter in insect development and survival, because it explains the age, sex ratio, survivorship, and fecundity of insect population (Southwood, 1978; Dicke, 2000). The R_o is an indicator of rate of population increase, where the highest rate of population increase is dependent on the fecundity, development and survival of insect pests (Huang and Chi, 2012). Variations in the host plants directly affect potential and achieved development and growth of *B. dorsalis* as in other insects (Awmack and Leather, 2002; Roy and Barik, 2013; Roy, 2014, 2015). The survivorship (l_x) of *B. dorsalis* observed in the twelve cohorts recorded high mortalities during early instar larvae and low mortality during later life stages indicated type III survivorship as in other insect pests (Carey, 1993; Roy, 2017). In general, short developmental time and high reproduction rate are presumed reflect the adaptability of the species. In this study, the life table results displayed that this particular *B. dorsalis* species shows high R_o and λ with lower DT on guava followed by on the other fruits (guava> water apple> rose apple> mango). This showed that the population of *B. dorsalis* has rapid build-up in short period of time on guava than the other fruit diets. In addition, based on the results of life table study, we could better understand when (and why) their populations suffer high mortality. Trap cropping system in different agronomic situations will be greatly enhanced if future research works are conducted with cropping patterns including other ecological concepts (Shelton *et al*., 2006; Holden *et al*., 2012). According to host preference the three fruits (guava> water apple> rose apple) plant can be used as trap cropping system for mango as main crop. Even, sustainable management of *B. dorsalis* can be obtained through judicious control measures at most vulnerable stage(s) by using their life tables for each fruit crop in both mono and poly culture system in near future.

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REFERENCES

Anuga S.W., Gordon C., Boon E. and Surugu J.M.I. (2019) Determinants of climate smart agriculture (CSA) adoption among smallholder food crop farmers in the techiman municipality, Ghana. Ghana Journal of Geography 11(1): 124–139. https://dx.doi.org/10.4314/gjg.v11i1.8.

Aslam I., Khan M.A., Ahmad T., Gul T., Nazeer N., Aslam F. and Shehzadi K. (2019) Feeding potential of fruit fly (Diptera: Tephritidae) on different artificial diets under laboratory conditions.Acta Scientific Agriculture 3(11):109–113. https://doi.org/10.31080/ASAG. 2019.03.0693.

Awmack C.S. and Leather S.R. (2002) Host plant quality and fecundity in herbivorous insects. Annual Review of Entomology 47:817–844. doi.org/10.1146/annurev.ento.47.091201.145300.

Bhonwong A., Stout M.J., Attajarusit J. and Tantasawat P. (2009) Defensive role of tomato polyphenol oxidases against cotton bollworm (*Helicoverpa armigera*) and beet armyworm (*Spodoptera exigua*). Journal of Chemical Ecology 35: 28–38.

Carey J.R. (1993) Applied demography for biologists with special emphasis on insects, Oxford University Press, New York, NY, USA. pp. 211.

Carey J.R. (2001) Insect biodemography. Annual Review of Entomology 46: 79–110. https://doi.org/10.1146/annurev.ento.46.1.79.

Carvalho F.P. (2017) Pesticides, environment, and food safety. Food and Energy Security 6(2): 48–60.

Chávez J.P., Jungmann D. and Siegmund S. (2018) A comparative study of integrated pest management strategies based on impulsive control. Journal of Biological Dynamics 12(1): 318–341. doi:10.1080/17513758.2018.1446551.

Chen Q., Li N., Wang X., Ma L., Huang J. B. and Huang G.H. (2017) Age-stage, two-sex life table of *Parapoynx crisonalis*(Lepidoptera: Pyralidae) at different temperatures. PLoS ONE 12(3): e0173380. https://doi.org/10.1371/journal.pone.0173380.

Cook S.M., Khan Z.R, Pickett J.A. (2007) The use of 'push–pull' strategies in integrated pest management. Annual Review of Entomology 52: 375–400.

Dicke M. (2000) Chemical ecology of host-plant selection by herbivorous arthropods: a multitrophic perspective. Biochemical Systematics and Ecology 28: 601–617. https://doi.org/10.1016/S0305-1978(99)00106-4.

Drew R.A.I. and Raghu S. (2002) The fruit fly fauna (Diptera: Tephritidae: Dacinae) of the rainforest habitat of the Western Ghats, India. Raffles Bulletin of Zoology 50: 327–352.

