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PREFERENCE AND PERFORMANCE OF *BEMISIA TABACI* (GENNADIUS) ON DIFFERENT HOST PLANTS

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ABSTRACT

Host preference and development biology of *Bemisia tabaci* (Gennadius) on brinjal, soybean, cucumber, cotton, tomato and *Solanum nigrum* L. was studied during 2020-21 at PAU, Ludhiana. Under free choice test conditions, cucumber was the most preferred host which attracted maximum number of adults followed by soybean. The other host plants in decreasing order of preference were cotton > brinjal > tomato > *S. nigrum.* Brinjal and cotton were the most suitable hosts having shorter development period, higher survival and fecundity. The survival of immature stages on soybean was 50% as compared to 67.5-72.5% on the most suitable hosts i.e. cotton and brinjal. Thus, soybean is a preferred host for adult feeding and oviposition but less suitable for immature stages of the *B. tabaci*. Hence, soybean may be exploited as a trap crop for the management of *B. tabaci.*

Key words: *Bemisia tabaci*, biology, cotton, development period, host preference, management, oviposition preference, soybean, trap crop, whitefly

Whitefly *Bemisia tabaci* (Gennadius) is one of the most important pests of vegetables, ornamentals and field crops in the tropics and subtropics of the world (De Barro, 2011). In India, *B. tabaci* was first time reported in 1905 on cotton and it becomes a serious pest of cotton in the late 1920s and early 1930. Both nymph and adults suck the cell sap from ventral surface of leaves, resulting in loss of plant vigour and yield (Attique et al., 2003). Apart from causing direct losses, *B tabaci* also causes damage by transmitting many viral diseases and secreting honeydew, on which black mould grows, resulting in reduced photosynthetic activities (Jones, 2003; Kranthi, 2014). Depending on the host plants, cultivar and environmental conditions, *B. tabaci* can cause heavy yield losses. Insecticides application is the main control strategy for this pest, though effective spraying is complicated because of the insect's preference for the abaxial side of the leaf (Simmons, 1994). Moreover, *B. tabaci* developed resistance to many active ingredients (Horowitz et al., 2005, Naveen et al., 2017) and sole reliance on insecticides is expected to increase tolerance to insecticides, in addition to the adverse effects on non-target organisms (Palumbo et al., 2000). Therefore, it is necessary to develop ecological based management strategies for *B. tabaci.*

Trap cropping is a promising pest control method that involves growing another crop to attract pests from main crop to reduce damage to the main crop (Shelton and Badenes, 2006). However, for successful pest control, the trap plants cultivated within agricultural fields should either retain high densities of pest to prevent insect pest dispersal to the main crop or increasing pest mortality on the trap crop (Holden et al., 2012). The selection of trap crop is based on the fact that herbivores show a distinct preference to certain plant species and cultivars (Cook et al., 2007), which need to be studied for devising ecological based pest management strategy. *Bemisia tabaci* shows dissimilar preference for oviposition, host suitability, adaptation, and efficiency of virus transmission (De Barro et al., 2005). It has a wide host range of about 1000 plant species in 74 plant families, including cotton, brinjal, tomato, soybean, cucumber and weed host, *Solanum nigrum* L. (Abd-Rabou and Simmons, 2010; Kedar et al., 2018). The effective management of such a polyphagous pest in diverse, year-round agricultural systems is often a challenge. The studies of host preference and developmental rates on different host plants are important tools to identify a potential trap crop for whitefly management (Muniz, 2000). Although a number of investigations have examined the performance of *B. tabaci* on various host plants, few studies have compared the differences in fitness of *B. tabaci* on different hosts under North Indian conditions. Therefore, the present study was carried out to investigate the host preference and suitability based on oviposition, developmental time and survival of *B. tabaci* on six preferred hosts of *B. tabaci* under Punjab conditions. The aim of the study was to identify

a potential trap crop for whitefly management in cotton.

