Mysore J. Agric. Sci., 55 (4) : 230-239 (2021)

Ovipositional Preference of Gravid Female Moths of *Spodoptera frugiperda* (J. E. Smith) among Selected Host Plants through Choice and No-choice Assays

T. D. NIDHEESH[1], K. S. JAGADISH[2], P. D. KAMALA JAYANTHI[3] AND B. SHIVANNA[4]
[1, 2&4]Department of Agricultural Entomology, College of Agriculture, UAS, GKVK, Bengaluru - 560 065
[3]ICAR - Indian Institute of Horticultural Research, Bengaluru - 560 089
e-Mail : nidheeshtdas123@gmail.com

ABSTRACT

Given the new spread and potential damage of the fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) in India, it has become inevitable to understand the ovipositional preference as well as developmental biology of this invasive species on selected host plants in newer geographical zones. In this study, thorough investigation was conducted on the ovipositional preference of FAW females on different host plants, under choice and non-choice tests. Fall armyworm gravid females had an ovipositional preference towards maize as compared to other host plants, including jowar and ragi and they had a reluctance for cotton and rice, which was confirmed during the choice and no-choice tests. Therefore, under no choice assay, the egg laying preference of gravid female moths were in the decreasing order : maize > jowar > ragi > cotton > rice. In no-choice assay, the results regarding larval count were in line with earlier assays done on ovipositional preference. Significantly the highest number of larvae were recorded on corn plants [36.60 ± 2.36 larvae; mean number of larvae / plant ± S. E. ; $F_{(4,20)} = 23.21$; $P<0.0001$] as compared to the other host plants chosen.

Keywords : *Spodoptera frugiperda*, Ovipositional preference, Choice test, No-choice test, Maize, Rice, Jowar, Ragi, Cotton

HOST habitat location followed by host-plant and its recognition by phytophagous insects is fundamental as it impacts offspring fitness and survival. Identifying potential host plants in an intricate environment is an essential component for the survival of phytophagous insects. The choice of a suitable host plant for oviposition by a gravid female is often thought to be extremely difficult, particularly in polyphagous and oligophagous species that feed on a variety of host plants. Several hypotheses have been suggested on this concept, emphasizing the function of progeny as well as adult success in shaping their host preference patterns, in addition to ecological and behavioural selection pressures. Host selection in polyphagous species is often influenced by the suitability of plant species for offspring survival, growth and performance.

The polyphagous species, *Spodoptera frugiperda* (J E Smith) (Lepidoptera : Noctuidae) also known as the fall armyworm (=FAW), recently invaded India, causing massive damage to maize (*Zea mays* L.). It's totally devastating and it's been reported to affect economically valuable graminaceous plants. The FAW is native to the tropical and subtropical America. From Argentina in the south to southern Florida and Texas in the north, the moth can be found year-round (Nagoshi *et al*., 2012 and Early *et al*., 2018). It was first reported from Nigeria, Sao Tome, Benin and Togo in 2016 (Goergen *et al*., 2016 and IPPC, 2016). Presently, it has been established in more than 30 African countries (FAO, 2018).

This notorious pest has received wide spread attention in the last three years in terms of its voracity, periodic outbreak and pestiferous nature with respect to economically important crops, especially cereals and millets. FAW is recognized as being the most important pest on maize inflicting severe damage leading to poor yield and establishment. This voracious feeder had undoubtedly preferred the poacean members amongst several other cultivated as well non-cultivated plant families (Casmuz *et al*., 2010). FAW is a cosmopolitan,

polyphagous pest which can feed on about 80 different plant species, including corn, rice, small millets, sugarcane, alfalfa, soybean, sorghum, cotton and vegetable crops, besides forage crops and grass species. It is most abundantly associated with wild and cultivated grasses, maize, rice, sorghum and sugarcane, which are among the most preferred host species. Montezano *et al*. (2018), based on a comprehensive literature review and additional surveys in Brazil, identified 353 host plant species from 76 plant families, primarily Poaceae (106), Asteraceae (31) and Fabaceae (31). Although it can consume various plant species, the larvae have an innate preference for grasses. As a result of feeding, the young larvae can inflict characteristic 'window pane like' holes in maize leaves, while older larvae can bite entire holes in the leaves and are even reported to consume parts of the cobs. This polyphagous pest, with world-wide distribution causes up to 34 per cent reduction in maize yields (annual loss of US$ 400 million) in Brazil (CABI, 2016), has recently invaded India and devastated maize in May-June, 2018 in Karnataka and has become a nightmare for our maize growers in peninsular India (Ganiger *et al*., 2018).

The genus *Spodoptera* consists of around 30 species, of which nearly half are considered to be pesti ferous in various parts of the world. Most species within this genus are highly polyphagous, feeding on hundreds of plants, grasses (Family: Poaceae) which seem to be the most preferred host plants for many *Spodoptera* species, suggests that they may be the ancestral host plants of the genus. *Spodopter aexigua* (Hubner), *S. litura* (Fabricius), *S. frugiperda* (J. E. Smith) and *S. littoralis* (Boisduval) which are viewed as among the major nuisance world wide because of different types of economically important plants they consume, their capacity of migration and their status as alien species. Although the pheromones for all four species have been studied and identified, most chemical ecology research on this genus concerns *S. littoralis* and *S. frugiperda* (Acin *et al*., 2010).

