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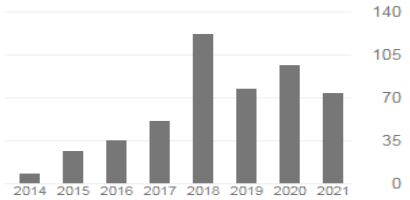

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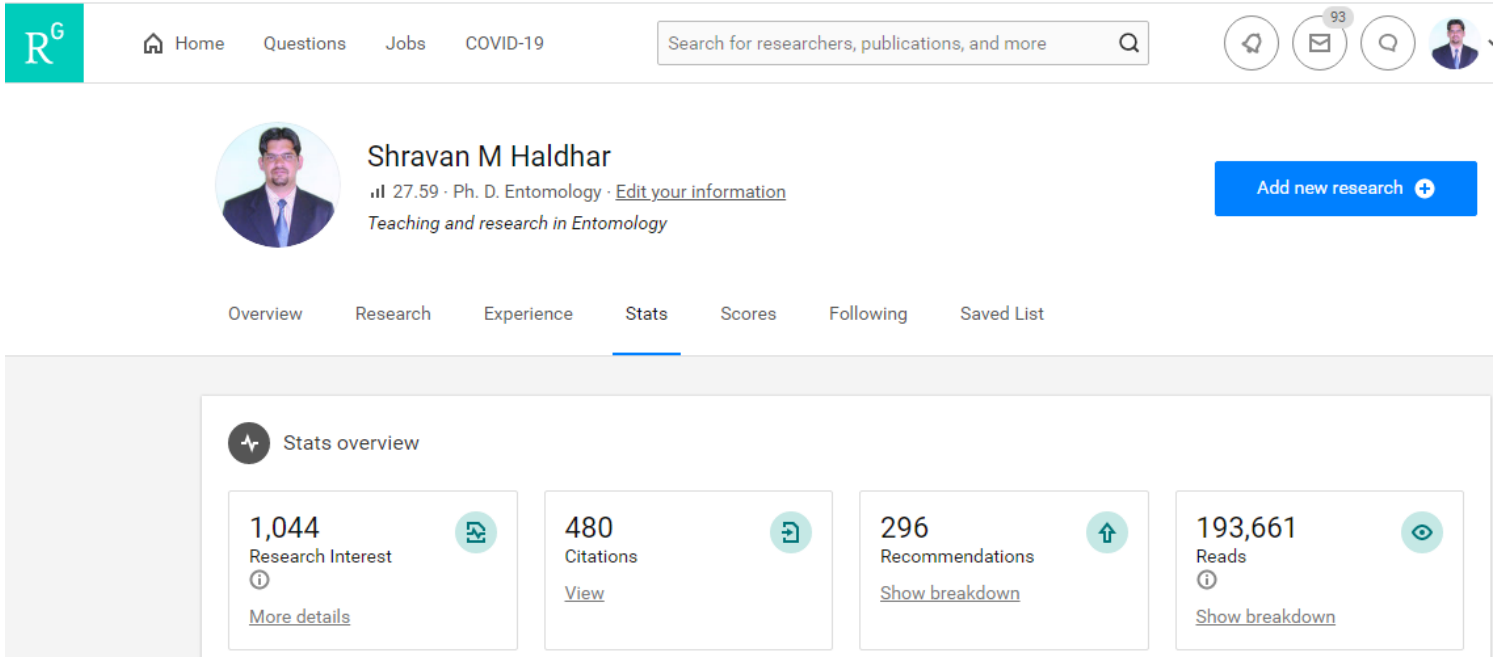

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Host plant resistance (HPR) traits of ridge gourd (*Luffa acutangula* (Roxb.) L. against melon fruit fly, (*Bactrocera cucurbitae* (Coquillett)) in hot arid region of India

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ABSTRACT

Host plant resistance is an important component of integrated pest management of the melon fruit fly, *Bactrocera cucurbitae* (Coquillett). Various phenotypic traits including length of ovary pubescence, rind hardness, rind thickness, fruit length, fibre content, and fruit diameter and alleochemical traits including flavonoid content, ascorbic acid, free amino acid, tannins content and phenols content of fruit were studied on fifteen varieties/genotypes of ridge gourd, *Luffa acutangula* in relation to resistance against *B. cucurbitae* under field conditions in the hot arid region of India. Significant differences were found in tested varieties/genotypes for fruit infestation and larval density per fruit. The varieties/genotypes AHRG-57 (15.92%), AHRG-29 (17.67%) and Pusa Nasdar (18.27%) were found resistant; AHRG-41 (21.77%), AHRG-35 (25.38%), Arka Sujata (30.08%), AHRG-36 (34.8%), S. Manjari (39.67%) and S. Uphar (42.3%) were moderately resistant; AHRG-30 (55.67%), AHRG-42 (57.63%) and AHRG-33 (57.67%) were susceptible; AHRG-47 (77.75%) and AHRG-31 (79.72) were found the highly susceptible varieties/genotypes to melon fruit fly infestation. A significant positive correlation ($r = 0.96$) was also observed between percent fruit infestation and larval density per fruit. The percent fruit infestation and larval density had significant positive correlation with fruit length and diameter and negative correlation with length of ovary pubescence, rind hardness and rind thickness. Based on Kaiser Normalization method, two principal components (PCs) were extracted explaining cumulative variation of 90% in melon fruit fly infestation and length of ovary pubescence, rind thickness, flavonoid content, ascorbic acid, free amino acid, tannins content, and phenols content were the reliable variables for characterization of resistance. Ridge gourd varieties/genotypes AHRG-57, Pusa Nasdar and AHRG-29 were classified as resistant to *B. cucurbitae* and these could be used in future breeding program as resistant sources.

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Article

Calligonum polygonoides L. as Novel Source of Bioactive Compounds in Hot Arid Regions: Evaluation of Phytochemical Composition and Antioxidant Activity

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Abstract: *Calligonum polygonoides* L. (Phog) is an endemic perennial herb that is highly resistant to all type of abiotic stresses and dominant biomass as well as phytochemicals producer in its natural habitat of the "Thar Desert" of Rajasthan, India. The present study was conducted to evaluate the effect of extreme environmental conditions on the phenolic, flavonoids, tannin content, and total antioxidant activities of *C. polygonoides* foliage harvested during different months. It exhibited a significant variation in the content of phenolic compounds, flavonoids, tannins, and antioxidant activity with harvesting time and all parameters are positively correlated to each other. The highest phenolic compounds and antioxidant activity was observed during severe winter and summer months, when monthly average environmental temperature was lowest and highest of the year, respectively. On the basis of the results, two harvests of *C. polygonoides* foliage during June and December are advised to maximize the phenolic compound production with highest antioxidant activity. These results demonstrate *C. polygonoides*, which is a dominant biomass producer under the harsh climatic conditions, can be an important source for the development of the functional foods rich in antioxidants in hot arid regions.

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Bottom-up effects of different host plant resistance cultivars on ber (*Ziziphus mauritiana*)-fruit fly (*Carpomyia vesuviana*) interactions

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ABSTRACT

The fruit fly, *Carpomyia vesuviana* Costa (Tephritidae: Diptera) is an important pest of ber (*Ziziphus mauritiana* L), leading to significant losses in yield in the hot arid agro-climate of India. Variation in resource input (anti-xenotics and allelochemicals) to plants trigger bottom-up effects on ber-fruit fly interactions. However, variation in plant extrinsic and intrinsic traits in response to resource availability may modify the bottom-up effects. The objectives of this study were to identify and categorize sources of resistance in ber cultivars to *C. vesuviana* from the arid region of India. We found that: (i) three cultivars were resistant; 13 cultivars were moderately resistant; 6 cultivars were susceptible and three cultivars were highly susceptible to fruit fly infestation; (ii) the phenol, tannin and flavonoid contents had significant negative correlations with percent fruit infestation. The percent fruit infestation had significant positive correlations with fruit length, pulp: stone ratio and had significant negative correlation with pericarp thickness. Pulp texture and fruit surface were found to be hardy and rough, respectively, in resistant cultivars of ber; and (iii) flavonoid and phenols content explained (89%) of the total variation in fruit fly infestation. Two principal components (PCs) were extracted which explained the cumulative variation of 84.7% in fruit fly infestation. PC1 explained 59.9% of the variation while PC2 explained 24.9% of the variation. Growers can adopt the potential resistant cultivars of ber (Tikadi, Katha and Illaichi cultivars) with minimal financial investment to obtain higher yields. Hence, a benefit of resistance cultivars for yield potential is apparent and resistance cultivars can be used as an important component of sustainable management.