MATERIALS AND METHODS

The survey conducted in the cotton growing area of Punjab during 2019 (data not presented) revealed that brinjal, cucumber, cotton, soybean, and tomato were the preferred cultivated host of *B. tabaci*. Ovipositional preference and developmental biology of *B. tabaci* on soybean (var. SL 958), tomato (var. Punjab Gaurav), brinjal (var. PBHR 41), cotton (var. RCH 773) and cucumber (var. Punjab Naveen) was evaluated along with a perennial weed host i.e *makoh*, *Solanum nigrum*. The experiments were conducted under screen house condition during 2020-21 and experimental design was completely randomized design (CRD). Oviposition preference of *B. tabaci* adults was studied under free choice test. The plants were sown/ transplanted in the earthen pots (12 cm height and 10 cm diameter) and kept under nylon cage (40 mesh) to avoid infestation by any other pest. The experiment was performed when plants were of four leaves stage. Potted plants of each species were placed at a uniform distance in nylon mesh cage (90 x 90 x 60 cm) and approximately 200 adults were released in the centre of the cage. The numbers of whitefly adults settled on each plant were recorded after 24, 48, 72 and 96 hours, while eggs deposited on each host plant were counted after 96 hours under stereo zoom binocular microscope. There were four replications and data was subjected to analysis of variance (ANOVA) for comparison.

The developmental biology of *B. tabaci* on different host plants was also studied under screen house at Entomological Research Farm. One generation of *B. tabaci* was reared on each host (brinjal, cotton, cucumber, soybean, tomato and *S. nigrum*) and adults that emerged were used to conduct the experiment when test plants were of four leaf stage. Newly emerged adults were separated on sex basis. A pair of adults was released in a cup cage on under surface of the leaves on 20 plants to obtain fresh eggs, each plant representing one replication. After 24 hr, the adults were removed and leaves were examined for eggs with the help of compound microscope. The eggs bearing leaves were tagged at petiole region and five eggs on each leaf were retained to observe the duration of different development stage and remaining were removed with the help of a fine brush. Cup cage were again attached to the leaves on selected leaves to avoid further infestation of whitefly or other insects. The time period between laying of eggs and appearance of the crawler were taken as incubation period. The observations on hatchability, nymphal and pupal survival and duration of different stages were recorded at 24 hr interval. To study the adult longevity and fecundity, the freshly emerged pair of male and female was released in cup cage on under surface of leaf and confined till the death of the adult. The mortality of adults in each cage was recorded daily and longevity of each sex was calculated. To calculate pre-oviposition, oviposition, post-oviposition period and fecundity, different set of experiments were performed. Freshly emerged adult pair was confined in the cup cage and numbers of eggs laid on leaf covered under cup cage was recorded daily and different periods and fecundity was calculated. The data was subjected to analysis of variance (ANOVA) for comparison of treatments.

RESULTS AND DISCUSSION

Feeding and oviposition preference*:* The results revealed significant differences in feeding and oviposition preference of *B. tabaci* under free choice test conditions (Table 1). The data recorded at 24, 48, 72 and 96 hr after release of whitefly adults, showed that cucumber was the most preferred host of *B. tabaci* for feeding and oviposition, followed by soybean. The relative preference of whitefly adults increased for cotton, whereas decreased in case of *S. nigrum* and tomato over time, as depicted in observations recorded at 24, 48, 72 and 96 hr. Mean number of whitefly adults were significantly highest on cucumber (36.57 adults/ leaf) followed by soybean (20.04 adults/ leaf), which was on par with cotton (16.92 adults/ leaf). *S. nigrum* was least preferred host which attracted minimum number of whitefly adults (2.49 adults/ plant) under free choice conditions. The mean number of whitefly adults on brinjal and tomato were on par with each other having mean value of 14.65 and 12.34 adults/ plant, respectively. Similar trend of relative preference for oviposition was observed in data recorded at 96 hr after release of whitefly adults. Significantly maximum eggs were recorded on cucumber (42.80 eggs/ three leaves) and minimum on *S. nigrum* (5.93 eggs/ three leaves).