In *S. frugiperda* little work has been done as far as host choice preference is concerned. This ravaging pest is found to have two ecotypes, the rice strain and the corn strain. Saldamando and Velez Arango (2010) showed that both strains have a preference for the host and yet that the two strains are not equally selective. The corn strain seems to be more tightly associated with corn than the rice strain which is with rice. In contrast with this, Meagher *et al*. (2011) found that at the point when the two strains were given the choice between corn plants and pasture grass, females of the corn strain laid as many egg batches on corn plants and grasses whereas the rice strain laid more egg batches on grasses than on corn. Field studies carried out by Juarez *et al*. (2012) in Argentina, Brazil and Paraguay did not show similar results and they proposed that host plant choice seems to be connected closer to crop history in the area and host availability, even though there are hereditary contrasts between the two strains.

In terms of ovipositional preference, the preference-performance hypothesis (Refsnider and Janzen, 2010) suggest that females will choose to oviposit in hosts with the highest nutritional quality for their offsprings and hence, the selected host would allow their progeny to shorten the developmental time, increase biomass, as well as their reproductive potential.

Host volatiles serves as a vital cue to aid the insects in egg laying. In general, majority of the researchers would resort to oviposition preference as says in order to determine the role of host kairomones for oviposition behaviour. Use of kairomones is a recent trend in developing semiochemical based pest monitoring and management. Exploiting the behaviourally active host kairomone as a potential tool for pest monitoring and mass trapping purposes offers a clean and green pest management method (Kumara *et al*., 2015). Owing to its polyphagous feeding habit it is reasonable to expect *S. frugiperda* may use certain general as well as specific host kairomone (host plant volatiles) to find its oviposition sites.

The Mysore Journal of Agricultural Sciences

Despite of this fact, no one to the best of our knowledge has studied in detail about the host finding behaviour and ovipositional preference of *S. frugiperda* across its wide host range. The present study has been framed to throw some light on the behavioural characteristics, ovipositional preference and olfactory response of *S. frugiperda* in complex host plant situations, which could be exploited for formulating management strategies. In this context, the primary focus of this present investigation was in the identification of the most preferred host plants for accomplishing the process of oviposition and fulfilling its nutritional requirements for further growth and development, whereas, elucidation of potent kairomones that have an influence on the gravid *S. frugiperda* moths would remain as a concept for further exploration.

Material and Methods

Studies were conducted at Department of Agricultural Entomology, UAS, GKVK, Bengaluru (located at latitude of 12° 58' 17.7564" N, longitude of 77° 35' 40.4268" E at an altitude of 924 m MSL) in collaboration with the Division of Entomology and Nematology, ICAR-Indian Institute of Horticultural Research (IIHR), Hessaraghatta Lake PO, Bengaluru during the period of October, 2019 to June, 2020.

Maintenance of Spodoptera frugiperda Cultures : Fall armyworm, *Spodoptera frugiperda* egg mass along with larvae and infested leaf whorls were collected from Zonal Agricultural Research Station, GKVK, Bengaluru and also from farmer's fields at Chikkaballapura and Gowribidanur taluks. In the laboratory, the larvae along with infested leaves were placed in plastic containers (13.63" l x 8.25" b x 4.88" h) lined with tissue papers to avoid moisture accumulation. The containers were covered with muslin cloth and tied with rubber bands to avoid larval escape. The containers having larvae were kept at ambient conditions (27 ± 1 °C, 75 ± 2% RH and 14L: 10D h photo period) until adult moth emergence. Further, rearing of FAW cultures were done on artificial diet prescribed by ICAR-NBAIR, Hebbal, Bengaluru.

Surface sterilization of eggs as well as pupae was carried out to destroy transovum-transmitted infections and pupal surface microbes by washing the eggs and pupae in sodium hypochlorite solution (0.2 & 0.3 %, respectively) for upto five min., then rinsed thoroughly with sterile distilled water and left to shade dry.

Adult moths emerging from these containers were collected and released into the net cages (1 m × 1 m × 1 m). The freshly emerged moths were provided with honey solution (0.5 %) on cotton wads *ad libitum* and allowed to mate. The walls of the cage were provided with white paper as a supporting platform for egg laying by the moths. The newly emerged moths were provided with food as mentioned earlier and allowed to mate. Mated pairs were collected during the first photo-phase and used for choice and no-choice assays.

*Maintenance of Host Plants :*The selected host plants *viz*., Maize (*Zea mays* L.), rice (*Oryza sativa* L.), ragi (*Eleusine coracana* L.), jowar (*Sorghum bicolor* L.) and cotton (*Gossypium arboreum* L.) were maintained in pots for experimental purpose. Seeds of freshly harvested maize (South African Tall), ragi (KMR 630), rice (HPR 14) were procured from V.C. Farm, Mandya, Karnataka. Whereas, seeds of jowar (Gundlupete local) and cotton (Suraj) were procured from AICRP (Sorghum) and AICRP (Cotton), Chamarajanagara, Karnataka. In this study, one-month old host plants were used and in each polybag, two plants were maintained, by adopting standard agronomic practices, without any pesticidal applications.

