Indian Journal of Entomology Online published Ref. No. e21140 DoI.: 10.55446/IJE.2021.350

BIOPHYSICAL BASIS OF RESISTANCE IN OKRA TO JASSIDS, *AMRASCA BIGUTTULA BIGUTTULA* (ISHIDA)

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ABSTRACT

Evaluation of biophysical parameters of okra germplasm for resistance or susceptibility to jassids *Amrasca biguttula biguttula* (Ishida) was conducted at the All India Coordinated Research Project on Vegetable Crops, Odisha University of Agriculture and Technology, Bhubaneswar during kharif 2018 and summer 2019. The results revealed that the plant height, number of leaves, leaf area, leaf thickness, and trichome length and density of 50 okra germplasm varied from 73.45 to 129.93 cm, 10.50 to 24.00 leaves/ plant, 203.70 to 389.25 cm^2, 0.40 to 0.96 mm, 0.38 to 0.96 mm and 3.50 to 10.25 trichomes/ cm^2, respectively. The plant height, number of leaves and leaf area showed positive correlation with incidence, whereas leaf thickness, trichome length and trichome density exhibited negative correlation. The okra germplasm BBSR-37, BBSR-36 and BBSR-57 were found to be resistant, while Pusa Sawani, BBSR-53 and BBSR-18 were observed to be susceptible.

Key words: *Amrasca biguttula biguttula*, kharif, leaf area, leaf thickness, number of leaves, plant height, resistant, summer, susceptible, trichome density, trichome length

Okra *Abelmoschus esculentus* (L.) Moench is an important vegetable crop, grown in tropical and subtropical regions of the world. One of the major limiting factors in economic productivity of okra is its insect pests. On okra, as many as 72 species of insects have been reported (Chandio et al., 2017). The sucking pest, jassid *Amrasca biguttula biguttula* (Ishida) is polyphagous, attacks about 17 host plants. It infests okra, cotton, brinjal, beans, castor and cucurbits, along with many other crops (Rahman et al., 2014). It is responsible for losses in okra yield ranging from 50.00- 52.00% (Rawat and Sahu, 1973), 40.00 - 56.00% (Krishnaiah, 1980), 40.00 - 60.00% (Narke and Suryawanshi, 1987), 59.79% (Atwal and Singh, 1990) and 32.06 - 40.84% (Singh and Brar, 1994). The losses in yield up to 35- 40% and can increase up to 60 - 70% during optimal environment (Sultana et al., 2017). Chemical control effectively controls insect pests, but leads to increase in cost of production, reduces natural enemies, and causes pesticide resistance besides polluting the environment (Kavitha and Reddy, 2002). Therefore, alternative methods must be designed, and host plant resistance is one such cost-effective and safe method. This study analyses the physiomorphic characteristics of okra germplasm with differing degrees of tolerance or susceptibility against *A. biguttula biguttula*.