These results revealed that when six host plants of *B. tabaci* were placed together, cucumber was the most preferred host for adult feeding and oviposition. The other host plants in decreasing order of preference were soybean, cotton, brinjal, tomato and *S. nigrum*. These results are in consonance of Sharma and Budha (2015), who also observed cucumber as the most preferred

Table 1. Host preference of *B. tabaci*

Incidence

Host plant	Mean (± SE) number of whitefly adults/ plant					Number of eggs / three leaves
	24 hrs	48 hrs	72 hrs	96 hrs	Mean	96 hrs
Brinjal	13.39± 1.04 (3.79)	15.71± 1.22 (4.08)	14.45± 0.64 (3.93)	15.06± 1.20 (4.01)	14.65± 0.49 (3.96)	22.73± 1.58 (4.87)
Cotton	15.33± 1.09 (4.04)	17.11± 1.18 (4.25)	16.72± 0.97 (4.21)	18.51± 1.69 (4.41)	16.92± 0.65 (4.23)	24.20± 1.33 (5.02)
Cucumber	31.33± 3.42 (5.67)	36.61± 2.34 (6.12)	38.11± 2.15 (6.25)	40.22± 2.51 (6.41)	36.57± 1.90 (6.11)	42.80± 3.49 (6.60)
Soybean	19.56± 2.03 (4.52)	21.72± 1.26 (4.76)	19.83± 1.14 (4.56)	19.06± 1.20 (4.47)	20.04± 0.58 (4.58)	28.40± 2.03 (5.41)
S. nigrum	4.61± 0.48 (2.36)	1.78± 0.24 (1.66)	2.17± 0.75 (1.75)	1.39± 0.34 (1.54)	2.49± 0.73 (1.83)	5.93± 1.45 (2.60)
Tomato	17.39± 1.03 (4.28)	12.22± 1.22 (3.63)	9.67± 1.21 (3.25)	10.06± 0.87 (3.32)	12.34± 1.78 (3.62)	19.27± 1.50 (4.49)
CD (p= 0.05)	(0.61)	(0.46)	(0.42)	(0.41)	(0.47)	(0.54)

Durations of immature stages

Host plant	Mean (± SE) duration (days)					
	Eggs	1st instar	2nd instar	3rd instar	4th instar	Total development
Brinjal	4.20± 0.18	3.90± 0.14	3.40± 0.11	3.65± 0.11	4.20± 0.17	19.35± 0.36
Cotton	4.10± 0.19	4.15± 0.15	3.30± 0.11	3.50± 0.11	4.60± 0.18	19.65± 0.18
Cucumber	4.25± 0.14	4.35± 0.11	3.75± 0.18	4.05± 0.15	4.65± 0.17	21.05± 0.41
Soybean	4.55± 0.14	4.40± 0.13	3.90± 0.14	4.20± 0.12	5.05± 0.15	22.10± 0.39
S. nigrum	4.30± 0.15	5.05± 0.17	4.40± 0.18	4.25± 0.16	5.15± 0.18	23.15± 0.49
Tomato	4.50± 0.11	4.42± 0.11	4.00± 0.16	4.55± 0.14	5.75± 0.16	23.22± 0.42
CD (p= 0.05)	NS	0.39	0.42	0.38	0.48	1.14

Survival of immature stages

Host	Survival (%)					
	Eggs	1st instar	2nd instar	3rd instar	4th instar	Egg to adult
Brinjal	92.50± 2.24	83.89± 2.62	90.20± 2.80	96.43± 3.20	100.0± 0.50	67.50± 2.24
Cotton	95.00± 2.59	86.94± 2.09	90.97± 2.71	100.0± 0	96.88± 2.80	72.50± 2.24
Cucumber	92.50± 2.24	81.75± 4.14	88.10± 2.56	92.26± 3.59	97.50± 4.79	62.50± 3.66
Soybean	91.88± 2.49	81.39± 2.05	83.48± 3.59	88.10± 4.03	90.83± 4.79	50.00± 4.88
S. nigrum	85.00± 2.59	70.00± 3.66	67.56± 3.47	82.50± 5.34	77.08± 7.07	32.50± 5.64
Tomato	84.62± 2.08	81.05± 3.54	80.71± 3.03	80.42± 1.77	83.75± 4.97	43.70± 2.31
CD (p= 0.05)	NS	8.94	7.96	8.71	10.45	8.15