Ovipositional Preference Studies : The ovipositional preference of gravid female moths were established through choice and no-choice assays by using selected host plants. Host plants that were raised in polybags were used to carry out the choice / no-choice experiments in protected conditions. This study will give a clue about the most attractive host plant to gravid female moths of *S. frugiperda*. Selected host plants raised in polybags (6" dia) by following standard recommended package of practices in a pest free environment without exposure to any pesticide were

used for this study. The different host plants selected for the study were arranged randomly (Completely Randomized Design) for choice and no-choice assays in net cages (made of nylon net 1 x 0.75 x 1 m, L x B x H; 40 / 50 mesh). On the whole, there were five treatments (5 different host plants) which were replicated five times.

No-Choice Assay : In no-choice assay, five plants of each host species were arranged randomly in separate net cages. Then plants were exposed to gravid females of *S. frugiperda* @ 10 pairs / treatment, continuously for five days. Same procedure was followed individually for all the five host plants selected.

Choice Assay : Choice assay can provide a better estimate of insect preference. In the free choice assay, a single plant from each host plant species was arranged randomly in a net cage. Then the plants were exposed to gravid females of *S. frugiperda* @ 10 pairs / treatment continuously for five days. These assays were repeated five times simultaneously or at different times. Observations were recorded on the number of eggs (egg mass) laid, number of eggs per egg mass, number of larvae and its survival on each host plant. Number of eggs was recorded five days after exposure and numbers of larvae were recorded 10 days after exposure. Egg masses laid on the cage surface were discarded. The experimental set up was more or less identical tothe one suggested by Vanitha *et al*. (2017).

Statistical Analysis : In order to reduce the skewness and follow normal distribution, the data obtained were subjected to square root transformation. The software application / programused to analyze the data was Graphpad Prism (Version 9.1.2). For no-choice assay, one-way ANOVA with multiple comparisons (Tukey's HSD post-hoc test) and for choice assay, repeated measure one-way ANOVA with multiple comparisons was done by using the afore-mentioned software package. Calculated means were differentiated by using Critical Difference (CD) with a set at 0.01.

Results and Discussion

Selection of appropriate host for oviposition by gravid female is decisive as it impacts off-spring

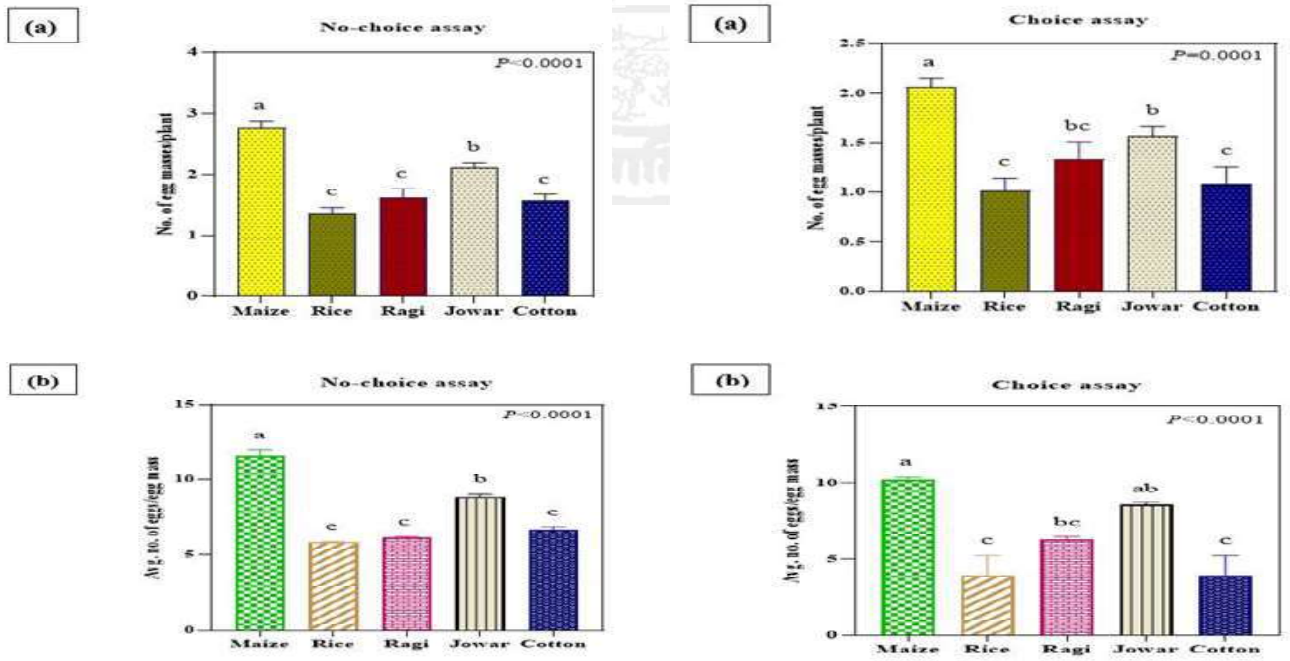

Fig. 1 : Egg laying preference of gravid female, *S. frugiperda* on selected host plants under no-choice [(a) Number of egg masses/plant (b) Average number of eggs/egg mass] and choice assays [(a) Number of egg masses/plant (b) Average number of eggs/egg mass].

fitness and survival. Ovipositional preference by *S. frugiperda* gravid females on different host plants were evaluated both under no-choice and choice situation (Fig. 1).