Dutta S. and Roy N. (2016) Life table and population dynamics of a major pest, *Leptocorisa acuta* (Thunb.)(Hemiptera: Alydidae), on rice and non-rice system. International Journal of Pure & Applied Biosciences 4(1): 199–207. doi: http://dx.doi.org/10.18782/2320-7051.2202.

Ekesi S., De Meyer M., Mohamed S.A., Virgilio M. and Borgemeister C. (2016) Taxonomy, ecology, and management of native and exotic fruit fly species in Africa. Annual Review of Entomology 61: 219–238.

Ekesi S., Nderitu P.W. and Chang C.L. (2007) Adaptation to and small-scale rearing of invasive fruit fly *Bactrocera invadens* (Diptera: Tephritidae) on artificial diet. Annals of the Entomological Society of America 100: 562–567.

Gomina G.M., Mondedji A.D., Nyamador W., Vayssieres J.F., Amevoin K. and Glitho A.I. (2014) Development and demographic parameters of *Bactrocera invadens* (Diptera: Tephritidae) in Guinean climatic zone of Togo. International Journal of Natural Sciences Research 2(11): 263–277.

Gu X.Y., Zhao Y., Su Y., Wu J.J., Wang Z.Y., Hu J.T., Liu L.J., Zhao Z.H., Hoffmann A.A., Chen B. and Li Z.H. (2019) A transcriptional and functional analysis of heat hardening in two invasive fruit fly species, *Bactrocera dorsalis* and *Bactrocera correcta*. Evolutionary Applications 12: 1147–1163. https://doi.org/10.1111/eva.12793.

Harborne J.B. (1973) Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis, Edn. 2, Chapman and Hall, New York. pp. 88–185.

Hokkanen H.M. (1991) Trap cropping in pest management. Annual Review of Entomology 36: 119–138.

Holden M.H., Ellner S.P., Lee D.H., Nyrop J.P. and Sanderson J.P. (2012) Designing an effective trap cropping strategy: The effects of attraction, retention and plant spatial distribution. Journal of Applied Ecology 49: 715–722.

Howe G.A. and Jander G. (2008) Plant immunity to insect herbivores. Annual Review of Plant Biology 59: 41–66.

Huang Y.B. and Chi H. (2012) Age stage, two sex life tables of *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae) with a discussion on the problem of applying female age specific life tables to insect populations. Insect Science 19: 263–273.

Huang Y.B. and Chi H. (2013) Life tables of *Bactrocera cucurbitae* (Diptera: Tephritidae): with an invalidation of the jack knife technique. Journal of Applied Entomology 137: 327–339.

Huang Y.B. and Chi H. (2014) Fitness of *Bactrocera dorsalis* (Hendel) on seven host plants and an artificial diet. Turkish Journal of Entomology 38(4): 401–414.

Jalaluddin S.M., Natarajan K., Sadakathulla S. and Balasubramaniyan S. (1999) Discovery of the guava fruit fly *Bactrocera correcta* (Bezzi). Entomon 24: 195–196

Jaleel W., Yin J., Wang D., He Y., Lu L. and Shi H. (2017) Using two-sex life tables to determine fitness parameters of four *Bactrocera* species (Diptera: Tephritidae) reared on a semi-artificial diet. Bulletin of Entomological Research 108(6): 1–8. https://doi.org/10.1017/S000748531700092X

Jiang H.B., Gui S.H., Xu L., Pei Y.X., Smagghe G. and Wang, J.J. (2017) The short neuropeptide F modulates olfactory sensitivity of *Bactrocera dorsalis* upon starvation. Journal of Insect Physiology 99: 78–85.

Jiji T., Thomas J., Singh H.S., Jhala R.C., Patel R.K., Napoleon A., Kumar S., Vidya C.V., Mohantha A., Sisodiya D.B., Joshi B.K., Stonehouse J.M., Verghese A. and Mumford J.D. (2005) Attraction of Indian fruit flies to coloured spheres. Pest management in Horticultural Ecosystem 11 (2): 88-90.

Kakde A.M., Patel K.G. and Tayade S. (2014) Role of life table in insect pest management-a review. IOSR Journal of Agriculture and Veterinary Science 7(1): 40–43. https://doi.org/10.9790/2380-07114043.

Kim K.H., Kabir E. and Jahan S.A. (2017) Exposure to pesticides and the associated human health effects. Science of the Total Environment 575: 525–535.

