www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(7): 2283-2287

www.thepharmajournal.com
Received: 06-04-2022
Accepted: 20-06-2022

Mansor Kumari Lodha
Department of Entomology, Maharana Pratap University of Agriculture and Technology, Rajasthan College of Agriculture, Udaipur, Rajasthan, India

S Ramesh Babu
Department of Entomology, Maharana Pratap University of Agriculture and Technology, Rajasthan College of Agriculture, Udaipur, Rajasthan, India

NL Dangi
Department of Entomology, Maharana Pratap University of Agriculture and Technology, Rajasthan College of Agriculture, Udaipur, Rajasthan, India

Virendra Singh
Department of Entomology, Maharana Pratap University of Agriculture and Technology, Rajasthan College of Agriculture, Udaipur, Rajasthan, India

Rinkita Biyani
Department of Entomology, Maharana Pratap University of Agriculture and Technology, Rajasthan College of Agriculture, Udaipur, Rajasthan, India

Corresponding Author:
Mansor Kumari Lodha
Department of Entomology, Maharana Pratap University of Agriculture and Technology, Rajasthan College of Agriculture, Udaipur, Rajasthan, India

Screening of sweet potato, *Ipomoea batatas* (L.) Germplasm for preference/non preference by sweet potato weevil

Mansor Kumari Lodha, S Ramesh Babu, NL Dangi, Virendra Singh and Rinkita Biyani

Abstract
The present investigation on "Screening of Sweet Potato, *Ipomoea batatas* (L.) Germplasm for preference/ non preference by sweet potato weevil, *Cylas formicarius* (Fabricius)" was carried out at Horticulture Farm, Rajasthan College of Agriculture, MPUAT, Udaipur during *Kharif*, 2021. Eight germplasm of *Ipomea batatas* (S.T.-14, Local, TSP-16-10, TSP-16-9, TSP-16-7, TSP-16-6, TSP-16-5, TSP-16-3) were evaluated for studying their relative susceptibility against *Cylas formicarius*. The result revealed that the vine infestation and tuber infestation were minimum in germplasm TSP-16-7 which recorded the highest marketable tuber yield of 24.86 t ha^{-1}. Whereas vine infestation and tuber infestation were maximum in germplasm ST-14 which recorded a marketable tuber yield of 13.82 t ha^{-1}. The germplasm are arranged in decreasing order with respect to mean per cent vine infestation and tuber infestation: ST-14 >Local > TSP-16-5 > TSP-16-9 > TSP-16-6 > TSP-16-3 > TSP-16-10 > TSP-16-7.

Keywords: Sweet potato, weevil, tuber, vine, infestation, marketable yield, incidence, screening

Introduction
Sweet potatoes are an important staple food in many parts of the country and are ranked as the seventh most significant crop in the world after wheat, rice, maize, potato, barley and cassava (Prakash *et al*., 2016; CIP, 2017; Prakash *et al.,* 2017). Over the last two decades, the role of sweet potato in the nutrition and food security of developing countries has changed significantly. The role of sweet potatoes in developing nations' diets and food security has altered substantially during the last 20 years. Sweet potatoes' usage as a staple food continued to drop, while their use in animal feed and the production of industrial starch increased in the main sweet potato-producing nations (Benjamin, 2007) [3]. The production of sweet potatoes is constrained by several biotic and abiotic factors. India's sweet potatoes are being infested by over 80 different insect species (Rajamma, 1982). In agricultural regions where sweet potatoes are grown, *Cylas formicarius* (Fabricius), *Euscepes postfasciatus* (Fairmaire), *Cylas brunneus* (Fabricius) and *Cylas puncticollis* (Boheman) are the four principal species of sweet potato weevils that are most destructive. Although there are several subspecies of sweet potato weevils that may be found in various geographical regions, their methods of attack remain the same. Worldwide, particularly in the tropics and subtropics, the sweet potato weevil, *Cylas formicarius* Fab. (Coleoptera: Brentidae), is the most destructive pest of *Ipomoea batatas*, both in the field and in storage (Sutherland, 1986) [23]. Since the 1500s, this insect has been connected to sweet potatoes and the harm it does reduces productivity and harms tubers.
The weevil infestations range from 20 to 50 per cent and in some cases 100 per cent, depending on the season and species (Sutherland, 1986) [23] because they complete their whole life cycle within *Ipomoea batatas* and their damage is devastating (Sutherland, 1986) [23]. The mature females lay their eggs near the base of vines or in tubers, as well as in cavities created in stems or tubers, where the grubs develop. The most harmful stage is white grub, which eats and tunnels into adult stems and storage roots (Chalfant *et al*., 1990) [4]. Small feeding and oviposition holes on the outside, as well as larval tunnels filled with frass in the tissues, are among the plant's injuries (Strong, 1936) [22]. Infestation of storage roots renders them inappropriate for human or animal food, even if only a tiny percentage of the flesh is affected, as the damaged tissue releases terpenes, which give the flesh a disagreeable odour and bitter flavour (Loebenstein and Thottappilly, 2009) [9]. During storage, it has been observed that weevil damage continues to rise (Chalfant *et al*., 1990) [9].