No-choice assays : In no-choice assay, all five selected host plants *viz*., maize, rice, ragi, jowar and cotton were exposed to gravid females of *S. frugiperda* individually and the mean number of eggs laid on each type of host plant was recorded (Table 1 and 3). Results indicated that there was significant difference among the host plants with respect to the number of eggs laid. *Spodoptera frugiperda* gravid females laid significantly more number of egg masses on maize [7.20 ± 0.58 egg mass; mean number of egg masses / plant ± S. E.; $F_{(4,20)}$ = 28.68; P<0.0001], followed by jowar [4.00 ± 0.32 egg mass], ragi [2.20 ± 0.49 egg mass], cotton [2.00 ± 0.32 egg mass] and rice [1.40 ± 0.24 egg mass] in that decreasing order (Fig. 1a). It is evident that, among the five host plants selected *viz.,* rice and cotton received minimal number of egg masses per plant in contrast to maize and jowar, which received more number of egg masses per plant. A revisitation by using the data from the no-choice assay revealed that on maize, gravid female moths laid 5.14 times more eggs as compared to that on rice, 3.27 times more eggs as compared to that on ragi, 1.80 times more eggs as compared to that on jowar and 3.60 times more eggs as compared to that on cotton. Thus, under no choice assay, the egg laying preference of gravid female moths was in the following descending order: maize > jowar > ragi > cotton > rice. Further comparisons with respect to average number of eggs per egg masses obtained from the host plants revealed that, maize [133.91 ± 10.94 eggs / egg mass; $F_{(4,20)}$= 76.80; P<0.0001] and jowar [78.24 ± 3.30 eggs/ egg mass] received significantly higher number of eggs/ egg mass when compared with the remaining host plants selected. Moreover, there was no significant difference in the number of eggs / egg mass figured out in this experiment between rice, ragi and cotton (Table 1.; Fig. 1b).

Further pair-wise comparisons among the host plants revealed that there was no significant difference in the number of egg masses laid by gravid female moths between rice and ragi, rice and cottonand ragi and cotton in no-choice assays (Table 3).

TABLE 1

Ovipositional preference of *Spodoptera frugiperda* on selected host plants under no-choice and choice assays

Host Plants	Number of egg mass on each host plants		Average number of eggs/egg mass on each host plants	
	No-choice (Mean±SE)	Choice (Mean±SE)	No-choice (Mean±SE)	Choice (Mean±SE)
Maize	7.20 ± 0.58 (2.77 ± 0.10)^{a}	3.80 ± 0.37 (2.07 ± 0.09)^{a}	133.91 ± 10.94 (11.56 ± 0.45)^{a}	104.22 ± 3.23 (10.23 ± 0.16)^{a}
Rice	1.40 ± 0.24 (1.37 ± 0.09)^{c}	0.60 ± 0.24 (1.02 ± 0.12)^{c}	37.37 ± 2.68 (6.14 ± 0.21)^{c}	22.00 ± 9.08 (3.94 ± 1.3)2^{c}
Ragi	2.20 ± 0.49 (1.62 ± 0.14)^{c}	1.40 ± 0.40 (1.33 ± 0.17)^{bc}	37.50 ± 0.97 (6.16 ± 0.08)^{c}	39.20 ± 1.81 (6.29 ± 0.15)^{bc}
Jowar	4.00 ± 0.32 (2.12 ± 0.08)^{b}	2.00 ± 0.32 (1.57 ± 0.10)^{b}	78.24 ± 3.30 (8.87 ± 0.19)^{b}	73.00 ± 2.51 (8.57 ± 0.14)^{ab}
Cotton	2.00 ± 0.32 1.57 ± 0.10^{c}	0.80 ± 0.37 1.09 ± 0.17^{c}	40.50 ± 3.76 6.38 ± 0.29^{c}	22.00 ± 9.36 3.93 ± 1.33^{c}
$F_{cal\ (4,20)}$	28.68	9.801	76.80	10.95
P	<0.0001	0.0001	<0.0001	<0.0001

Note: Values in the parenthesis are square root transformed and values do not share any common letters are significantly different.

TABLE 2

Larval count of *S. frugiperda* on selected host plants under no-choice and choice assays

Host Plants	No-choice (Mean±SE)		Choice (Mean±SE)	
Maize	36.60 ± 2.36	(6.08± 0.20) [a]	30.00 ± 3.38	(5.49 ± 0.30) [a]
Rice	7.20 ± 2.13	(2.59 ± 0.50) [d]	3.40 ± 0.51	(1.96 ± 0.13) [d]
Ragi	16.20 ± 1.36	(4.07 ± 0.17) [c]	9.20 ± 1.28	(3.09± 0.21) [c]
Jowar	25.20 ± 1.56	(5.06 ± 0.15) [b]	19.60 ± 1.03	(4.48± 0.11) [b]
Cotton	13.20 ± 1.43	(3.68 ± 0.20) [c]	5.00 ± 1.14	(2.29± 0.25) [d]
$F_{cal\ (4,20)}$	23.21		48.88	
P	<0.0001		<0.0001	

Note : Values in the parenthesis are square root transformed and values do not share any common letters are significantly different.

Concisely, under no-choice conditions, maize was found to be the most preferred host plant for egg laying by gravid females of *S. frugiperda* as compared to other selected host plants. The most striking observation to emerge from the study was, FAW laid similar number of egg masses on the inner walls of the cage as well as in the maize plants (data have not shown), but, in contrast, FAW highly preferred the cage wall to lay their eggs instead of cotton, rice and ragi plants.