Adult longevity and fecundity

Host	Mean (± SE) duration (days)					Fecundity (mean± SE)
	Pre oviposition period	Oviposition period	Post oviposition period	Female longevity	Male longevity	
Brinjal	1.10± 0.10	5.80± 0.27	1.20± 0.22	8.10± 0.31	5.29± 0.19	28.32± 3.44
Cotton	1.74± 0.14	7.21± 0.22	1.11± 0.18	10.05± 0.29	5.83± 0.26	33.74± 4.11
Cucumber	1.37± 0.16	3.89± 0.20	1.16± 0.21	6.42± 0.33	4.94± 0.27	26.53± 2.16
Soybean	1.53± 0.16	3.63± 0.15	0.89± 0.25	6.05± 0.26	4.72± 0.22	24.58± 2.37
S. nigrum	1.32± 0.24	3.05± 0.10	1.11± 0.25	5.47± 0.23	4.28± 0.17	19.37± 2.37
Tomato	1.47± 0.22	2.68± 0.18	0.95± 0.26	5.11± 0.34	4.06± 0.19	22.63± 3.43
CD (p= 0.05)	NS	0.47	NS	0.68	0.44	5.91

Figures in parentheses quare root transformed values; SE=Standard error

host plant of *B. tabaci* for feeding and oviposition in free choice among brinjal, tomato and capsicum. Lanjar et al. (2012) observed higher *B. tabaci* adult counts on cucurbits than on non-cucurbit hosts and their results revealed that cucumber was most preferred host followed by melon, brinjal, cluster bean, Indian squash, cotton, ridge gourd, sesame, pumpkin, water melon, okra, bitter gourd, chillies and cowpea. Foda (2000) studied the feeding and oviposition responses of *B. tabaci* on four host plants and reported that cotton and tomato attracted highest whitefly adults, whereas cantaloupe and cucumber were preferred for oviposition. However, the results of Morales and Cermeli (2001) were in contradiction to our findings, which showed that *B. tabaci* adults preferred cucumber over tomato. Present study also showed non-significant difference in preference of whitefly for brinjal and tomato, but these results disagree to findings of Khan et al. (2011), who reported that number of adults and eggs were higher on brinjal in comparison to tomato. Hossain et al. (2018) also reported that adults and egg counts of whitefly were higher on brinjal than tomato, which indicated its suitability for oviposition and feeding in a free choice experiment. This disparity was probably due to the differences in varieties of tested host plants.

Development and survival: The data pertaining to influence of host plants on development and survival of immature stages of *B. tabaci* are presented in Table 1. The incubation period varied from 4.10 to 4.55 days on different host plants, but differences were non-significant. The first instar nymphs lasted for 3.90 to 5.05 days on different host plants and significantly maximum duration was recorded on *S. nigrum.* The shortest duration of first instar nymph on brinjal (3.90 days) was on par with cotton (4.15 days). Similar trend was observed during 2nd instar nymphs, the development period was significantly longer on *makoh* (4.40 days), while shortest period was registered on cotton (3.30 days), followed by brinjal (3.40 days). The third instar nymphs lasted for longest period on tomato (4.55 days), which was statistically on par with soybean (4.20 days) and *makoh* (4.25 days). The similar trend was observed in fourth instar nymphs, the mean duration varied from 4.20 to 5.75 days on different host plants. The total development period (egg to adult) varied from 19.35 to 23.22 days and shortest duration was registered on brinjal, which was statistically on par with cotton (19.65 days). Significantly longer development period was recorded on tomato (23.22 days) followed by *S. nigrum* (23.15 days). The data also showed significant variations in survival of immature stages of *B. tabaci* on different host plants (Table 1). The egg hatchability varied between 84.62 and 95.00%, being highest on cotton, and lowest on tomato. The survival of first instar, second instar, third instar and fourth instar varied from 70.00 to 86.94, 67.56 to 90.97, 80.42 to 100.0 and 77.08 to 100.0%, respectively. The overall survival of immature stages (from egg to adult) ranged between 32.50 to 72.50% on different hosts and it was significantly lowest in *makoh* followed by tomato (43.70%). The highest mean survival on cotton (72.50%) was on par with brinjal (67.50%), which was further on par with cucumber (62.50%). The perusal of the survival data revealed that cotton and brinjal were most suitable hosts of *B. tabaci* supporting its growth and development. The other hosts in decreasing order of suitability for development of whitefly was cucumber, soybean, tomato and *S. nigrum*