1. Introduction

Plant-arthropod interactions are thought to be of utmost importance for understanding the dynamics of ecological communities (Sarmento et al., 2011; Han et al., 2016). Plant defence strategies against insect herbivores may involve the synthesis of a plethora of biologically active compounds (allelochemicals), which are phylogenetically conserved in specific plant families or genera (Mithofer and Boland, 2012). Plants frequently display genetic variation within and between population for traits that influence the preference and non-preference of insects on their hosts that are resistance traits (Johnson and Agrawal, 2005; Haldhar et al., 2017; Samadia and Haldhar, 2017; Muthusamy et al., 2017). It has been widely recognised that biological diversity plays a vital role in structuring community ecosystem processes (Snyder et al., 2006; Haddad et al., 2011; Sarmento et al., 2011; Tooker and Frank, 2012). The genotypic variation may influence the distribution and damage levels of herbivores on focal plants through processes referred to as associational resistance or susceptibility (Barbosa et al., 2009). Exploitation of bottom-up effects in the crop plant is an economical and environment-friendly method of insect management. The attractive and beneficial feature of bottom-up effects is that they are farmer friendly and do not need much financial investment for pest control. The identification and development of crop specific genotypes with resistance to pests is determined by the nutrients and concentrations of secondary metabolites. Host plants play an important role in determining insect populations in respect to concentrations and proportions of nutrients, which differ among species (Schoonhoven et al., 2005). Plants having antibiosis characters such as flavonoids, phenols, tannins etc. may cause reduced insect survival, prolonged development time, decreased size and reduced fitness of new generation adults (Gogi et al., 2010; Haldhar et al., 2013a). Hence, such mechanisms of plant resistance have been effectively and widely used for managing insect pests in horticultural crops (Moslem et al., 2011; War et al., 2012; Haldhar et al., 2015a, 2015b, 2017). Direct defenses are mediated by plant characteristics that affect the herbivore's biology such as mechanical protection on the surface of the plants (e.g., hairs, trichomes, thorns, spines, and thicker leaves) that retard the development of herbivores (Hanley et al., 2007).

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Host plant genotypes determine bottom-up effect of *Cucumis melo* var. *callosus* against melon fruit fly

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ABSTRACT

The melon fruit fly, *Bactrocera cucurbitae* (Coquillett) (Tephritidae: Diptera) is an important pest of cucurbits and is found to be effecting kachri (*Cucumis melo* var. *callosus*), leading to significant losses in yield potential in the hot arid agro-climate of India. The objectives of this study were to identify and categorize sources of resistance in kachri genotypes to *B. cucurbitae* from the arid region of India. Two genotypes were found to be highly resistant; 4 further genotypes were found to be resistant; 10 genotypes were moderately resistant; 6 genotypes were susceptible and two genotypes were found to be the highly susceptible to melon fruit fly infestation. The phenols ($r = -0.90$), tannin ($r = -0.89$), total alkaloids ($r = -0.80$) and flavonoid ($r = -0.96$) contents had significant negative correlations with percent fruit infestation. The percent fruit infestation did not correlate with fruit length ($r = 0.17$), fruit diameter ($r = 0.31$) and had significant negative correlation with length of ovary pubescence ($r = -0.95$), rind hardness ($r = -0.94$) and rind thickness ($r = -0.91$). Flavinoid and tannin contents explained (91.2 and 92.1%, respectively) of the total variation in fruit fly infestation and in larval density per fruit. Maximum variation in fruit infestation and larval density was explained by the length of ovary pubescence (89.5 and 84.8%, respectively) followed by rind hardness (4.3 and 3.3%, respectively). Based on the Kaiser Normalization method, two principal components (PCs) were extracted explaining the cumulative variation of 88.2% in melon fruit fly infestation. PC1 explained 71.6% of the variation while PC2 explained 16.6% of the variation. Kachri genotypic variability can improve plant fitness via bottom–up effects on fruit fly infestation. Growers can adopt potential genotypes of kachri as identified for resistance (two genotypes) with minimal financial investment for obtaining higher yields. Hence, a benefit of diversity for yield potential is recognized and thus genotypes diversity is used to become an important answer for sustainable management.

1. Introduction

A goal of many integrated pest management (IPM) researchers and practitioners has been to develop sustainable management programmes that are more resilient and less reliant on synthetic pesticides (Sharma and Ortiz, 2002; Lin, 2011; Tooker and Frank, 2012; Bustos-Segura et al., 2017). It has been widely recognised that biological diversity plays and a vital role in structuring community ecosystem processes (Tilman et al., 2006; Snyder et al., 2006; Haddad et al., 2011; Tooker and Frank, 2012). The genotypic variation may influence the distribution and damage levels of herbivores on focal plants through processes referred to as associational resistance or susceptibility (Barbosa et al., 2009). The bottom-up effects in the crop plant is an economical and environment-friendly method of insect management. The attractive and beneficial feature of botton up effect is that it is farmer friendly and does not need much financial investment for pest control. The identification and development of crop specific genotypes with resistance to pests is determined by the nutrients and concentrations of secondary metabolites. Host plants play an important role in determining insect populations in respect to concentrations and proportions of nutrients and differ among species (Schoonhoven et al., 2005). Plants having antibiosis characters such as flavinoid, alkaloid, phenols, tannins etc. may cause reduced insect survival, prolonged development time, decreased

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PLANT PHENOLOGICAL GROWTH STAGES

Phenological growth stages of Indian jujube (*Ziziphus mauritiana* Lamk.) according to the BBCH scale

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Indian jujube (*Ziziphus mauritiana* Lamk.) has been recognised as an underutilised plant worthy of further research and development by the Indian National Genetic Resources Programme and the International Centre for Underutilised Crops, UK. It is an important fruit crop of the hot arid regions in India as it forms an integral part of the life of the locals as a source of nutrition, fodder (leaves), fuel (pruned wood) and it has several ethnobotanical uses. In this study, 8 of the 10 principal growth stages based on the existing Biologische Bundesantalt, Bundessortenamt und Chemische Industrie (BBCH) scale were used to describe Indian jujube. These growth stages were vegetative bud development (Stage 0), leaf development (Stage 1), shoot development (Stage 3), inflorescence development (Stage 5), flower development (Stage 6), fruit development (Stage 7), fruit maturity (Stage 8) and senescence or beginning of dormancy (Stage 9). The phenological BBCH scale for Indian jujube can be used to guide the growers as to when to carry out orchard management practices such as canopy training and pruning, nutrient and water application, pest and disease control and post-harvest processing.

KEYWORDS
BBCH scale, *ber*, environmental factors, phenology, phenophase

1 | INTRODUCTION

Indian jujube (*Ziziphus mauritiana* Lamk.) belongs to the family Rhamnaceae and is an indigenous fruit crop of India (Krishna, Parashar, Awasthi, & Singh, 2014). It is known by various names such as Indian plum, Indian cherry, Chinese date, Chinese fig, Malay jujube and in India, most commonly as *ber* or *bor*. It is recognised as an underutilised plant worthy of further research and development by the Indian National Genetic Resources Programme and the International Centre for Underutilised Crops, UK (Krishna & Parashar, 2013). Indian jujube is widely distributed in warm regions of the world but India is its main site of cultivation. Currently, it is grown over approximately 49,000 ha with 481,000 t production per year in India (Anon., 2017). It is an important fruit crop of the hot arid regions in India as it forms an integral part of the life of the locals as a source of nutrition, fodder (leaves), fuel (pruned wood) and has several ethnobotanical uses (Krishna & Parashar, 2013; Morton, 1987). It is a dominant component of the natural vegetation in the Thar desert of India and thrives under a maximum annual temperature of 35–42°C and minimum temperature of 4–12°C (Azam-Ali et al., 2006). Meghwal, Khan, and Tewari (2007) asserted that *ber* trees should not be grown in areas experiencing temperatures lower than 4°C for prolonged periods. The plant can tolerate temperatures as high as 49–50°C and as low as −2°C (Awasthi & More, 2009). It can produce fruits even in areas which receive average annual rainfall of only 150–200 mm and thus is a suitable crop for the arid and semi-arid regions of the world (Tel-Zur & Schneider, 2009).