Choice Assays : Adult moths oviposited on all five host plants, but the host species drastically affected oviposition behaviour. Results of choice assay also unveileda similar trend in ovipositional preference as observed in case of no-choice assays. However, the number of eggs laid on each host plant varied significantly. FAW females preferentially oviposited more on maize [3.80 ± 0.37 egg mass; mean number of egg mass/plant ± S. E.; $F_{(4,20)}$= 9.801; P =0.0001] as compared to all other graminaceous host plants (Table 1 and 3 and Fig. 1a & 1b) and in contrast it preferred to lay least number of eggs on rice (Table 1). Therefore, under choice assay, the ovipositional preference of gravid female moths to different host plants was in the following order : maize > jowar > ragi > cotton > rice.

Pair-wise comparisons among the different host plants selected for the study revealed that there was no significant difference in the number of egg masses laid by gravid female moths between maize and jowar, rice and ragi, rice and jowar, rice and cotton, ragi and jowar, ragi and cotton and jowar and cotton (Table 3).

Considering both choice and no-choice assays, maize was found to be consistently preferred by the gravid female fall armyworm moths for egg laying and cotton was least preferred. Selecting an appropriate oviposition site by gravid females is not only a complex process that involves multiple modalities, but is crucial for offspring survival (Kamala Jayanthi *et al*., 2014). Therefore, ovipositional preference of a particular gravid female moth has its own sphere of influence on its fecundity and also on the larval development on a particular host plant.

Larval Counts on Different Host Plants under No-Choice and Choice Assays : After exposing the host plants to gravid female moths for oviposition, the subsequent larval counts on selected host plants under no-choice and choice conditions were recorded. Observations were recorded one week after experimental setup on number of larvae in each host plant. Larval count differed under both no-choice and choice assay (Fig. 2). Further, it also differed according to the host plants on which eggs were laid. In no-choice assay, the results regarding larval counts were in line with earlier ovipositional preference assays. Significantly highest number of larvae were recorded on maize plants [36.60 ± 2.36 larvae; mean number of larvae/plant ± S. E.; $F_{(4,20)}$= 23.21; P < 0.0001] as compared to the other host plants chosen. The second highest larval population was noticed on jowar [25.20 ± 1.56 larvae;

The Mysore Journal of Agricultural Sciences

TABLE 3

Tukey's multiple comparison test: Ovipositional and larval preferences of *S. frugiperda* to selected host plants under no-choice and choice assays

Host Plants	Ovipositional preference				Larval preference			
	No choice		Choice		No choice		Choice	
	Mean Difference	*P*	Mean Difference	*P*	Mean Difference	*P*	Mean Difference	*P*
Maize vs. Rice	1.202	<0.0001	0.9780	0.0005	2.396	<0.0001	3.198	<0.0001
Maize vs. Ragi	1.152	<0.0001	0.7320	0.0084	2.002	0.0005	2.404	<0.0001
Maize vs. Jowar	0.6520	0.0025	0.5000	0.1062	1.016	0.1089	1.012	0.0236
Maize vs. Cotton	1.404	<0.0001	1.050	0.0002	3.490	<0.0001	3.532	<0.0001
Rice vs. Ragi	-0.05000	0.9971	-0.2460	0.7035	-0.3940	0.8491	-0.7940	0.1025
Rice vs. Jowar	-0.5500	0.0114	-0.4780	0.1315	-1.380	0.0161	-2.186	<0.0001
Rice vs. Cotton	0.2020	0.6629	0.07200	0.9954	1.094	0.0742	0.3340	0.8015
Ragi vs. Jowar	-0.5000	0.0237	-0.2320	0.7452	-0.9860	0.1257	-1.392	0.0014
Ragi vs. Cotton	0.2520	0.4630	0.3180	0.4790	1.488	0.0087	1.128	0.0102
Jowar vs. Cotton	0.7520	0.0005	0.5500	0.0639	2.474	<0.0001	2.520	<0.0001

All treatment effects were highly significant at $P<0.05$ by Tukey's HSD

mean number of larvae / plant ± S. E.], followed by ragi [16.20 ± 1.36 larvae; mean number of larvae/ plant ± S. E.], cotton [13.20 ± 1.43 larvae; mean number of larvae / plant ± S. E.] and rice [7.20 ± 2.13 larvae; mean number of larvae / plant ± S. E.]. As mentioned above, the larval population as well as survival was the least on rice and cotton. In explicably, there was meagre oviposition on cotton as mentioned earlier *vis-u-vis* less number of larvae. Results of choice assay also revealed similar trend