Kunprom C., NanorkSopaladawan P. and Pramual P. (2015) Population genetics and demographic history of guava fruit fly *Bactrocera correcta* (Diptera: Tephritidae) in northeastern Thailand. European Journal of Entomology 112: 227–234. https://doi.org/10.14411/eje.2015.033.

Liu X., Zhang L., Haack R.A., Liu J. and Ye H. (2019) A noteworthy step on a vast continent: new expansion records of the guava fruit fly, *Bactrocera correcta* (Bezzi, 1916) (Diptera: Tephritidae), in mainland China. BioInvasions Records 8(3): 530–539.https://doi.org/10.3391/bir.2019.8.3.08.

Liu X.F., Jin Y. and Ye H. (2013) Recent spread and climatic ecological niche of the invasive guava fruit fly, *Bactrocera correcta*, in mainland China. Journal of Pest Science 86: 449–458, https://doi.org/10.1007/s10340-013-0488-8.

Maia H.N.M., Luiz A.J.B. and Campanhola C. (2000) Statistical inference on associated fertility life table parameters using jack knife technique: computational aspects. Journal of Economic Entomology 93(2): 511–518.

Midega C.A., Khan Z.R., Pickett J.A. and Nylin S. (2011) Host plant selection behaviour of *Chilo partellus* and its implication for effectiveness of a trap crop. Entomologia Experimentalis et Applicata 138: 40–47.

Mir S., Dar S., Mir G. and Ahmad S. (2014) Biology of *Bactrocera cucurbitae* (Diptera: Tephritidae) on cucumber. Florida Entomologist 97: 753–758.

Mobarak S.H., Roy N. and Barik A. (2019) Two-sex life table and feeding dynamics of *Spilosoma obliqua*Walker (Lepidoptera: Arctiidae) on three green gram cultivars. Bulletin of Entomological Research 110(4): 1–13. https://doi:10.1017/S0007485319000452.

Mohamed S., Roseli M., Sajili M.H., and Adam N.A. (2019) Life Table and Demographic Parameters of *Bactrocera dorsalis* Reared on Mango (*Mangifera indica* L.). Bioscience Research 16(SI): 311–318.

Qin Y.J., Ni W., Wu J., Zhao Z., Chen H. and Li Z.H. (2015) The potential geographic distribution of

Bactrocera correcta (Diptera: Tephrididae) in China based on eclosion rate model. Applied Entomology and Zoology 50: 371–381. https://doi.org/10.1007/s13355-015-0344-9.

Rashmi M.A., Verghese A., Shivashankar S., Reddy P.V.R. and Subhash Kandakoor S. (2020) Chemical defense and herbivory: A case study of phenolics versus *Bactrocera dorsalis* (Hendel) infestation in mango. Pest Management in Horticultural Ecosystems 26 (1): 121-128.

Rhino B., Verchère A., Thibaut C. and Ratnadass A. (2016) Field evaluation of sweet corn varieties for their potential as a trap crop for *Helicoverpa zea* under tropical conditions. International Journal of Pest Management 62: 3–10.

Roy N. (2014) Role of *Chorchorus capsularis* phytochemicals on the feeding dynamics of *Diacrisia casignetum* Kollar (Lepidoptera: Arctiidae). Journal of Entomology and Zoology Studies, 2: 227–236.

Roy N. (2015) Host phytochemicals in regulation of nutritional ecology and population dynamics of *Podontia quatuordecimpunctata* L.(Coleoptera: Chrysomelidae). International Journal of Horticulture 5(4): 1–11. https://doi.org/10.5376/ijh.2015.05.0004.

Roy N. (2017) Life table and nutritional ecology of *Epilachna vigintioctopunctata* Fab. (Colioptera: Coccinellidae) on three host plants. International Journal of Horticulture 7(2): 7–19. https://doi.org/10.5376/ijh.2017.07.0002.

Roy N. (2018) Host preference and potency of *Altica cyanea* as a bio-control agent of major rice field weeds, *Ludwigia spp.* International Journal of Zoological Studies 3(2): 227–231.

Roy N. (2019a) Jute leaf physicochemical cues mediated behavioral responses of *Diacrisia casignetum* Kollar. Agricultural Research 8: 287-296.https://doi.org/10.1007/s40003-018-0362-2.

Roy N. (2019b) Life table and economic threshold concept for ecologically sustainable management of *Diacrisia casignetum* Kollar (Lepidoptera: Arctiidae) on Jute. Entomon 44(2): 103–110. https://doi.org/10.33307/entomon.v44i.436.