MATERIALS AND METHODS

The present study was carried out under the All India Coordinated Research Project on Vegetable Crops at Odisha University of Agriculture and Technology, Bhubaneswar (20°27′N,85°78′E, 47 masl). during kharif 2018 and summer 2019. The experiment was laid out in randomized block design (RBD) with 50 treatments and two replications with a plot size of 2x 3 m. The treatments comprised of 50 okra germplasm including a resistant, Pusa A-4 and a susceptible check, Pusa Sawani. Sowing was done in the last week of September (kharif) and first week of April (summer), @ two seeds/ hill at a spacing of 45 x 30 cm, and package of practices of okra were followed except insecticide application. Observations were made on *A. biguttula biguttula* nymph and adult on five randomly selected plants of each germplasm. Three leaves were chosen from each selected plants, one from top, middle and bottom canopy of the plant; number present on the upper and lower surfaces of the leaf was recorded at weekly intervals during the early morning hours. The biophysical attributes viz., trichome length and density on leaf, leaf thickness, leaf area, plant height and number of leaves were also recorded. The leaf area was measured using leaf area meter, and average of leaf area worked out and expressed in cm^2. The thickness of the leaf was calculated by digital vernier calipers and expressed in mm. The trichome length and density on leaf were measured with a binocular microscope connected to a computer. The trichomes from the pieces of leaf lamina at 60x magnification were captured and their length measured. The trichome density on leaf was counted with 1 cm^2 leaf pieces. At physiological maturity, from five randomly selected plants, plant height was measured from base to the apex with the help of measuring scale; mean was worked out and expressed in cm. The total number of leaves were counted and mean was calculated. The data obtained on *A. biguttula biguttula* incidence and various biophysical attributes were subjected to square root transformations and analysed by randomized block design procedure using OPSTAT software. F test was conducted to test the significance of variations. The standard error mean [SE (m) ±] and critical difference (CD, p = 0.05) were also calculated following Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The incidence of *A. biguttula biguttula* on okra germplasm was observed to vary between 3.15 and 11.10/ leaf (Table 1); least incidence was observed on BBSR-37 (3.15/ leaf), which was followed by BBSR-36 (3.50/ leaf) and BBSR-57 (3.65/ leaf); while the maximum was on germplasm BBSR-53 (11.10/ leaf) followed by Pusa Sawani (10.17/ leaf) and BBSR-18 (9.95/ leaf). These findings corroborate with those of Ramachandra (2018). Priyanka et al. (2020) observed 4.52 to 11.71/ leaf, while Srasvan (2017) observed 4.34/ leaf on genotype IC-282280 and 12.36/ leaf on Pusa Sawani. The plant height ranged from 73.45 to 129.93 cm, with maximum being in BBSR-53 (129.93 cm), which was at par with Pusa Sawani (127.98 cm), and the least with BBSR-22 (73.45 cm), which was at par with BBSR-11 (73.85 cm) and BBSR-10 (75.03 cm). Gurve (2016) also observed similar measurements. Srasvan (2017) observed these to be 80.12 to 118.12 cm, whi8le enotypes. Nagar et al. (2017) found this as 98.40 cm in IIVR-11 to 136.60 cm in Anika. The number of leaves ranged between 10.50 and 24.00/ plant, with maximum in BBSR-53 (24.00/ plant), which was at par with Pusa Sawani (23.00/ plant) and BBSR-18 (22.50/ plant); and the least with BBSR-37 (10.50/ plant), which was at par with BBSR-36 (12.00/ plant) and Pusa A-4 (12.25/ plant). These observations correspond with those of Kadu (2018); germplasm with thick foliage was more susceptible to *A. biguttula biguttula*. This might be due to dense foliage provide ample food, shelter and congenial condition for the pest to thrive (Kadu, 2018).

The leaf area varied from 203.70 to 389.25 cm^2, with minimum value in BBSR-37 (206.88 cm^2) and BBSR-57 (207.45 cm^2); while maximum was in BBSR-53 (389.25 cm^2), differing significantly with Pusa Sawani (379.83 cm^2). The present findings are more or less similar to those of Nain and Rathee (2017). According to Kadu (2018), the leaf area was maximum on genotype IC- 282288 (450.92 cm2), which harboured more incidence of *A. biguttula biguttula*. Prabhu et al. (2009) observed that larger leaf area contributed for harbouring more incidence/ leaf. The leaf thickness ranged between 0.40 and 0.96 mm; and maximum was in BBSR-37 (0.96 mm), which was at par with BBSR- 36 (0.95 mm); while minimum was in BBSR-53 (0.40 mm), which differed significantly with Pusa Sawani (0.42 mm). These observations are in-line with those of Kadu (2018). The genotype with thin leaves harboured more incidence. The results revealed that the trichome length varied from 0.38 to 0.96 mm, with maximum trichome length being with BBSR-37 (0.96 mm), which was at par with BBSR-36 (0.95 mm), BBSR-57 (0.95 mm) and Pusa A-4 (0.94 mm); least values were in BBSR-53 (0.38 mm), which was at par with Pusa Sawani (0.39 mm) and BBSR-18 (0.41 mm). These observations are in partial agreement with those of Sandhi et al. (2017). More the trichome length, less is the incidence. The trichome density was between 3.50 and 10.25/ cm^2; and maximum was in BBSR-37 (10.25/ cm^2), which was at par with BBSR-57 (9.75/ cm^2); while least one was in BBSR-53 (3.50/ cm^2), which was at par with Pusa Sawani (3.50/ cm^2). These results agree with those of Kadu (2018). Srasvan (2017) recorded 4.56/ cm^2 in Pusa Sawani to 8.11/ cm^2 in VRO-3. Higher the trichome density, less is the incidence.