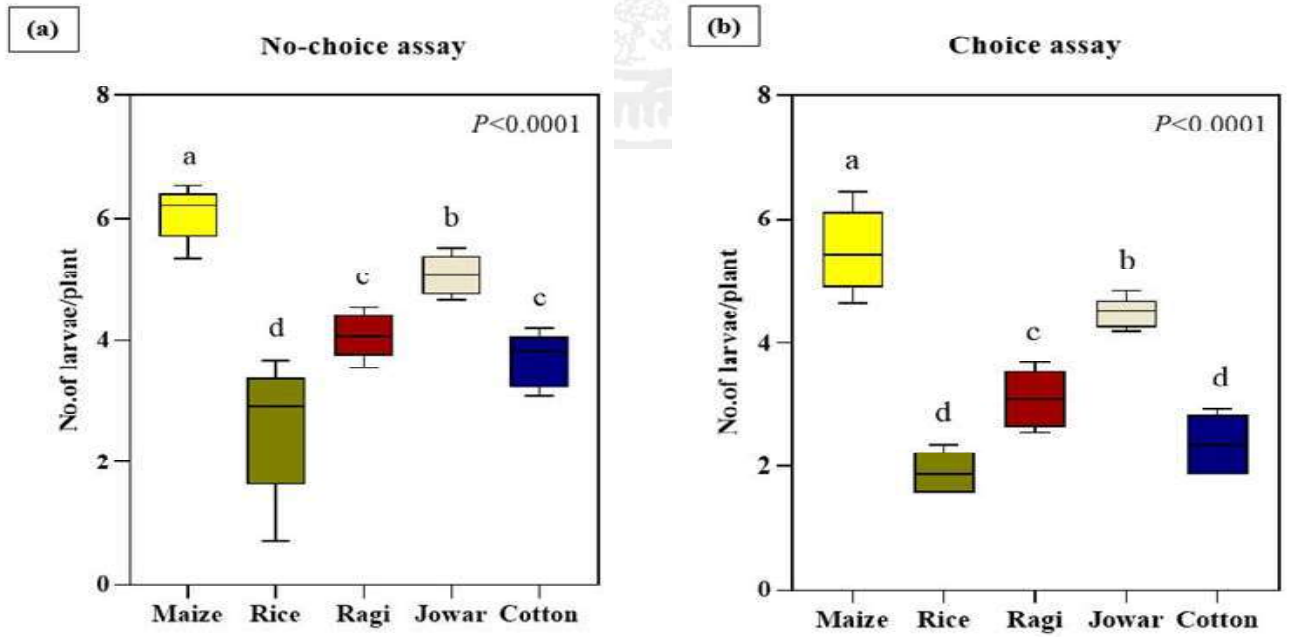

Fig. 2 : Larval counts of *S. frugiperda* on selected host plants under no-choice (a) and choice assays (b)

in ovipositional preference as observed in no-choice assays. However, number of eggs laid on each host plant differed significantly (Table 2; Fig. 2b).

With respect to no-choice assay, the percentage of larvae hatched from eggs laid on each host plant revealed that maize supported maximum larval survival (88.41%), followed by jowar (78.82%), ragi (67.17%), cotton (42.64%) and rice (18.93%) (Fig. 3a). Similar trend for larval survival was observed in choice assay also, with a maximum larval survival on maize (89.74%), followed by jowar (76.10%), ragi (40.85%), cotton (14.71%) and rice (9.00%) in that decreasing order (Fig. 3b). Considering both choice and no-choice assays, maizewas found to support *S. frugiperda* larvae consistently in terms of its development and survival and the other hosts *viz*., jowar, ragi, rice and cotton comparatively supported less number of larvae. These findings suggest that maize is a highly preferred and suitable host for larval feeding and oviposition by females, which is consistent with the previous research results of He *et al*. (2021).

Pair-wise comparisons among the various host plants chosen for the study revealed that there is no significant difference between the host plants *viz*., maize and jowar, rice and ragi, rice and cotton and ragi and jowar in supporting *S. frugiperda* larvae in case of no-choice assays. On the contrary, the results of Tukey's multiple comparison test with respect to the free choice assay revealed that there are no significant differences between the host plants *viz*., rice and ragi and rice and cotton in supporting FAW larvae (Table 3).

This study clearly indicated that given the situation either choice or no-choice, maize continued to be the most preferred host for oviposition and its further development compared to all other selected host plants. This is in complete agreement with the resultsof Sotelo-Cardona *et al*. (2021), wherein, they concluded that, FAW female adults significantly preferred maize plants for oviposition as compared to other crops under a free choice arena. Further more, the amount of egg masses [$F_{(3,27)}$=13.27; $P < 0.0001$] and mean number of eggs [$F_{(3,27)}$=17.01; $P < 0.0001$] was significantly higher in maize plants followed by soybean and cabbage. No egg masses as well as eggs from FAW were found in tomato plants when other vegetables were given as a choice. During oviposition, the tomato leafminer, *Tutaabsoluta* females may detect small differences in the odour