Roy N. (2020) Population ecology and ETs based time series for climate smart pest management of *Spilosoma obliqua* Walker. Entomon 45(1): 15–30. https://doi.org/10.33307.

Roy N. and Barik A. (2012) The impact of variation in foliar constituents of sunflower on development and reproduction of *Diacrisia casignetum* Kollar (Lepidoptera: Arctiidae). Psyche 9. ID 812091.https://doi.org/10.1155/2012/812091.

Roy N. and Barik A. (2013) Influence of four host plants on feeding, growth and reproduction of *Diacrisia casignetum* (Lepidoptera: Arctiidae). Entomological Science 16(1): 112–118. https://doi.org/10.1111/j.1479-8298.2012.00546.x.

Satarkar V.R., Krishnamurthy S.V., Faleiro J.R. and Verghese A. (2009) Spatial distribution of major *Bactrocera* fruit flies attracted to methyl eugenol in different ecological zones of Goa, India. International Journal of Tropical Insect Science 29: 195–201. https://doi.org/10.1017/S174275840999035X.

Schoonhoven L.M., Van Loon J.J.A. and Dicke M. (2005) Insect-plant biology, Oxford University Press, Oxford, UK.

Shelton A.M. and Badenes-Perez F.R. (2006) Concepts and applications of trap cropping in pest management. Annual Review of Entomology 51: 285–308.

Shinwari I., Khan S., Khan M.A., Ahmad S., Shah S.F., Mashwani M.A. and Khan, M.A. (2015) Evaluation of artificial larval diets for rearing of fruit fly *Bactrocera zonata* (Diptera: Tephritidae) under laboratory condition. Journal of Entomology and Zoology Studies 3: 189–193.

Shobana K., Murugan A. and Kumar N. (2010) Influence of host plants on feeding, growth and reproduction of *Papilio polytes* (the common mormon). Journal of Insect Physiology 56:1065–1070. https://doi.org/10.1016/j.jinsphys.2010.02.018.

Slansky F. and Scriber J.M. (1985) Food consumption and utilization. In: Kerkot G.A. and Gillbert L.I. (eds), Comprehensive insect physiology, biochemistry and pharmacology, Pergamon, Oxford, England. pp. 87–113. https://doi.org/10.1016/b978-0-08-030805-0.50009-2.

Southwood T.R.E. (1978) Ecological methods particular reference to study of insect population, The English Language Book Society and Chapman and Hall, London. pp. 524.

Turunen S. (1990) Plant leaf lipids as fatty acid sources in two species of Lepidoptera. Journal of Insect Physiology 36: 665–672. https://doi.org/10.1016/0022-1910(90)90071-M.

War A.R., Paulraj M.G., Ahmad T., Buhroo A.A., Hussain

B., Ignacimuthu S. and Sharma H.C. (2012) Mechanisms of plant defense against insect herbivores. Plant Signaling and Behavior 7: 1306–1320.

Waseem M., Naganagoud A., Sagar D. and Kareem M.A. (2012) Biology of melon fly, *Bactrocera cucurbitae* (Coquillett) on cucumber. BIOINFOLET 9: 232–239.

Wee S.L. and Tan K.H.(2005) Female sexual response to male rectal volatile constituents in the fruit fly, *Bactrocera carambolae* (Diptera: Tephritidae). Applied Entomology and Zoology 40(2): 365–372.

White I.M. and Elson-Harris M.M. (1992) Fruit Flies of Economic Significance: Their Identification and Bionomics. Wallingford, CAB International, Wallingford, Oxon, UK. 601 pp. ISBN 0-85198-790-7.

Yang P., Carey J. and Dowell R. (1994) Host-specific demographic studies of wild *Bactrocera tau* (walker) (Diptera: Tephritidae). The Pan-Pacific Entomologist 70: 253–258.

Zar J.H. (1999) Biostatistical Analysis. Prentice Hall, Upper Saddle River, New Jersey, USA.

Zeng Y., Reddy G.V.P., Li Z.H., Qin Y.J., Wang Y.N., Pan X.B., Jiang F., Gao F. and Zhao Z.H. (2019) Global distribution and invasion pattern of oriental fruit fly, *Bactrocera dorsalis* (Diptera: Tephritidae). Journal of Applied Entomology 143: 165–176. https://doi.org/10.1111/jen.12582.

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