The data revealed that the height of the plant, number of leaves and leaf area were significantly positively correlated with *A. biguttula biguttula* incidence (r= 0.774**, 0.982** and 0.937**, respectively); while leaf thickness, trichome length and trichome density were significantly negatively correlated (r = -0.945**, r = -0.925** and r = -0.943**, respectively). Plant height was observed with significant positive correlation (Nagar et al., 2017; Ramachandra, 2018); number of leaves were found positively correlated (r = 0.310) (Ramachandra, 2018). Srasvan (2017) observed that the correlation was positive (r = 0.372). The thickness of the leaf lamina revealed a negative correlation (r = -0.873) (Kadu, 2018). The trichome length showed significantly negative correlation (Srasvan, 2017). The hair length on upper and lower leaf lamina exhibited a negative correlation (Prithiva et al., 2019).

Table 1. Biophysical parameters of okra germplasm vs. *A. biguttula biguttula* incidence (kharif, 2018, summer, 2019 and pooled data)

Treat-ments	Germ-plasm	*A. biguttula biguttula* (Ishida) incidence/ leaf			Plant height (m)			Number of leaves (No./ plant)			Leaf area (cm^2)			Leaf thickness (mm)			Trichome length (mm)			Trichome density (No./ cm^2)		
		2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T1	BO-1	6.83 (2.80)	6.19 (2.68)	6.51 (2.74)	79.88	83.65	81.76	16.00	16.50	16.25	267.55	264.70	266.13	0.73	0.79	0.76	0.77	0.76	0.77	8.00	7.00	7.50
T2	BBSR-27	8.54 (3.09)	9.07 (3.17)	8.81 (3.13)	116.00	116.55	116.28	19.50	21.00	20.25	357.50	352.85	355.18	0.49	0.44	0.46	0.45	0.43	0.44	4.00	4.50	4.25
T3	BBSR-09-2	7.42 (2.90)	6.42 (2.72)	6.92 (2.81)	84.75	96.30	90.53	17.50	17.50	17.50	283.30	283.50	283.40	0.64	0.67	0.65	0.65	0.62	0.64	7.00	6.50	6.75
T4	PRERNA	7.03 (2.83)	6.62 (2.76)	6.82 (2.80)	88.70	87.40	88.05	17.00	17.50	17.25	279.35	280.05	279.70	0.69	0.69	0.69	0.67	0.65	0.66	7.00	6.50	6.75
T5	ARKA ABHAY	4.33 (2.31)	4.25 (2.29)	4.29 (2.30)	87.90	86.95	87.43	13.50	14.50	14.00	243.50	230.30	236.90	0.83	0.88	0.85	0.93	0.88	0.90	9.00	9.00	9.00
T6	BBSR-59	7.65 (2.94)	7.53 (2.92)	7.59 (2.93)	113.50	108.00	110.75	19.50	19.50	19.50	358.65	354.80	356.73	0.52	0.47	0.49	0.45	0.45	0.45	4.50	4.50	4.50