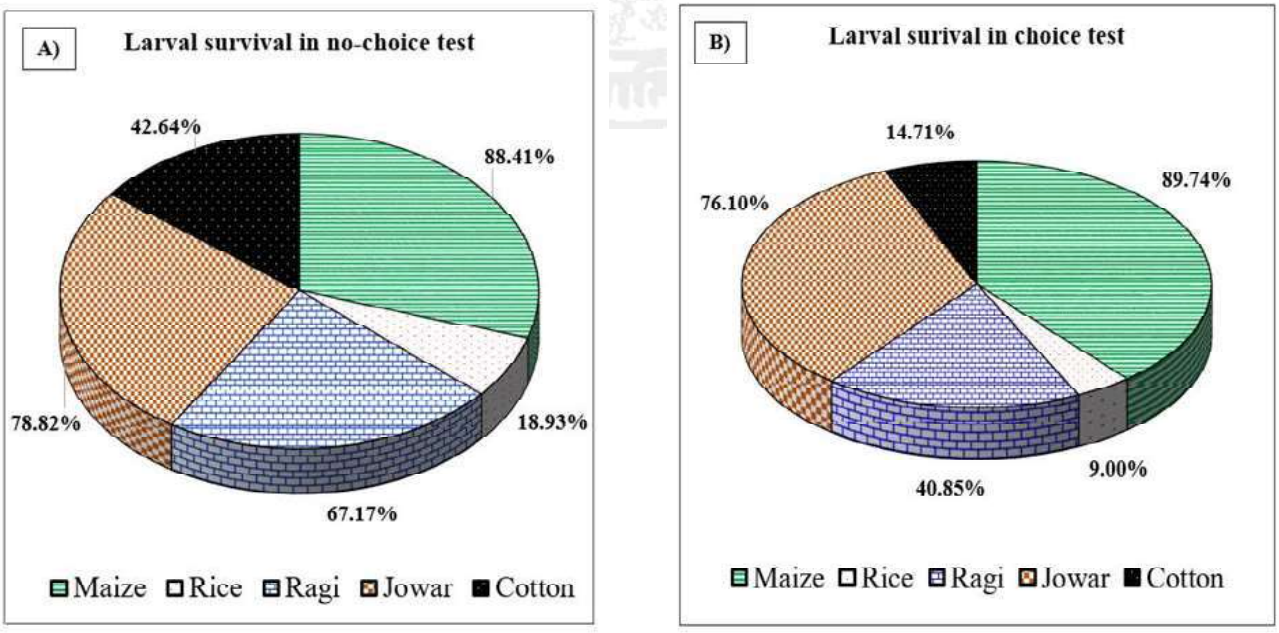

Fig. 3 : Larval survival of *S. frugiperda* under no-choice (A) and choice assays (B)

The Mysore Journal of Agricultural Sciences

blend of solanaceous plants and adapt their oviposition behaviour according to plant volatile cues (Proffit *et al*., 2011).

Oviposition on a suitable host in response to plant cues is of major importance for an herbivore insect to maximize its fitness (Kamala Jayanthi *et al*., 2012; Bawin *et al*., 2015a & 2015b). Though, *S. frugiperda* can infest several plants belonging to the family Poaceae in general, as per literature, the present investigation and studies carried out elsewhere clearly showed that all poacean or graminaceous plants are not equally preferred by the gravid females for oviposition.

This study gives an account of oviposition preference of *S. frugiperda* gravid female moths when provided with its major host plants in two choice situations *viz*., no-choice as well as choice assay. These findings suggest that females will choose to oviposit in hosts with the highest nutritional quality for their progeny and hence, the selected host would allow the progeny to shorten the developmental time, increased biomass, as well as the reproductive potential. The present study has only examined ovipositional preference by gravid females of fall army worm. The current study has clearly shown that maize plant volatiles elicit attraction in gravid females of *S. frugiperda* and the biochemical compounds responsible for attraction have to be identified. This will make possible future studies where a lure for adult *S. frugiperda* could be developed for monitoring and mass trapping of this pest. Having an attractant for adults greatly increases the scope for using semio-chemical based management strategies against this notorious invasive pest.

Acknowledgements : The authors are highly indebted to University of Agricultural Sciences, GKVK, Bengaluru; ICAR - Indian Institute of Horticulture Research (ICAR - IIHR), Hessarghatta, Bengaluru and ICAR- National Bureau of Agricultural Insect Resources (ICAR-NBAIR), Hebbal, Bengaluru for providing all the pre-requisites for the smooth conduct of present study. DST - INSPIRE Fellowship given to the first author is also gratefully acknowledged.

References

Acin, P., Rosell, G., Guerrero, A. and Quero, C., 2010, Sex pheromone of the spanish population of the beet army worm *Spodoptera exigua*. *J. Chem. Ecol.,* **36** (7) : 778 - 786.

Bawin, T., Dujeu, D., De Backer, L., Fauconnier, M. L., Lognay, G., Delaplace, P., Francis, F. and Verheggen, F. J., 2015a, Could alternative solanaceous hosts act as refuges for the tomato leafminer, *Tuta absoluta*. *Arthro. Plant Inter*., **9** : 425 - 435.

Bawin, T., Dujeu, D., De Backer, L., Francis, F. and Verheggen, F. J., 2015b, Ability of *Tuta absoluta* (Lepidoptera : Gelechiidae) to develop on alternative host plant species. *Can. Entomol.*, **148** : 434 - 442.

Cabi, Data sheet, 2016, *Spodoptera frugiperda* (fall armyworm) - Invasive species compendium, http://www.cabi.org/isc/datasheet/29810.

Casmuz, A., Juarez, M. L., Socias, M. G., Murua, M. G., Prieto, S., Medina, S., Willink, E. and Gastaminza, G., 2010, Revision de loshospederos del gusanoco gollero del maíz, *Spodoptera frugiperda* (Lepidoptera : Noctuidae). *Revista de la Socie - dad Entomologica Argentina*, **69** : 209 - 231.

Early, R., Gonzalez-Moreno, P., Murphy, S. T. and Day, R., 2018, Forecasting the global extent of invasion of the cereal pest *Spodoptera frugiperda*, the fall armyworm. *Neo Biota*, **40** : 25 - 50.