Indian jujube is a spiny shrub or a small tree with ends of branches decurved or drooping. It has a characteristic shoot growth pattern which may be an adaptation to arid and semi-arid conditions. It produces three types of proleptic shoots: vigorous, normal and spur-type by reiteration or following pruning of the previous season's growth. It also produces a dense canopy by sylleptic branching when conditions are favourable for growth, and shows rapid morphogenetic adjustments by the way of shoot tip abscission or dormancy of apical buds at the onset of drought (Kurian & Reddy, 1999). The plant is

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Research Paper

Host plant accessions determine bottom-up effect of snapmelon (*Cucumis melo* var. *momordica*) against melon fly (*Bactrocera cucurbitae* (Coquillett))

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ICAR-Central Institute for Arid Horticulture, Sri Ganganagar Highway, Beechwal Industrial Area, Bikaner–334006, India

The melon fly, *Bactrocera cucurbitae* (Tephritidae: Diptera) is an important pest of snapmelon (*Cucumis melo* var. *momordica*), leading to significant losses in yield in the hot arid agro-climate of India. The accessions IC-430190 (11.21%), DKS-AHS 2011/4 (14.97%) and DKS-AHS 2011/3 (18.57%) were found to be novel resistant accessions against melon fly, *B. cucurbitae* infestation. Free amino acid and total soluble solid (TSS) were in positive correlation with percent fruit infestation whereas phenols, tannin, total alkaloids and flavonoid contents had significant negative correlation with percent fruit infestation. The percent fruit infestation had significant positive correlation with fruit length, fruit diameter and flesh thickness and negative correlation with length of ovary pubescence, rind hardness at immature stage, rind hardness at mature stage and pericarp thickness. Based on Kaiser Normalization method, two principal components (PCs) were extracted explaining cumulative variation of 82.80% in melon fly infestation. PC1 explained 53.41% of the variation while PC2 explained 29.39% of variation. The flavonoid, total alkaloid, tannins, phenols content, length of ovary pubescence and rind hardness were the novel antibiosis and antixenotic characters found in snapmelon resistant melon fly, *B. cucurbitae* and therefore, could be used as marker traits in plant breeding programs to select resistant accessions.

Key Words: *Bactrocera cucurbitae*, *Cucumis melo* var. *momordica*, intra-specific diversity, bottom-up effect, plant defense, plant-insect interactions, host arid environment.

Introduction

A goal of many integrated pest management (IPM) researchers and practitioners has been to develop sustainable management programs that are more resilient and less reliant on synthetic pesticides (Bustos-Segura *et al.* 2017, Sharma and Ortiz 2002, Tooker and Frank 2012). It has been widely recognized that biological diversity playing and a vital role in structuring communities ecosystem processes (Haddad *et al.* 2011, Tooker and Frank 2012). The genotypic variation may influence the distribution and damage levels of herbivores on focal plants through processes referred to as associational resistance or susceptibility (Barbosa *et al.* 2009, Muthusamy *et al.* 2017). The feature of bottom-up effects is that it is farmer-friendly and environment-friendly method of insect management. The attractive and beneficial feature of bottom up effect is farmers friendly and does not need much financial investment toward pest control. The identification and development of crop specific genotypes with resistance to pests is determined by the nutrients and concentrations of secondary metabolites. Host plant plays an important role in determining insect populations in respect to concentrations and proportion of nutrients and differs among species (Schoonhoven *et al.* 2005). Considerable progress has been made in identification and development of crop cultivars with resistance to the major pests in different crops. There is a need to transfer resistance genes into high-yielding cultivars with adaptation to different agro-ecosystems (Samadia and Haldhar 2017, Sharma and Ortiz 2002). Plants are generally exposed to a variety of biotic and abiotic factors that may alter their genotypic and phenotypic properties resulting in expression of different mechanisms of resistance to pest attack (Gogi *et al.* 2010, Haldhar *et al.* 2015a). Such mechanisms of plant resistance have been effectively used against insect pests in many field and horticultural crops (Dhillon *et al.* 2005, Gogi *et al.* 2010, Haldhar *et al.* 2015b). Plants having antibiosis characters like flavonoid, alkaloid, phenols, tannins etc. may cause reduced insect survival, prolonged developmental time, decreased size and reduced fitness of new generation adults (Choudhary *et al.* 2015, Gogi *et al.* 2010, Haldhar

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Allelochemical resistance traits of muskmelon (*Cucumis melo*) against the fruit fly (*Bactrocera cucurbitae)* in a hot arid region of India

Shravan M. Haldhar · R. Bhargava · B. R. Choudhary · Garima Pal · Suresh Kumar

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Abstract Host plant resistance is an important component for management of the melon fruit fly, *Bactrocera cucurbitae* (Coquillett), owing to difficulties associated with its chemical and biological control. Various biochemical traits including total sugar, reducing sugar, non-reducing sugar, tannins, phenols, alkaloids, flavinoid and pH contents of fruit were studied on 11 varieties/ genotypes of muskmelon, *Cucumis melo* L., in relation to resistance against *B. cucurbitae* under field conditions. Significant differences were found in tested varieties/ genotypes for fruit infestation and larval density per fruit. AHMM/BR-1, RM-50 and AHMM/BR-8 were the most resistant; MHY-5, Durgapura Madhu and Pusa Sarabati were moderately resistant; AHMM/BR-13, Pusa Madhuras and Arka Jeet were susceptible; whereas Arka Rajhans and GMM-3 were the highly susceptible varieties/ genotypes to fruit fly in both seasons, 2011 and 2012. The larval density per fruit increased with an increase in percent fruit infestation and there was a significant positive correlation ($r = 0.97$) between percent fruit infestation and larval density per fruit. Total sugar, reducing sugar, non-reducing sugar and pH were lowest in resistant and highest in susceptible varieties/ genotypes, whereas tannins, phenols, alkaloids and flavinoid contents were highest in resistant and lowest in susceptible varieties/ genotypes. Total alkaloid and pH contents explained 97.96% of the total variation in fruit fly infestation and 92.83% of the total variation in larval density per fruit due to alkaloids and total sugar contents.

Keywords Antibiosis · Biochemical traits

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Introduction

Muskmelon (*Cucumis melo* L.) is an important horticultural crop worldwide and plays an important role in international trade. Different forms of melon are

REPORT OF *HOMOEOCERUS VARIABILIS* (HEMIPTERA: COREIDAE) ON KHEJRI (*PROSOPIS CINERARIA*) IN RAJASTHAN, INDIA: INCIDENCE AND MORPHOMETRIC ANALYSIS

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ABSTRACT

An infestation of *Homoeocerus variabilis* Dallas (Hemiptera: Coreidae) on khejri, *Prosopis cineraria*, was first noticed in 2010 at the Experimental Farm of Central Institute for Arid Horticulture and other fields of Bikaner district, Rajasthan, India. The maximum incidence was observed in December (66.7%) and minimum in June (16.7%). The number of this bug ranged between 27.3 and 222.9 adults per plant. This species is characterized by an ochraceous body with a broad red basal fascia on the pronotum between the humeral angles, small pale scutellum, antennae 4-segmented, the basal part of second and third segment is pale yellow, third segment flattened at the tip and fourth segment is the shortest. The mean body lengths of the male and female adult vary and were recorded as 12.2 mm and 15.5 mm, respectively.

Key Words: *Homoeocerus variabilis*, *Prosopis cineraria*, bug, morphometric characters

RESUMEN

Se observó por primera vez en 2010 una infestación de *Homoeocerus variabilis* Dallas (Hemiptera: Coreidae) en khejri, *Prosopis cineraria*, en la Granja Experimental del Instituto Central de Horticultura Árido y otros campos del Distrito Bikaner, Rajastán, India. Se observó la incidencia máxima (% de árboles infestados) en diciembre (66.7%) y el mínimo en junio (16.7%). La densidad de la población de este chinche coreido varió entre 27.3 y 222.9 adultos por planta. El chinche coreido se caracteriza por tener el cuerpo del color café con una fascia ancha basal en el pronoto entre los ángulos laterales, el escutelo pálido y pequeño, las antenas de 4 segmentos con la parte basal del segundo y tercer segmento de color amarillo, el el apice del tercer segmento aplanado y el segmento 4 es el más corto. El promedio de la longitud del cuerpo de los machos y hembras varía y fue registrado a 12.2 mm y 15.5 mm, respectivamente.

Palabras Clave: *Homoeocerus variabilis*, *Prosopis cineraria*, bug, incidence, morphometric

Prosopis cineraria (L.) Druce (Fabales, Fabaceae), commonly called khejri (synonyms: jambi, jambu, shumi, jandi) is a leguminous, multipurpose tree species distributed in hot arid and semi-arid regions of India, Afghanistan, Pakistan, Iran and Arabia (Pareek & Purohit 2002; Hanelt & IPK, 2001). It is the most revered indigenous plant of hot arid and semi-arid regions of western India and mostly found in north-western parts of Rajasthan, Gujarat and Haryana. Khejri is also known as "Queen of the Desert", and it is predominant constituent of the vegetation complex in the hot arid region of Rajasthan. It is an integral part of the life support systems of rural communities. Leaves of this tree are used as animal fodder and its young pods used as vegetable. Apart from these uses, it is extremely drought tolerant, promotes soil fertility by increasing organic carbon, N, P and K under its canopy (Srivastava & Hetherington 1991).