T7	BBSR-30	7.68 (2.95)	7.04 (2.83)	7.36 (2.89)	106.00	107.00	106.50	19.00	19.50	19.25	339.40	329.55	334.48	0.53	0.50	0.51	0.48	0.48	0.48	5.00	5.00	5.00
T8	GO-2	8.83 (3.13)	7.34 (2.89)	8.08 (3.01)	110.55	98.65	104.60	19.50	20.00	19.75	375.80	364.55	370.18	0.49	0.45	0.47	0.45	0.44	0.44	4.50	4.50	4.50
T9	BBSR-09-3	6.83 (2.80)	6.91 (2.81)	6.87 (2.81)	98.40	102.80	100.60	17.00	17.50	17.25	281.25	280.70	280.98	0.69	0.68	0.68	0.66	0.63	0.64	7.00	6.50	6.75
T10	BBSR-13	6.28 (2.70)	6.74 (2.78)	6.51 (2.74)	89.40	96.00	92.70	16.50	17.00	16.75	268.10	266.20	267.15	0.71	0.79	0.75	0.77	0.75	0.76	7.50	7.00	7.25
T11	BBSR-49	6.98 (2.82)	7.14 (2.85)	7.06 (2.84)	107.55	107.25	107.40	18.00	18.00	18.00	294.65	292.05	293.35	0.65	0.63	0.64	0.60	0.58	0.59	6.00	6.00	6.00
T12	BBSR-09-6	7.46 (2.91)	6.42 (2.72)	6.94 (2.82)	82.60	91.50	87.05	17.50	17.50	17.50	285.55	285.70	285.63	0.65	0.65	0.65	0.65	0.62	0.63	7.00	6.50	6.75
T13	BBSR-36	3.33 (2.08)	3.68 (2.16)	3.50 (2.12)	79.95	82.55	81.25	11.50	12.50	12.00	213.80	193.60	203.70	0.95	0.94	0.95	0.97	0.94	0.95	9.50	10.00	9.75
T14	BBSR-11	6.24 (2.69)	5.55 (2.56)	5.89 (2.63)	73.15	74.55	73.85	16.00	16.50	16.25	259.60	261.15	260.38	0.74	0.82	0.78	0.81	0.83	0.82	8.00	7.50	7.75
T15	BBSR-37	3.14 (2.04)	3.16 (2.04)	3.15 (2.04)	77.00	80.05	78.53	10.50	10.50	10.50	218.20	195.55	206.88	0.97	0.96	0.96	0.97	0.95	0.96	10.00	10.50	10.25
T16	BBSR-47	4.40 (2.32)	3.92 (2.22)	4.16 (2.27)	83.45	84.85	84.15	12.50	13.50	13.00	236.10	229.90	233.00	0.86	0.89	0.87	0.93	0.91	0.92	9.00	9.00	9.00
T17	BBSR-57	3.83 (2.20)	3.47 (2.11)	3.65 (2.16)	79.40	83.55	81.48	12.00	13.00	12.50	206.65	208.25	207.45	0.92	0.93	0.92	0.96	0.93	0.95	9.50	10.00	9.75
T18	BBSR-10	6.54 (2.75)	4.88 (2.42)	5.71 (2.59)	83.60	66.45	75.03	15.50	16.50	16.00	254.45	260.50	257.48	0.73	0.83	0.78	0.83	0.83	0.83	8.00	7.50	7.75
T19	BBSR-22	4.78 (2.40)	5.38 (2.53)	5.08 (2.47)	73.45	73.45	73.45	15.00	15.00	15.00	245.80	254.80	250.30	0.77	0.86	0.81	0.87	0.85	0.86	8.50	8.50	8.50
T20	BBSR-52	6.91 (2.81)	6.51 (2.74)	6.71 (2.78)	87.25	86.05	86.65	16.50	17.00	16.75	274.30	277.00	275.65	0.69	0.73	0.71	0.72	0.70	0.71	7.50	7.00	7.25