Fao, 2018, Briefing Note on FAO actions on fall army worm in Africa 31 January 2018. In: briefing note on FAO actions on fall armyworm in Africa 31 January 2018, FAO, Rome, Italy, pp. : 6 .

Ganiger, P. C., Yeshwanth, H. M., Muralimohan, K., Vinay, N., Kumar, A. R. V. and Chandrashekar, K., 2018, Occurrence of the new invasive pest, fall army worm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), in the maize fields of Karnataka, India. *Curr. Sci.*, **115** (4) : 25.

Goergen, G., Kumar, P. L., Sankung, S. B., Togola, A. and Tamo, M., 2016, First report of outbreaks of the fall

armyworm *Spodoptera frugiperda* (J E Smith) (Lepidoptera, Noctuidae), a new alien invasive pest in West and Central Africa. *PLoS ONE*, **11** (10) : e0165632.

He, L. M., Zhao, S. Y., Gao, X. W. and Wu, K. M., 2021, Ovipositional responses of *Spodoptera frugiperda* on host plants provide a basis for using *Bt*-trans genic maize as trap crop in China. *J. Integr. Agri.,* **20** (3) : 804 - 814.

Ippc, 2016, The damage caused by *Spodoptera frugiperda*. (Les degatscauses par *Spodoptera frugiperda*). In : IPPC official pest report. Rome, italy : FAO. https://www.ippc.int/

Juarez, M. L., Gabriela Murua, M., Gabriela Garcia, M., Ontivero, M., Teresa Vera, M., Vilardi, J. C., Groot, A. T., Castagnaro, A. P., Gastaminza, G. and Willink, E., 2012, Host association of *Spodoptera frugiperda* (Lepidoptera : Noctuidae) corn and rice strains in Argentina, Brazil and Paraguay. *J. Econ. Entomol*., **105** (2) : 573 - 582.

Kamala Jayanthi, P. D., Woodcock, C. M., Caufield, J., Birkett, M. A. and Bruce, T. J. A., 2012, Isolation and identification of host cues from mango, *Mangifera indica*, that attract gravid female oriental fruit fly, *Bactrocera dorsalis*. *J. Chem. Ecol*., **38** : 361 - 369.

Kamala Jayanthi, P. D., Kempraj, V., Aurade, R. M., Venkataramanappa, R. K., Nanadgopal, B., Verghese, A. and Bruce Ruce, T. J. A., 2014, Specific volatile compounds from mango elicit oviposition in gravid *Bactrocera dorsalis* females. *J. Chem. Ecol*., **40** (3) : 259 - 266.

Kumara, A. D. N. T., Chakravarthy, A. K. and Subaharan, K., 2015, Role of kairomones in ovipositional preference of coconut black-headed caterpillar *Opisina arenosella* Walker (Lepidoptera: Oecophoridae). *Mysore J. Agric. Sci.,* **49** (2) : 314 - 317.

Meagher, R. L., Nagoshi, R. N. and Stuhl, C. J., 2011, Oviposition choice of two fall armyworm (Lepidoptera : Noctuidae) host strains. *J. Insect Behavior.*, **24** (5) : 337 - 347.

Montezano, D. G., Specht, A., Sosa-Gomez, D. R., Roque-Specht, V. F., Sousa-Silva, J. C., Paula-Moraes, S. V., Peterson, J. A. and Hunt, T. E., 2018, Host plants of *Spodoptera frugiperda* (Lepidoptera : Noctuidae) in the Americas. *African Entomol.*, **26** (2) : 286 - 300.

Nagoshi, R. N., Meagher, R. L. and Hay-Roe, M., 2012, Inferring the annual migration patterns of fall army worm (Lepidoptera : Noctuidae) in the United States from mitochondrial haplotypes. *Ecol. Evol*., **2** (7) : 1458 - 1467.

Proffit, M., Birgersson, G., Bengtsson, M., Reis Jr., R., Witzgall, P. and Lima, E., 2011, Attraction and oviposition of *Tuta absoluta* females in response to tomato leaf volatiles. *J. Chem. Ecol*., **37** (6) : 565 - 574.

Refsnider, J. M. and Janzen, F. J., 2010, Putting eggs in one basket: Ecological and evolutionary hypotheses for variation in oviposition-site choice. *Annu. Rev. Ecol. Evol. Syst*., **41** : 39 - 57.

Saldamando, C. I. and Velez-Rango, A. M., 2010, Host plant association and genetic differentiation of corn and rice strains of *Spodoptera frugiperda* Smith (Lepidoptera : Noctuidae) in Colombia. *Neotrop. Entomol.,* **39** (6) : 921 - 929.

Sotelo-Cardona, P. A., Chuang, W., Lin, M., Chiang, M. and Ramasamy, S., 2021, Oviposition preference not necessarily predicts offspring performance in the fall armyworm, *Spodoptera frugiperda* (Lepidoptera : Noctuidae) on vegetable crops. *Scientifc Reports*, **11** : 15885.

Vanitha, S., 2017, Host plant interaction of south american tomato leaf miner, *Tutaabsoluta* (Meyrick): Deciphering potent kairomones. *M. Sc. (Horti.) Thesis* (Unpub.), University of Horticultural Sciences., Bagalkot.

(*Received :* August 2021 *Accepted :* September 2021)