In the recent years, khejri tree decline has been noticed in the Thar Desert of India. The tree decline has been suspected to be caused by the lowering of the water table, mechanization of farm lands and incidence of pests. Some 153 insect and non-insect pests have been reported to damage *P. cineraria* in the world (Beeson 1941; Mathur & Singh 1960; Singh & Bhandari 1986; Parihar 1993; Parihar & Singh 1993), of which 26 are known to be potential threats in arid and semi-arid regions (Ahmed et al. 2004). The coreid bug infestation on khejri has not yet been reported. Here, we report the new information on the incidence of *H. variabilis* on khejri, its morphological characters and taxonomic identification.

MATERIALS AND METHODS

Incidence and Symptoms

Twenty 4-yr old khejri trees were randomly selected in each of 3 replicates at the Experimental

Antixenotic and allelochemical resistance traits of watermelon against *Bactrocera cucurbitae* in a hot arid region of India

Shravan M. Haldhar, B. R. Choudhary, R. Bhargava, and S. R. Meena*

Abstract

Host plant resistance is an important component of integrated pest management of the melon fly, *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae). We studied various antixenotic and allelochemical traits in the fruit for 15 varieties/genotypes of watermelon *Citrullus lanatus* (Thunb.) Matsumara & Nakai (Cucurbitales: Cucurbitaceae) in relation to resistance against *B. cucurbitae* under field conditions in a hot arid region of India. Results showed significant differences in tested varieties/genotypes in levels of fruit infestation and larval density per fruit. The varieties/genotypes 'Asahi Yamato' (12.73%), 'AHW/BR-16' (15.10%), and 'Thar Manak' (18.27%) were found to be resistant; 'Durgapura Lal' (23.03%), 'Sugar Baby' (26.67%), 'AHW/BR-12' (29.73%), 'Arka Manik' (34.15%), 'Charleston Gray' (38.70%), 'AHW-65' (35.80%), and 'AHW-19' (48.97%) were found to be moderately resistant; and 'IC 582909' (53.18%), 'AHW/BR-60' (55.52%), 'BSM-1' (59.10%), 'AHW/BR-137' (60.58%), and 'AHW/BR-9' (67.37%) were found to be susceptible to fruit fly infestation. Significant positive correlation ($r = 0.99$; $P < 0.01$) was observed between percentage fruit infestation and larval density per fruit. Percentage fruit infestation and larval density per fruit were significantly and positively correlated with fruit length ($r = 0.57$ and 0.55, respectively) and with days to first fruit harvest ($r = 0.75$ and 0.76, respectively), but negatively correlated with length of ovary pubescence ($r = -0.91$ and -0.91, respectively), rind hardness ($r = -0.86$ and -0.87, respectively), and rind thickness ($r = -0.77$ and -0.75, respectively). Maximum variation in fruit infestation and larval density were explained by length of ovary pubescence (82.5 and 83.6%, respectively) followed by fruit length (4.3 and 3.0%, respectively) and rind thickness (3.2 and 2.0%, respectively). Free amino acid content was lowest in the resistant 'Asahi Yamato' and highest in the susceptible 'BSM-1', whereas the contents of phenols, tannins, total alkaloids, and flavonoids were highest in resistant and lowest in susceptible varieties/genotypes. Flavonoid and total alkaloid contents explained 88.4 and 92.0%, respectively, of the total variation in fruit fly infestation and in larval density per fruit.

Key Words: flavonoid; alkaloid; phenol; tannin; 'Asahi Yamato'; 'BSM-1'

Resumen

La resistencia de las plantas hospederas es un componente importante para el manejo integrado de plagas de la mosca del melón, *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae). Estudiamos varios características antixenoticas y de aleloquímicos en el fruto de 15 variedades/genotipos de sandía *Citrullus lanatus* (Thunb.) Matsumara y Nakai (Cucurbitales: Cucurbitaceae) en relación a la resistencia contra *B. cucurbitae* en condiciones de campo en una región árida y caliente de la India. Los resultados mostraron diferencias significativas en las variedades/genotipos probados en los niveles de infestación de la fruta y de la densidad de larvas por fruto. Las variedades/genotipos 'Asahi Yamato' (12,73%), 'AHW/BR-16' (15,10%) y 'Thar Manak' (18,27%) resultaron ser resistentes; 'Durgapura Lal' (23,03%), 'Sugar Baby' (26,67%), 'AHW/BR-12' (29,73%), 'Arka Manik' (34,15%), 'Charleston Gray' (38,70%), 'AHW-65' (35,80%) y 'AHW-19' (48,97%) resultaron ser moderadamente resistente; y se encontraron 'IC 582909' (53,18%), 'AHW/BR-60' (55,52%), 'BSM-1' (59,10%), 'AHW/BR-137' (60,58%) y 'AHW/ BR- 9' (67,37%) susceptibles a la infestación de mosca de la fruta. Se observó una correlación positiva significativa ($r = 0,99$; $P < 0,01$) entre el porcentaje de infestación de fruta y la densidad de larvas por fruto. Se correlacionaron significativamente y positivamente el porcentaje de infestación de frutas y la densidad de larvas por fruto con la longitud del fruto ($r = 0,57$ y 0,55, respectivamente) con el número de días hasta la primera cosecha de la fruta ($r = 0,75$ y 0,76, respectivamente), pero fueron negativamente correlacionados con la duración de la pubescencia de ovario ($r = -0,91$ y $-0,91$, respectivamente), la dureza de corteza ($r = -0,86$ y $-0,87$, respectivamente), y el grueso de la corteza ($r = -0,77$ y $-0,75$, respectivamente). Se explica la variación máxima de la infestación de frutas y la densidad larval por la longitud de pubescencia del ovario (82,5 y 83,6%, respectivamente) seguido de la longitud del fruto (4,3 y 3,0%, respectivamente) y el grueso de la corteza (3,2 y 2,0%, respectivamente). El contenido de aminoácidos libres fue más bajo en el resistente 'Asahi Yamato' y más alto en el susceptible 'BSM-1', mientras que el contenido de fenoles, taninos, alcaloides totales y flavonoides fue más alto en las variedades/genotipos resistentes y menor en las variedades susceptibles. El contenido de alcaloides y flavonoides totales explicaron el 88,4 y 92,0%, respectivamente de la variación total de la infestación por la mosca de la fruta y de la densidad de larvas por fruta.

Palabras Clave: flavonoides; alcaloide; fenol; taninos; 'Asahi Yamato'; 'BSM-1'

Watermelon (*Citrullus lanatus* [Thunb.] Matsumara & Nakai; Cucurbitales: Cucurbitaceae) is a popular dessert crop throughout the tropics and the Mediterranean regions of the world (Tindall 1983). Because of its antioxidant properties, the fruit is being rated equal to apple, banana, or orange. Fruits contain diverse carotenoids that are responsible for the different flesh colors. Different carotenoid patterns

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First report of *Colotis amata* (Lepidoptera: Pieridae) on *Salvadora persica* (Capparales: Salvadoraceae) in Rajasthan, India: incidence and morphometric analysis

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Abstract

An infestation of the small salmon Arab, *Colotis amata* (F.) (Lepidoptera: Pieridae), on pilu (*Salvadora persica* L.; Capparales: Salvadoraceae) plants was first noticed in 2012 at the Experimental Farm of the Central Institute for Arid Horticulture and other fields of Bikaner District, Rajasthan, India. The maximum incidence (80%) was observed on 18 Dec and the minimum (13%) on 4 Sep. The average numbers of insects ranged between 6.2 and 22.3 larvae per 3 leaves. Adults of this small butterfly were salmon-pink in color. Eggs were laid singly on leaves or young shoots and were 0.58–0.72 mm in length, 0.38–0.43 mm in width, and white in color when first laid, later developing red blotches. The length and width of 1st instar larvae were 1.98–2.29 mm and 0.36–0.48 mm, respectively. The lengths of 2nd, 3rd, and 4th instars were 5.04 mm, 9.77 mm, and 14.27 mm, respectively. The 5th instars were 19.30 mm long and 3.33 mm wide. Pupae were 14.10 mm long and 5.73 mm wide and laterally compressed. Adults were salmon-pink in color, and females had a body length of 9.71 mm and a wingspan of 33.62 mm. Bodies of males were 7.59 mm long and their wingspan measured 25.67 mm. The lengths of male and female antennae were 4.63 mm and 5.46 mm, respectively.