(contd.)

T21	BBSR-31	5.76 (2.60)	8.24 (3.04)	7.00 (2.83)	114.35	111.05	112.70	17.50	18.00	17.75	287.55	289.65	288.60	0.66	0.66	0.66	0.62	0.60	0.61	6.50	6.00	6.25
T22	B0-23	6.70 (2.78)	6.76 (2.79)	6.73 (2.78)	80.85	86.40	83.63	17.00	17.50	17.25	275.45	277.80	276.63	0.68	0.72	0.70	0.68	0.68	0.68	7.00	6.50	6.75
T23	BBSR-23	6.57 (2.75)	6.62 (2.76)	6.60 (2.76)	91.50	91.00	91.25	16.50	17.00	16.75	273.00	270.05	271.53	0.72	0.75	0.73	0.73	0.74	0.74	7.50	7.00	7.25
T24	BBSR-3	4.49 (2.34)	5.29 (2.51)	4.89 (2.43)	84.05	87.00	85.53	14.00	13.50	13.75	242.45	230.90	236.68	0.82	0.87	0.84	0.94	0.86	0.90	9.00	9.00	9.00
T25	VS-7109	6.54 (2.75)	5.85 (2.62)	6.20 (2.68)	92.45	91.40	91.93	16.00	16.50	16.25	263.05	262.90	262.98	0.74	0.81	0.77	0.79	0.80	0.79	8.00	7.50	7.75
T26	BBSR-4	4.92 (2.43)	5.09 (2.47)	5.01 (2.45)	111.45	107.45	109.45	15.00	14.50	14.75	245.55	249.55	247.55	0.78	0.87	0.82	0.91	0.85	0.88	9.00	9.00	9.00
T27	BBSR-26	4.86 (2.42)	5.71 (2.59)	5.29 (2.51)	99.40	100.50	99.95	15.50	16.50	16.00	246.50	254.95	250.73	0.75	0.85	0.80	0.85	0.84	0.84	8.50	8.00	8.25
T28	BBSR-24	6.42 (2.72)	6.69 (2.77)	6.56 (2.75)	93.75	97.35	95.55	16.50	17.00	16.75	270.50	267.35	268.93	0.71	0.77	0.74	0.74	0.74	0.74	7.50	7.00	7.25
T29	BBSR-29	7.04 (2.84)	7.47 (2.91)	7.26 (2.87)	110.55	105.40	107.98	18.50	19.00	18.75	309.20	308.00	308.60	0.59	0.54	0.57	0.52	0.53	0.52	5.00	5.00	5.00
T30	BBSR-50	6.79 (2.79)	6.84 (2.80)	6.82 (2.80)	96.40	103.45	99.93	17.00	17.50	17.25	277.50	278.05	277.78	0.68	0.70	0.69	0.67	0.67	0.67	7.00	6.50	6.75
T31	BBSR-56	7.75 (2.96)	6.79 (2.79)	7.27 (2.88)	90.80	98.35	94.58	18.50	19.00	18.75	329.20	319.25	324.23	0.57	0.53	0.55	0.51	0.52	0.51	5.00	5.00	5.00
T32	VRO-51	9.63 (3.26)	10.24 (3.35)	9.94 (3.31)	121.15	123.25	122.20	20.50	21.50	21.00	357.95	355.25	356.60	0.47	0.43	0.45	0.43	0.43	0.43	4.00	4.00	4.00
T33	VRO-6	7.54 (2.92)	6.46 (2.73)	7.00 (2.83)	95.95	90.45	93.20	17.50	18.00	17.75	288.50	290.40	289.45	0.65	0.64	0.64	0.62	0.59	0.60	6.00	6.00	6.00
T34	BBSR-7	7.49 (2.91)	6.75 (2.78)	7.12 (2.85)	87.95	96.45	92.20	18.00	18.50	18.25	296.95	293.35	295.15	0.64	0.60	0.62	0.58	0.57	0.57	5.50	6.00	5.75
T35	K-442	6.63 (2.76)	6.64 (2.76)	6.63 (2.76)	90.40	93.40	91.90	16.50	17.00	16.75	273.45	276.70	275.08	0.72	0.74	0.73	0.73	0.73	0.73	7.50	7.00	7.25
T36	BBSR-09-15	8.14 (3.02)	6.29 (2.70)	7.22 (2.87)	85.80	90.10	87.95	18.50	19.00	18.75	303.85	297.20	300.53	0.60	0.56	0.58	0.53	0.53	0.53	5.00	5.50	5.25
T37	BBSR-18	9.85 (3.29)	10.05 (3.32)	9.95 (3.31)	119.95	127.00	123.48	22.00	23.00	22.50	365.15	372.90	369.03	0.47	0.42	0.44	0.42	0.41	0.41	4.00	4.00	4.00
T38	BO-2	5.08 (2.47)	5.61 (2.57)	5.34 (2.52)	91.55	95.40	93.48	15.50	16.50	16.00	252.25	259.35	255.80	0.76	0.84	0.80	0.84	0.84	0.84	8.50	8.00	8.25
T39	KEONJAR LOCAL	7.15 (2.85)	7.11 (2.85)	7.13 (2.85)	106.05	105.50	105.78	18.00	18.50	18.25	297.90	293.80	295.85	0.63	0.59	0.61	0.56	0.56	0.56	5.50	5.50	5.50
T40	BBSR-44	7.44 (2.90)	7.20 (2.86)	7.32 (2.88)	108.95	98.00	103.48	18.50	19.00	18.75	320.00	321.40	320.70	0.55	0.51	0.53	0.50	0.49	0.49	5.00	5.00	5.00
T41	JOL-2K-19	6.07 (2.66)	6.76 (2.79)	6.41 (2.72)	88.05	88.60	88.33	16.00	16.50	16.25	265.45	263.60	264.53	0.73	0.80	0.76	0.78	0.77	0.77	8.00	7.00	7.50
T42	BBSR-53	10.74 (3.43)	11.46 (3.53)	11.10 (3.48)	126.20	133.65	129.93	23.50	24.50	24.00	391.00	387.50	389.25	0.41	0.40	0.40	0.38	0.39	0.38	3.50	3.50	3.50
T43	MUKTA	8.00 (3.00)	6.97 (2.82)	7.48 (2.91)	102.45	101.30	101.88	19.50	19.50	19.50	361.45	364.50	362.98	0.53	0.49	0.51	0.48	0.46	0.47	4.50	4.50	4.50

(contd.)