Adult longevity and fecundity: The female longevity varied among different host plants and it ranged between 5.11 to 10.05 days (Table 1). Significantly longer longevity of female adults was recorded on cotton (10.05 days), followed by brinjal (8.10 days). The female adults lived for a shortest period on tomato (5.11 days), which was on par with *S. nigrum* (5.47 days). Preoviposition period varied from 1.10 to 1.74 days and differences among host plants were non-significant. However, oviposition period was significantly longer on cotton (7.21 days), followed by brinjal (5.80 days). The post oviposition period varied from 0.89 to 1.20 days, but host plants differed non significantly. The longevity of male ranged between 4.06 and 5.83 days, being longest on cotton and shortest on tomato. The data pertaining to fecundity of *B. tabaci* completed one generation on different hosts showed significant differences, being maximum of 33.74 eggs in case of cotton, which was on par with brinjal (28.32 eggs). The lowest fecundity on *S. nigrum* (19.37 eggs per female) was on par with soybean (24.58 per female) and tomato (22.63 eggs per female).

Scrutiny of the data revealed that brinjal and cotton were the most suitable host of *B. tabaci* having shorter development period, higher survival and fecundity among tested host plants. These results disagree with findings of Foda (2000), who reported that cotton and tomato was preferred host for adults feeding, but cucumber and cantaloupe were more suitable hosts than cotton or tomato in term of growth and development of *B. tabaci.* However, our results were in conformity with the reports of Kakimoto et al. (2007), who studied the growth, development and survival of *B. tabaci* on

four vegetable hosts and observed that development time was shortest on brinjal (21.8 days), followed by cucumber (22.4 days), sweet pepper (22.7 days) and tomato (25.6 days). They also reported higher survival of immature stages and fecundity on brinjal than other crops and study concluded that brinjal was most suitable host among cucumber, tomato, and sweet pepper. Fekrat and Shishehbor (2007) studied the development of *B. tabaci* on three host plants and recorded shortest life cycle on potato (14.2 days) followed by brinjal (14.9 days) and longest on tomato (20.0 days). Similarly, Khan et al. (2010) examined host preference and survival of *B. tabaci* on brinjal, tomato and chilli and registered lower whitefly attack on other host plants in the presence of brinjal. Later, Fekri et al. (2013) studied biological parameters of *B. tabaci* on different tomato varieties and stated that short development period and higher survival on a suitable variety will result in more number of generations/ year. The present results derive support from Shah and Liu (2013), who stated that eggplant was suitable host for development of immature stages of *B. tabaci*, where cucumber and tomato were rated as marginal hosts. The present study concluded that host plants had significant effect on growth and reproduction of *B. tabaci*. The cucumber was the most preferred host for oviposition by *B. tabaci* and soybean ranked second in the order of preference. The survival of immature stages on soybean was lower as compared to the most suitable hosts of cotton and brinjal. Thus, soybean may be exploited as a trap crop for management of *B. tabaci.*

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AUTHOR CONTRIBUTION STATEMENT

NA conceived and designed the research GS conducted the experiments and analysed the data. GS wrote the manuscript and both authors read and approved the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

REFERENCES

Abd-Rabou S, Simmons A M. 2010. Survey of reproductive host plants of *Bemisia tabaci* (Hemiptera: Aleyrodidae) in Egypt, including new host records. Entomology News 121(5): 456-465.

Attique M R, Rafiq M, Gaffar A, Ahmad Z, Mahyuddin A I 2003. Hosts of *Bemisia tabaci* (Genn.) (Homoptera: Aleyrodidae) in cotton areas of Punjab, Pakistan. Crop Protection 22: 715-720.

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.

De Barro P J, Liu S S, Boykin L M, Dinsdale A B. 2011. *Bemisia tabaci*: A statement of species status. Annual Review of Entomology 56: 1-19.

De Barro P J, Trueman J W H, Frohlich D R. 2005. *Bemisia argentifolii* is a race of *B. tabaci* (Hemiptera: Aleyrodidae): the molecular genetic differentiation of *B. tabaci* populations around the world. Bulletin of Entomological Research 95: 193-203.

Fekrat L, Shishehbor P. 2007. Some biological features of cotton whitefly, *Bemisia tabaci* (Homoptera: Aleyrodidae) on various host plants. Pakistan Journal of Biological Sciences 10: 3180-3184.