Key Words: small salmon Arab; pilu; morphometric characters

Resumen

Se observó por primera vez en 2012 una infestación de la pequeña salmón árabe, *Colotis amata* (F.) (Lepidoptera: Pieridae), sobre plantas de Pilu (*Salvadora persica* L .; Capparales: Salvadoraceae) en la Granja Experimental del Instituto Central para Zonas Áridas y Horticultura otros campos de Bikaner Distrito, Rajasthan, India. La incidencia máxima (80%) fue observada en el 18 de diciembre y el mínimo (13%) en el 04 de septiembre. El promedio del número de insectos vario entre 6.2 y 22.3 larvas por 3 hojas. Los adultos de esta pequeña mariposa son amarillos y de color blanco. Los huevos se ponen individualmente en las hojas o brotes jóvenes y fueron 0.58 a 0.72 mm de longitud, 0.38-0.43 mm de ancho, y de color blanco cuando acaban de ser puestos y luego desarrollan manchas rojas. La longitud y anchura de las larvas del primer instar fueron 1.98 a 2.29 mm y 0.36 a 0.48 mm, respectivamente. La longitud de las larvas del segundo, tercero y cuarto instar fuer 5.04 mm, 9.77 mm y 14.27 mm, respectivamente. Las larvas del quinto estadio fueron 19.30 mm de longitud y 3.33 mm de ancho. Las pupas fueron 14.10 mm de longitud y 5.73 mm de ancho y comprimido lateralmente. Los adultos fueron del color rosa-salmón y las hembras tenían una longitud de 9.71 mm y una envergadura de 33.62 mm. El cuerpo de los machos fue 7.59 mm de largo y su envergadura mide 25.67 mm. La longitud de las antenas masculinos y femeninos fueron 4.63 mm y 5.46 mm, respectivamente.

Palabras Clave: pequeño salmón árabe; Pilu; incidencia; caracteres morfométricos

The genus *Salvadora* belongs to the family Salvadoraceae. It comprises 3 genera (i.e., *Azima*, *Dobera*, and *Salvadora*) and 10 species distributed mainly in the tropical and subtropical regions of Africa and Asia (Mabberley 2008). On the Indian subcontinent, this family is represented by only 1 genus with 2 species, namely *Salvadora persica* L. and *Salvadora oleoides* Decne. (Qureshi 1972; Stewart 1972; Perveen & Qaiser 1996). *Salvadora persica*, or pilu, is a medium-sized tree or shrub with a crooked trunk, seldom more than 0.3 m in diameter. It has a pleasant fragrance as well as a warm and pungent taste. Fruits have a sweet, agreeable, aromatic, and slightly sour flavor. They can be eaten raw, cooked, or dried and stored when dried. Fruits with or without seeds are said to contain 1.7–1.9% sugars when ripe, and delicious drinks can be made from them. *Salvadora persica* is a popular chewing stick commonly known as "miswak" and is one of the most popular medicinal plants throughout the Indian subcontinent as well as other parts of Asia and the Middle East (Ezmirly et al. 1978; Almas 2002; Al-Otaibi et al. 2003, 2004; Sofrata et al. 2007). When *S. persica* occurs on river terraces, it is a preferred host of *Cistanche tubulosa* (Schenk) R. Wight (Lamiales: Orobanchaceae), an obligate phanerogamic root parasitic plant (Sher et al. 2010). Furthermore, defoliating larvae of several beetles and of *Colotis ephyia* (Klug) (Lepidoptera: Pieridae) often attack the tree, and the mite *Eriophyes* sp. causes leaf galls (Kumar et al. 2012). The genus *Colotis* comprises 40 species, 39 of which are primarily or entirely Afrotropical in distribution. The majority of species have pure white uppersides, with prominent orange, yellow, or crimson tips of the forewings. *Colotis amata* is distributed across Africa from Sen-

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Author(s)	S.M. Haldhar, R. Thangjam, V. Kadam, B.L. Jakhar, R. Loganathan, K.I. Singh1, K. Rolania, S. Singh, S.R. Dhaka and K.M. Singh

Dear **Dr. Shravan M Haldhar,**

We are pleased to inform you that as per recommendations of the review-panel and approval from R & D Division, your above-mentioned manuscript has been **accepted** for publication in the *Journal of Environmental Biology* and is expected to be published in Volume **42 (2021)** .

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We thank you for opting *Journal of Environmental Biology* for the publication of your research.

To,
Dr. Shravan M Haldhar
Associate Professor, Department of Entomology College of Agriculture
Imphal, Manipur – 795 004, India

Sincerely yours,

Executive Secretary
Journal of Environmental Biology

Indian Journal of Agricultural Sciences **84** (2): 303–5, February 2014/Short Communication

Report of *Dictyla cheriani* (Hemiptera: Tingidae) on Indian cherry (*Cordia myxa*) in Rajasthan, India: Incidence and morphometric analysis

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Key words : *Cordia myxa*, *Dictyla cheriani*, Incidence, Lace bug, Morphometric characters

Cordia myxa L. commonly called Indian cherry (synonyms: clammy chery, franrant manjack, lasora, shelu, cinnanakkeru, bahubara, chokri, lahsoda, lahsua, gonda, gondi) belongs to Boraginaceae family, this tree is a multipurpose species distributed in hot arid and semi-arid regions of India, originated in North-Western part of the country (Stewart and Brandis 1992) and distributed in warmer regions of Myanmar, Afghanistan, China, Africa, Australia etc. and more recently also in the America. Singh *et al.* (1999) identified two types of lasora fruits based on fruit maturity one early type with small, turnip shaped fruits and another late type with large size and spherical shape fruits. There are no standard varieties of lasora, however, they can be grouped into two on the basis of their fruit size namely bold and small fruits (Kaushik and Dwivedi 2004, Malik *et al.* 2010). Unripe fresh fruits are acrid and used for vegetable and pickle. Ripe fruits are eaten as fresh. Fruit pulp is rich in carbohydrates, extractive matter and ash. Fruit is highly mucilaginous and used in cough mixture to cure diseases of chest and is given as laxative for bilious infections (Malik *et al.* 2010).

According to the National Tree Seed Project (1999), insect damage on *Cordia africana* seeds was 45%, 30% and 20% from Sekoru, Arjo and Wondo Genet places, respectively. Tibebu (2002) studied pre-dispersal insect seed predators on seeds of these two tree species, 10 and found 20% of *Cordia africana* seeds collected from Sekoru, and 8-10% of seeds collected from Denbi, Jimma and Arjo places. Few studies were made on the bug, *D. cheriani* infestation on *Cordia* sp. (India) and bug, *D. monotropidia* infestation on *Cordia verbenacea* (Brazil) by Daniel *et al.* (2008). However no attempts were made on the incidence and morphological characterization of *Dictyla cheriani* on *Cordia myxa* which is widely cultivated in Indian condition. Here, we report the information on the incidence of *D. cheriani* on Indian cherry, its morphological characters.

Twenty Indian cherry trees were randomly selected in each of 3 replicates at the Experimental Farm of the Central Institute for Arid Horticulture (CIAH) (N 28° 06' E 73° 21' and at altitude of 234.84 m above sea level). Incidence of infested trees, number of lace bugs observed on each leaves and symptoms of damage and decline (in comparison with un-infested plants) were recorded from August 2010 to July 2011. The sampling was done by visual observation and manual counting. Average incidence was calculated as the percent of whole trees infested with *D. cheriani*. Average number of lace bugs per leaves was calculated on the basis of observations recorded on ten randomly selected leaves of whole plant with 3 replications. Twenty lace bugs (10 males and 10 females) were used for observation and measurements. The average linear measurements of various body parts of male and female lace bugs were obtained under a stereo binoculars microscope (Radical Instruments, Ambala, Haryana, India) using Jenoptic Pro 2.8.0 software. The terminology used to denote different parts of the body of the coreid lace bug followed Albrecht (1955) The lace bug samples collected from the CIAH farm and other fields were preserved in 70 per cent alcohol and deposited at the Insect Biosystematic Section, Division of Entomology, Indian Agricultural Research Institute, New Delhi for taxonomic identification. Statistical Analysis: Square root transformation values were used as necessary to achieve normality in the data before analysis. The data on incidence and population of lace bugs were analyzed through one-way ANOVA using SPSS software (O'Connor 2000). The means of significant parameters, among tested month wise incidence and population were compared using Turkey's honestly significant difference (HSD) tests for paired comparisons at probability level of P=0.05. The standard error of the mean was calculated by this formula ** where, 's' is the sample standard deviation and 'n' is the size (number of observations) of the sample.