(contd. Table 1)

T44	SUPER GREEN	7.27 (2.88)	7.02 (2.83)	7.15 (2.85)	97.80	101.40	99.60	18.50	18.50	18.50	300.95	295.55	298.25	0.61	0.57	0.59	0.56	0.55	0.55	5.50	5.50	5.50
T45	ARKA ANAMIKA	3.98 (2.23)	4.13 (2.26)	4.05 (2.25)	90.30	93.95	92.13	13.00	13.50	13.25	241.80	221.05	231.43	0.87	0.90	0.88	0.94	0.92	0.93	9.50	9.50	9.50
T46	KASHI KRANTI	7.46 (2.91)	6.81 (2.79)	7.14 (2.85)	96.50	101.75	99.13	18.00	18.50	18.25	299.95	294.80	297.38	0.62	0.58	0.60	0.56	0.55	0.55	5.50	5.50	5.50
T47	KASHI PRAGATI	7.31 (2.88)	6.68 (2.77)	7.00 (2.83)	90.15	95.90	93.03	17.50	18.00	17.75	287.10	288.60	287.85	0.64	0.66	0.65	0.63	0.61	0.62	6.50	6.00	6.25
T48	BO-13	7.69 (2.95)	6.46 (2.73)	7.07 (2.84)	92.15	94.55	93.35	18.00	18.00	18.00	296.70	292.90	294.80	0.64	0.62	0.63	0.58	0.57	0.58	6.00	6.00	6.00
T49	PUSA A-4 (RC)	3.95 (2.22)	4.08 (2.25)	4.01 (2.24)	81.45	85.65	83.55	12.00	12.50	12.25	214.65	213.05	213.85	0.90	0.92	0.91	0.95	0.93	0.94	9.50	9.50	9.50
T50	PUSA SAWANI (SC)	9.47 (3.24)	10.86 (3.44)	10.17 (3.34)	124.65	131.30	127.98	22.50	23.50	23.00	382.15	377.50	379.83	0.43	0.41	0.42	0.39	0.38	0.39	3.50	3.50	3.50
SE(m) ±					2.617	2.123	1.676	0.915	1.160	0.734	3.084	5.091	2.890	0.011	0.010	0.007	0.013	0.015	0.010	0.587	0.738	0.468
CD (p = 0.05)					7.459	6.052	3.936	2.608	3.307	1.723	8.791	14.511	6.788	0.033	0.028	0.017	0.036	0.043	0.023	1.674	2.104	1.100

Figures in parentheses square root transformed values $\sqrt{(x+1)}$; RC - Resistance check; SC - Susceptible check

The correlation between trichome density/ cm^2 leaf and incidence was observed significant and negative (Srasvan, 2017; Ramachandra, 2018; Chatterjee et al., 2019; Prithiva et al., 2019). The germplasm having more trichome density showed resistant reaction, similarly the genotypes having less trichome density were susceptible (Kadu, 2018). Thus, more plant height, dense foliage, more leaf area favours *A. biguttula biguttula*; thicker leaf, dense trichome density and lengthy trichomes were not favourable for attack. The okra germplasm BBSR-37, BBSR-36 and BBSR-57 were found to be resistant, whereas Pusa Sawani, BBSR-53 and BBSR-18 were susceptible.

ACKNOWLEDGEMENTS

The authors acknowledge the All India Coordinated Research Project on Vegetable Crops, Odisha University of Agriculture and Technology and Central Horticultural Experiment Station, Bhubaneswar for their facilitation, support and cooperation.

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(Manuscript Received: June, 2021; Revised: November, 2021;
Accepted: December, 2021; Online Published: March, 2022)
Online published (Preview) in www.entosocindia.org Ref. No. e21140