Fekri M S, Samih M A, Imani S, Zarabi M. 2013. Study of host preference and the comparison of some biological characteristics of *Bemisia tabaci* (Genn.) on tomato varieties. Journal of Plant Protection Research 53:137-142.

Foda M E. 2000. Population dynamics, host preference and seasonal distribution patterns of whitefly, *Bemisia tabaci* (Genn.) in middle Egypt. Proceedings of the Beltwide Cotton Conference. National Cotton Council, Memphis, Tennessee. pp. 1380-1382.

Holden M H, Ellner S P, Lee D H, Nyrop J P, 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.

Horowitz A R, Kontsedalow S, Khasdan V, Ishaaya I. 2005. Biotypes B and Q of *Bemisia tabaci* and their relevance to neonicotinoid and pyriproxyfen resistance. Archives of Insect Biochemistry and Physiology 58: 216-225.

Hossain I, Khan M M H, Jahan S M H, Ullah M H, Rahman M Z V. 2018. Host preference, fecundity and longevity of whitefly, *Bemisia tabaci* on brinjal and tomato. Bangladesh Journal of Entomology 28*:* 23-30.

Jones D. 2003. Plant viruses transmitted by whiteflies. European Journal of Plant Pathology 109: 197-221.

Kakimoto K, Inoue H, Yamaguchi T, Ueda S, Honda K I, Yano E. 2007. Host plant effect on development and reproduction of *Bemisia argentifolii* Bellows *et* Perring (B. *tabaci* [Gennadius] B-biotype) (Homoptera: Aleyrodidae). Applied Entomology and Zoology 42: 63-70.

Kedar S C, Saini R K, Kumaranag K M. 2018. Whitefly, *Bemisia tabaci* (Gennadius) as influenced by host plants in Haryana. Indian Journal of Entomology 80(2): 257-262.

Khan M A, Akram W, Khan H A A, Asghar J, Khan T M. 2010. Impact of *Bt* cotton on whitefly, *Bemisia tabaci* (Genn.) population. Pakistan Journal of Agricultural Sciences 47: 327-332.

Khan M R, Ghani I A, Khan M R, Ghaffar A, Tamkeen A. 2011. Host plant selection and oviposition behaviour of whitefly *Bemisia tabaci* (Gennadius) in a mono and simulated polyculture crop habitat. African Journal of Biotechnology 10:1467-1472.

Kranthi K R. 2014. Cotton leaf curl virus time bomb. Cotton Statistics and News 4:1-7.

Lanjar A G, Baloch N, Rustamani M A, Lohar M K, Solangi A W. 2012. Preferential distribution of whitefly, *Bemisia tabaci* Genn. on cucurbit and non-cucurbit crops. Sindh University Research Journal 44: 381-384.

Morales P, Cermeli M. 2001. Evaluation of the preference of the sweet potato whitefly *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) in five agricultural crops. Entomotropica 16: 73-78.

Muniz M. 2000. Host suitability of two biotypes of *Bemisia tabaci* (Hemiptera: Aleyrodidae) on some common weeds. Entomologia Experimentalis et Applicata 95: 63-70.

Naveen N C, Caubey R, Kumar D, Rebijith K B, Rajagopal R, Subrahmanyam B, Subramanian S. 2017. Insecticide resistance status in the whitefly, *Bemisia tabaci* genetic groups Asia-I, Asia-II-1 and Asia-II-7 on the Indian subcontinent. Scientific Reports 7: 40634.

Palumbo J C, Toscano N C, Blua M J, Yoshida H A. 2000. Impact of *Bemisia* whiteflies (Homoptera: Aleyrodidae) on alfalfa growth, forage yield and quality. Journal of Economic Entomology 93: 1688-1694.

Shah M M R, Liu T X. 2013. Feeding experience of *Bemisia tabaci* (Hemiptera: Aleyrodidae) affects their performance on different host plants. Plos One 8: 77368.

Sharma M and Budha P B (2015) Host preference of tobacco whitefly *Bemisia tabaci* (Gennadius, 1889) on vegetables in Nepal. Journal of Insect Science 20: 133-137.

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

Simmons A M. 1994. Oviposition on vegetables by *Bemisia tabaci* (Homoptera: Aleyrodidae): temporal and leaf surface factors. Environmental Entomology 23: 381-389.

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