Lace bugs were observed on Indian cherry tree in the hot

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Report of morphomatric and biology of leaf eating caterpillar, *Diaphania indica* in arid region of India

S. M. Haldhar ✉, B. R. Choudhary, D. K. Samadia & A. K. Verma

Vegetos (2021) | Cite this article

Metrics

Abstract

Present paper deals with the morphomatric analysis, incidence and biology of leaf eating caterpillar, *Diaphania indica*, carried out on cucurbits in arid region. The incidence of leaf eating caterpillar was first reported on fruits of different cucurbits and highest fruit infestation was recorded in muskmelon followed by round melon and watermelon fruits at farm of ICAR-CIAH, Bikaner. Eggs are laid on leaves or young shoots or fruits. The female fly laid the eggs in the cavities made by the ovipositor, just beneath the skin of the fruit. The pooled mean duration of the different stages of *D. indica* viz., the female fecundity (163.35 number), egg period of 3.59 days, larval period of 9.10 days, pre-pupal period of 2.14 days, pupal period of

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DIGAMA HEARSEYANA (LEPIDOPTERA: NOCTUIDAE), A NEW THREAT TO KARONDA (*CARISSA CARANDUS*) IN RAJASTHAN

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ABSTRACT

An infestation of *Digama hearseyana* Moore, 1859 (Lepidoptera: Noctuidae) on karonda, *Carissa carandus*, was first noticed in 2014 as sporadic occurrence at the experimental farm of the ICAR-Central Institute for Arid Horticulture at Bikaner in Rajasthan. The maximum incidence was observed in second fortnight of August and minimum in second fortnight of April during 2014 and 2015. The number of larvae ranged between 1.07 to 5.77 and 1.23 5 to 5.97 larvae / plant during second fortnight of April and second fortnight of October 2014 and 2015. This species is characterized by the male forewing pale greyish-brown; hind wing testaceous- yellow with a small brown mark on middle margin; abdomen testaceous with a dorsal row of black dots and legs yellowish with dark bands. The mean body length up to genitalia of the male and female adult vary (11.28 mm and 11.28 mm, respectively). Since *D. hearseyana* belongs to a species complex of *Digama* where reliable identification of individual species is very daunting task, DNA barcode based on standard barcoding gene cytochrome oxidase I (COI) of the mitochondrial DNA was developed and subsequently molecular identity established.

Key words: *Digama hearseyana*, *Carissa carandus*, incidence, diagnostics, morphometrics, mtCO1, first report, seasonal incidence, damage

In the species complex of *Digama* moths (Noctuidae: Aganainae), the morphological identification of the individual species is very difficult. One of its species, *Digama hearseyana* Moore (1859) is herein reported for the first time as a new threat to the cultivated plant karonda. *Digama hearseyana* is distributed in South Africa, China, throughout India, Sri Lanka, Myanmar and Australia (Smetacek, 2008; Hampson, 1892). Karonda grows naturally in the Himalaya at elevations of 30 to 1,800 m, in the Siwalik Hills, the Western Ghats and in Nepal and Afghanistan. It is cultivated in India on a limited scale in Rajasthan, Gujarat, Bihar, West Bengal and Uttar Pradesh, as well as in the Sri Lanka lowland rain forests. It is a hardy, drought tolerant plant that thrives well in a wide range of soils (Khare, 2007; Lim 2012). The pest status of *D. hearseyana* is unknown and hence this study explores it's diagnostics, morphology and mtCOI DNA barcode.

under a stereozoom microscope (Radical Instruments, Ambala, Haryana) using Jenoptic Pro 2.8.0 software. The larvae were reared under laboratory conditions (28 ± 2 °C and 60 ± 5 % RH). The terminology followed is after Haldhar (2012), Haldhar and Singh (2014) and Haldhar et al. (2015). The illustrations were scanned at 600 dpi black and white, and mounted using Adobe Photoshop c8.0. Three years old karonda trees were randomly selected with three replications at the Experimental Farm of the ICAR-Central Institute for Arid Horticulture (28°06'E 73°21') with replications being at different locations. Incidence of *D. hearseyana* was observed on each tree and symptoms of damage (in comparison with uninfested plants) were observed from April to October, 2014 and 2015, respectively. The sampling was done by visual observation and manual counting. Mean incidence was calculated as % of trees infested with and number/ trees calculated.

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SUSCEPTIBILITY OF WATERMELON GENOTYPES TO FRUIT FLY *BACTROCERA CUCURBITAE* (COQUILLETT)

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ABSTRACT

Host plant resistance is an important component for management of the melon fruit fly, *Bactrocera cucurbitae* (Coquillett) owing to difficulties associated with its chemical and biological control. A total of 27 watermelon varieties/ genotypes were evaluated for their susceptiblity to the fruit fly in hot arid region of Rajasthan. The results showed that the varieties/ genotypes *viz.* percentage of fruit infestation and larval population per fruit varied significantly. Pooled data showed that the varieties/genotypes *viz.*, AHW/BR-60, BSM-1, IC 582909, AHW/BR-9, AHW/BR-137, Durgapura Kesar, AHW/BR-10, AHW/BR-18, AHW/BR-8, AHW/BR-21, AHW/BR-20 and YF-4 can be categorized as susceptible with considerable fruit infestation (55.72%, 59.28%, 53.05%, 67.20%, 60.43%, 61.83%, 63.87%, 63.62%, 59.45%, 59.62%, 62.52% and 55.68%, respectively) and with larval population per fruit *viz.* 17.12, 17.85, 16.45, 19.23, 17.90, 18.48, 18.38, 18.32, 18.40, 17.57, 17.93 and 17.70, respectively. The varieties/ genotypes Asahi Yamato, AHW/BR-16 and Thar Manak had 12-18% fruit infestation (12.75%, 15.05% and 18.18%, respectively) with 1-1 lawal per fruit (10.13, 10.82 and 11.08, respectively) and declared which can be considered resistant. Lower values of host plant susceptibility indices based on fruit infestation (HPSI) were recorded on resistance varieties/ genotypes, *viz.*, Asahi Yamato, AHW/BR-16 and Thar Manak (28.85%, 34.05% and 41.14%, respectively). These could be used as a source of resistance for developing watermelon varieties/ genotypes resistant to fruit fly.

Key words: *Citrullus lanatus, Bactrocera cucurbitae, infestation, density, HPSI*

Watermelon [*Citrullus lanatus* (Thunb.) Mansf.] is a popular desert crop and fruit fly, *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae: Dacinae) is its economically important pest. This fruit fly has more than 81 plant species as its hosts (Dhillon *et al.*, 2005a), but plants of family Cucurbitacae are considered to be its preferred hosts (Allwood *et al.*, 1999). Development of varieties resistant to melon fruit fly is an impotent component of integrated pest management (Panda and Khush, 1995). But YF-7, AHW/BR-10, Durgapura Kesar, AHW/BR-137, Durgapura Lal, AHW/BR-9, Sugar Baby, AHW-65, AHW-19, IC 582909, BSM-1, AHW/BR-16, Charleston Grey, Asahi Yamato, Arka Manik, AHW/BR-60, AHW/BR-12 and Thar Manak were sown at experimental farm of Central Institute for Arid Horticulture (CIAH), Bikaner (28°06'N, 73°21'E). The crop was sown in summer, 2012 and kharif, 2013 with three replicates (blocks) for each variety/ genotype following a randomized block design. The area of each bed was 5

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BIOLOGY OF BER FRUIT FLY *CARPOMYIA VESUVIANA* COSTA

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ABSTRACT

Biology, incidence and morphometrics of the ber fruit fly *Carpomyia vesuviana* Costa were studied on Indian jujube *Ziziphus mauritiana* Lamark. The observations revealed that the female laid its eggs in the cavities made by the ovipositor, just beneath the skin of the fruit. The eggs were small, elongate, spindle shaped and creamy white. The duration of lifestages (in days) were- egg 1.90, maggot 8.75, prepupal 4.43 (hr), pupal 8.40, adult longevity 13.85; with a total lifecycle of 29.95 days. The length, width and wing expanse of female measured up to 4.82, 1.33 and 3.91 mm, respectively; and that of male 4.44, 1.21 and 3.83 mm, respectively. The incidence was maximum in October followed by December, with the least being in January. Correlation coefficients of incidence with weather factors revealed a significant and positive one with maximum RH (0.70) and negative with maximum temperature (-0.54).

Key words: *Carpomyia vesuviana, Ziziphus mauritiana*, biology, life stages, incidence, morphometrics, duration, population dynamcis, temperature, relative humidity

The ber (*Ziziphus mauritiana* Lamark) also called as desert apple, jujube, Chinese apple, Kul or Boroi, Ber (Hindi), Indian plum and Permseret (Anguilla) is a tropical fruit tree species, belonging to the family *Rhamnaceae* (Balikai et al., 2013). Balikai (2009) reported a total of 22 insect and non-insect pests on ber, while Kavitha and Savithri (2002) about 23 pests However, pests such as fruit fly *Carpomyia vesuviana* Costa, *Meridarchis scyrodes* Meyr, chafer beetle, *Holotrichia consanguine* Blanch and bark eating caterpillar, *Indarbela tetraonis* Moore; *I.quadrinotata*

pea-size stage. Adults insert the eggs on the young developing fruits by making puncture with small cavity using protrusive ovipositor just below the epidermis of the immature fruits (Lakra and Singh, 1983; Dashad et al., 1999). Thus, newly emerged maggots feed on the pulp and making the galleries with accumulated excreta. In severe case, infestation may cause the fruit deformation and finally result in fruit drop (Lakra and Singh, 1983). This study explores the biology, incidence and morphometrics *C. vesuviana* on *Z. mauritiana*.

I, hitherto known as SANJIV KUMAR/SANJEEV KUMAR/SANJEEV GUPTA son of Shri RAJ KUMAR GUPTA, residing at 26, Nalanda Apartment, 'D' Block, Vikas Puri, New Delhi-110018, have changed my name and shall hereafter be known as SAMEER GARG.

It is certified that I have complied with other legal requirements in this connection.

SANJIV KUMAR
[Signature (in existing old name)]

I, hitherto known as JEENU BANSAL, wife of

I, hitherto known as Dr. SHRAVAN LAL JAT son of Shri NANU RAM JAT, employed as Scientist, Agriculture Entomology, residing at Central Institute for Arid Horticulture, Beechhwal, Bikaner, have changed my name and shall hereafter be known as Dr. SHRAVAN MANBHAR HALDHAR.

It is certified that I have complied with other legal requirements in this connection.

SHRAVAN LAL JAT
[Signature (in existing old name)]

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SURVEY, DISTRIBUTION PATTERNS AND ABUNDANCE OF PYRGOMORPHID FAUNA (ORTHOPTERA: PYRGOMORPHIDAE) IN AGROECOSYSTEMS OF SOUTH WESTERN RAJASTHAN

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ABSTRACT

Surveys conducted in the five districts of Rajasthan viz., Banswara, Dungarpur, Rajsamand, Sirohi and Udaipur during 2005-06 and 2006-07 indicated that five species of short horned grasshoppers belonging to the family Pyrgomorphidae were regular and abundant. The diversity comprised of four genera *(Chrotogonus, Atractomorpha, Pyrgomorpha* and *Poekilocerus)* and five species *i.e. Chrotogonus trachypterus* (Blanchard), *Chrotogonus oxypterus* (Blanchard), *Atractomorpha crenulata* Fabricius, *Pyrgomorpha bispinosa* Walker and *Poekilocerus pictus* Fabricius. *C. trachypterus* (33.34±7.63) and *C. oxypterus* 29.45±6.93), were relatively more abundant in Udaipur district than in the other four districts. *A. crenulata* (07.09±1.66) and *P. bispinosa* (06.35±1.54) had a relatively equal representation in all the districts, but their abundance was a little more in the district Banswara. *P. pictus* (07.00±2.82) was relatively more in Rajsamand and was not recorded from Banswara. The mean population of the surface grasshoppers. *C. trachypterus* and *C. oxypterus* was relatively more in Udaipur. *Atractomorpha* was almost equally represented in all the five districts. However, their population was relatively more in Banswara. *Pyrgomorpha* also had a similar representation from all the five districts surveyed, though the hopper population was relatively more at Banswara with a mean population of (3.42 hoppers/ 25 stops). *Poekilocerus* was relatively more in Rajsamand with 2.43 hoppers per 25 stops.

Key words: Abundance, density pattern, pyrgomorphid, survey

A central problem in ecology is to identify and understand patterns in the distribution and abundance of species. Widespread species are generally locally abundant, and have populations that fluctuate than the scarce, geographically restricted species. Predicted effects of body size are less well supported, although common, widespread, widely fluctuating species tend to be small (Gaston and Lawton, 1988). Orthoptera are a group of large and easily recognized insects that include the grasshoppers, locusts, ground hoppers, crickets, bush crickets, mole crickets and camel crickets as well as some lesser groups. Members of the Acrididae and Pyrgomorphidae (earlier considered as a subfamily Pyrgomorphinae, under the family Acrididae), grasshoppers and surface grasshoppers, are important pests of forage and crop plants. Of the nearly five thousand known species of grasshoppers, only nine belonging to the family Pyrgomorphidae, characterized by the presence of *fastigial furro;* and the apical *areolae,* besides having the lower basal lobe of the hind femora longer than the upper lobe. Misari and Raheja (1976) reported that the most abundant species of pygomorphids were *Chrotogonus senegalensis* and *Pyrgomorpha vignaudi.* Khaemba (1979) recorded *Acrotylus patruelis, Chrotogonus hemipterus, Gastrimargus africanus, Morphacris fasciata, Ornithacris* sp., and *Zonocerus elegans,* as pests of sunflower before the flowering stage. Loss of vegetation due to grasshopper have also been evaluated thoroughly in some other parts of the globe; an estimated 6 to 12% of the available forage is consumed by them in U.S.A. (Cowan, 1958). Anderson (1961) reported 25.9 % to 62.1 % loss of forage due to grasshopper in Montana range lands of U.S.A.

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Short communication

Screening of different mustard varieties for resistance against mustard aphid, *Lipaphis erysimi* (Kalt.)

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Mustard, *Brassica juncea* (Linn.) Czern. & Coss. is an important oilseed crop of family Cruciferae. It is mainly grown in *rabi* season as oilseed, condiment and medicinal crop. The green leaves and stems of mustard are good source of green vegetables and fodder. The oil content in seeds ranges from 32 to 42%, used for edible purposes. In India, important mustard growing state are Rajasthan, Uttar Pradesh, Madhya Pradesh, West Bengal, Punjab and Assam. The area under the crop in Rajasthan was 1.19 m. ha with an annual production of 1.17 m. tones and average productivity of 989 kg/ha during the year 2002-2003. Mustard aphid, *Lipaphis erysimi* Kalt. is one of the most serious pest of this crop (Rai, 1976) causing 9.0-95.0% losses in seed yield and on an average 15.0% loss in its oil yield. Both nymph and adult stages of this pest cause quantitative and qualitative losses to crop. In integrated pest management programme growing of resistance varieties against insect, is one of the most important tool in the management of aphid without additional cost.

The field experiment was conducted during *rabi* 2003-04 at S. K. N. College of Agriculture, Jobner- Rajasthan. The experiment was laid out in Randomize Block Design with three replications and 10 cultivars. The plot size was 4 x 3 m^2 with row to row and plant to plant distance of 30 cm and 10 cm, respectively. The crop was sown on 5th November 2003. The observations on the population of aphid were recorded at weekly interval from the appearance of aphid to harvesting of the crop. The aphids were counted visually on upper 10 cm shoot of five randomly selected tagged plants (Bakhetia and Sandhu, 1973). The total phenols and free amino acids were estimated from leaf of the plant at the time of peak aphid population. Total phenol and free amino acids were

January and reached to its peak in the first week of February and continued up to middle of March. The minimum mean aphid population (16 aphids/plant) was observed on variety T-59 (Varuna), while maximum (56 aphids/plant) on RZM-1359. The population was comparatively less on varieties T-59 (Varuna) and Bio-902 could be categorized as least preferred. On varieties *viz*., TM-4, PCR-7, RH-30, RH-781 and PBR-91 the aphid population was of middle order and thus categorized as moderately preferred. The aphid population was more on varieties GM-2, JM-1 and RZM-1359 which was recognized as highly preferred varieties. The present investigation corroborates with those of Vir *et al.* (1990), Jat *et al.* (1993) and Takar *et al.* (2003) who observed that varieties T-59 (Varuna), Bio-902 and PCR-7 were highly resistant to mustard aphid.

The morphological character of plant *viz*., plant height ® = - 0.988), siliqua/plant ® = - 0.946) and seeds/siliqua ® = - 0.965) were negatively correlated with the peak aphid population. An increase in aphid population was responsible for reduction of plant height, siliqua/plant and seeds/siliqua. These results are in conformity with those of Malik and Deen (1998).

The total phenols was negatively correlated ® = -0.990) while, free amino acids was positively correlated ® = 0.992) with aphid population. The minimum aphid population was recorded in variety T-59 (Varuna) which had highest of total phenols and lowest of free amino acids (4.52 % and 1.30 %) whereas, the maximum aphid population was found in variety RZM-1359 which had lowest of total phenols and highest of free amino acids (2.97 % and 2.18 %).

Sachan and Sachan (1991) and Ram Dhari *et al.* (1995)

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Influence of Food Plants on Growth and Development of *Chrotogonus trachypterus* Blanchard

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Laboratory experiments were conducted with the surface grasshopper, *Chrotogonus trachypterus*, to evaluate the effect of food plants on its growth and development. As indicated by a growth index for hoppers, in descending order of effectiveness were; lucerne, wheat, barley, mixed food, oats, chickpea, bermuda grass, spinach, nut grass and pigweed. On lucerne, hoppers took the shortest period (17.40 days) to develop into a fledglings, while on pigweed, development took the longest (25.25 days). Hoppers had 100 per cent survival on lucerne, wheat and barley; survival was lowest when reared on pigweed: 82.50, 72.50 and 67.50 per cent for hopper survival of the IVth, Vth and VIth instars respectively). However, irrespective of the food plant, the sixth instar hoppers developed into fledglings, showing a cent (emergence the 100 per cent adult) per cent survival. The effect of different food plants on food utilization indices evinced that efficiency of conversion of ingested food (ECI) was high when the hoppers were reared either on wheat (36.53%) or mixed food (35.20%), but pigweed (16.21%) followed by nut grass (19.28) had lowest ECI. The approximate digestibility (AD) was high when the hoppers were reared on lucerne (45.20%) and significantly low in gram (38.39%). The efficacy of conversion of digested food (ECD) into body substances was significantly the maximum for hoppers raised on wheat (89.50%) and was significantly the lowest for hoppers on pigweed (42.14%).

Key words: Surface grasshopper, *Chrotogonus trachypterus*, food plants, growth and development.

Surface grasshoppers (*Chrotogonus trachypterus* and *C. oxypterus*) are widely distributed in the Orient and Africa. In India, *Chrotogonus trachypterus* is more common in the north, whereas *C. oxypterus* occurs in the southern regions. The surface grasshopper is a pest of pastures throughout the year. The common desert representative of the genus (Kevan, 1959) collected from western Rajasthan appeared to belong to *Chrotogonus trachypterus trachypterus*, being widely distributed on the ground (their habitat is the surface of the soil) and more frequently collected from nurseries, gardens and wheat fields. It is distributed throughout the plains in India including Orissa, South Arcot, Madura, Coimbatore, Bellary, Madhya Pradesh and Rajasthan. Akhtar (1971) examined nymphs

Asad *et al.* (2001) reported that when adults of *C. trachypterus* were provided leaves of 41 plant species belonging to 25 families as food, 36 were accepted and 5 rejected. It was found that the grasshopper preferred, the seedlings of wheat, millet (*Pennisetum glaucum*) and cotton (*Gossypium hirsutum*). The most preferred food plants were berseem (Egyptian clover, *Trifolium alexandrianum*), cotton, mustard (*Brassica campestris*), lucerne, potato, and tomato. An estimated 6 to 12 percent of the available forage is consumed by them in U.S.A. (Cowan, 1958). Anderson (1961) reported 25.9 % to 62.1 % loss of forage due to grasshopper in Montana range lands of U.S.A.

Materials and Methods

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SPECIES RICHNESS, DENSITY AND DIVERSITY INDICES OF GRASSHOPPERS FAUNA (ORTHOPTERA: PYRGOMORPHIDAE) IN MAIZE-WHEAT CROPPING SYSTEM OF SOUTH-WESTERN RAJASTHAN (INDIA)

by

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Abstract

Survey conducted in the five districts of Rajasthan *viz.*, Banswara, Dungarpur, Rajsamand, Sirohi and Udaipur during 2005-06 and 2006-07 yielded four different species *Chrotogonus trachypterus* (Blanchard), *Chrotogonus oxypterus* (Blanchard), *Atractomorpha crenulata* Fabricius and *Pyrgomorpa bispinosa* Walker. Based on the mean density data recorded during the investigation, the two species of *Chrotogonus* (*C. trachypterus* and *C. oxypterus*) had the highest mean density in the month of February with (12.88 & 12.13/ 180 ft²) at Udaipur and lowest mean density in the month of October with (2.30 & 1.88/ ft²) at Rajsamand, respectively. In the south-western regions of Rajasthan, the maximum mean density was during February in maize-wheat cropping system. The relative density of *C. trachypterus* and *C. oxypterus* was the maximum during the month of May (50.56 & 48.41 % respectively) at Dungarpur district. Due to sparse vegetation during May in most parts of Rajasthan the geophilus species, *Chrotogonus* had relatively the highest relative density as compared to the other pyrgomorphids. The mean density for *Atractomorpha crenulata* happened to be the maximum during the month of August with 4.38 per ft² and relative density was the highest in September (31.10 %) at Banswara. The grasshopper, *Pyrgomorpha bispinosa* had the maximum mean density (3.88/ ft²) during the month of August at Banswara. The relative density (28.39 %) was the highest during September at Banswara. The Simpson Diversity Index and Shannon Weiner Diversity Index values were the maximum in August during both the years. This conspicuously indicates the fact that the monsoon season (August-September) happened to comprise greater diversity of the Pyrgomorphids than the spring season (February-March). Based on the habitat preference and their behaviour, the Pyrgomorphids could be grouped as the geophilus and arboreal types. A comparison within the geophilus species showed that the relative density was nearly equal depicting a 1: 1 ratio at all districts and the diversity indices were 1.915 to 2.00 during both the year. Similarly, comparison between the arboria species indicated that their relative density was also nearly equal depicting a similar 1: 1 ratio and the diversity indices were 1.00 to 1.997 during both years.

Introduction

A central problem in ecology is to identify and understand patterns in the distribution and

and camel crickets as well as some lesser groups. Members of the orthopteran families Acrididae and Pyrgomorphidae (earlier considered as a sub-family, Pyrgomorphinae, under the family

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ORIGINAL ARTICLE

GC-MS/MS-Based Phytochemical Screening of Therapeutic Potential of *Calligonum polygonoides* L. Flower Bud against Chronic Diseases

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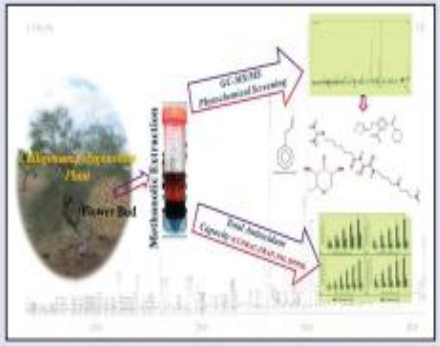
ABSTRACT

Background: *Calligonum polygonoides* is an endemic plant species, belongs to Polygonaceae family, native to the "Thar Desert" of India. It is highly tolerant to multiple stresses with dominant biomass and phytochemical producer under extreme niche. It has significant ethnopharmacological applications, but not yet scientifically validated. **Materials and Methods:** The methanolic extract of *C. polygonoides* flower bud was subjected to gas chromatography mass spectroscopy (GC-MS) analysis and antioxidant potential assay was done on different radical scavenging scales. The phytochemicals were identified based on retention time and matching their mass spectra to spectra in NIST 14 library. **Results:** The results revealed the presence of fatty acids, phenolics, terpenoides, flavanoids, alkaloids, tannins, steroids, ketones, esters, and amino acid derivatives, which comprises 93 compounds. Most of the detected compounds have been proved to possess important bio-activities such as anti-microbial, anti-inflammatory, anticancer, anti-diabetic, hepatoprotective, cardiovascular, antioxidant, and antimutagenic. Interestingly, some compounds such as furan-2,5-dimethyl, 2,3-dihydro-2,5-dihydroxy-6 -methyl-4H-pyran-4-one (DDMP), dehydromevalonic lactone, deoxyspergualin, 2-methoxy-4-vinylphenol, benzeneethanol4-hydroxy-, quinic acid, lauric acid, linolenic acid, and squalene were detected which have proved pharmaceuticals applications against major diseases such as cancer, diabetics, cardiovascular, and some other chronic diseases. Furthermore, the methanolic extract also attributed very high level of antioxidant potential on cupric reducing antioxidant capacity, ferric reducing antioxidant power, 2,2-diphenyl-1-picrylhydrazyl, and phosphomolybdenum assay scales. **Conclusion:** The identified phytochemicals with ample pharmaceutical application explore the worthiness of this endemic plant species. Along with pharmaceutical, it has an immense scope in nutraceutical and functional food industry. These medicinal importance advised for its conservation and artificial regeneration, to sustain the agro-ecological balance of Thar Desert of India.

Key words: Bioactive compounds, *Calligonum polygonoides*, GC-MS/MS, pharmaceutical applications, phog, phytochemical screening

SUMMARY

- In the present study, GC-MS/MS based phytochemical screening along with antioxidant potential on different scavenging scales like cupric-reducing antioxidant capacity, ferric-reducing antioxidant power, 2,2-diphenyl-1-picrylhydrazyl, and phosphomolybdenum assay has been done in methanolic extract of *Calligonum polygonoides* flower bud. The presence of some distinct phytochemicals like furan-2,5-dimethyl, DDMP, dehydromevalonic lactone, deoxyspergualin, 2-methoxy-4-vinylphenol, benzeneethanol-4-hydroxy and some ω-3 fatty acids with well-established pharmaceuticals applications along with extremely higher total antioxidant activity on all scales revealed its medicinal properties against cancer, diabetics, cardiovascular, and other chronic diseases.



Abbreviations used: CUPRAC: Cupric reducing antioxidant capacity; FRAP: Ferric reducing antioxidant power assay; PM: Phosphomolybdenum assay; DPPH: 2,2-diphenyl-1-picrylhydrazyl assay; TAA: Total antioxidant activity; RT: Retention time.

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