Keeping in view, the above facts, studies on "Screening of Sweet Potato, *Ipomoea batatas* (L.) Germplasm for preference/non preference by sweet potato weevil, *Cylas formicarius* (Fabricius)" was carried out.

Materials and Methods

The field experiment was carried out at the Horticulture farm, Rajasthan College of Agriculture, Udaipur, during Kharif, 2021 with eight treatments and three replications was undertaken in a Randomized Block Design (RBD) to screen the Sweet Potato, *Ipomoea batatas* (L.) Germplasm for preference/ non preference by sweet potato weevil. The various treatments were S.T.-14, Local, TSP-16-10, TSP-16-9, TSP-16-7, TSP-16-6, TSP-16-5, and TSP-16-3. The row-to-row and plant-to-plant distances were 50 cm and 40 cm, respectively.

Table 1: Field experimental details

Crop	Sweet potato
Pest	Sweet potato weevil
Spacing	50×40 cm
Design	RBD
Treatments	8
Replications	3
Experimental period	Six months

Table 2: Treatments detail

Treatments	Germplasm
T1	TSP-16-3
T2	TSP-16-5
T3	TSP-16-6
T4	TSP-16-7
T5	TSP-16-9
T6	TSP-16-10
T7	ST-14 (Bhusona)
T8	Local

Observation

i. Extent of insects caused foliage damage

By using a 1- 5 damage score, where 1 = 0%; 2 = 1- 25%; 3 = 26 - 50%; 4 = 51 - 75%; and 5 = 76 - 100%. The extent of foliage damage was analyzed from the central 1 m section of the middle ridge of each plot.

ii. Tuberization depth

At the time of harvesting, five tubers from each plot were dugout using a hoe. By using scale depth at which tubers are formed for five germplasm was measured and the average value of tuberization depth was calculated. Based on tuberization depth the germplasm was differentiated into different categories:-

a. Shallow rooted: Tuberization depth up to 5cm
b. Medium rooted: Tuberization depth up to 5-10cm
c. Deep rooted: Tuberization depth above 10 cm

iii. Vine thickness

The vine thickness of five randomly chosen plants from each plot at 90 DAP (Days after planting) was measured. Using a thread and scale, the average thickness of the main vine was measured and recorded.

iv. Determination of Dry Matter Content

The storage root tubers from the surviving plants on each ridge were carefully dug up, collected and weighed to obtain the overall weight per plot. Percentage dry matter content was determined within 24 hours of harvest. The fresh root tuber of each cultivar was sliced into pieces and 100 g was dried in an oven at 80 ˚C for 24 hours until a constant weight was achieved. Percentage dry matter content was calculated by using the following formula:

$$I = \frac{a}{a + b} X\, 100$$

Where
I = percentage dry matter content
a = final weight of infested tubers – initial weight of infested tuber
b = (final weight of infested tubers – initial weight of infested tubers) + (final weight of uninfested tubers – initial weight of uninfested tubers)

v. Per cent weevil infestation in vine and tuber:

Weevil infestation in the vine was recorded 80 days after planting. Per cent vine infestation (%) was computed by using the formula mentioned below:

$$\text{Per cent vine infestation} = \frac{\text{Number of vines infested}}{\text{Total number of vines}} \text{x } 100$$

During harvesting based on the presence of ovipositional punctures on the tuber, infested tubers were sorted out from the healthy ones**.** Tuber infestation (%) was computed by using the formula mentioned below**:**

$$Per\ cent\ tuber\ infestation = \frac{Weight\ of\ weevil\ infested\ tubers}{Total\ weight\ of\ tubers} x\ 100$$

vi. Marketable tuber yield (t/ha)

During observation for tuber infestation, healthy tubers were sorted out and weighed plot-wise and finally, marketable tuber yield was calculated in terms of t/ha.

vii. Grade of germplasm

By adopting the procedure of Netam *et al.* 2008 [13], the germplasm used for investigating was categorized into different resistant/susceptible groups.

Table 3: Percent incidence Reaction

Grade	Percent incidence	Reaction
0	0	Highly resistant
1	1-20	Resistant
2	20-40	Moderately resistant
3	40-60	Moderately susceptible
4	60-80	Susceptible
5	80	Highly susceptible

Result and Discussion

The result of foliage damage showed that four germplasm TSP-16-3, TSP-16-6, TSP-16-7, TSP-16-10 showed a 2 damage score (1-25% damage) and four germplasm TSP-16-9, TSP-16-5, ST-14, Local showed a 3 damage score (26 - 50% damage) (Table-4). This result confirms the findings of Cockerham *et al*. (1954). They stated that tubers were preferred over vines and leaves at a ratio of 75% to 11%. Smit (1997) [21] reported that adults of *Cylas* weevils feed on foliage, and the larvae feed in the stem or the leaf and pupate inside sweet potato vines.

Table 4: Extent of foliage damage caused by sweet potato weevil (*Cylas formicarius* Fab.) in sweet potato during *Kharif*, 2021

Foliage damage score	Range of damage (%)	Germplasm
1	0	-
2	1 - 25	TSP-16-3, TSP-16-6, TSP-16-7, TSP-16-10
3	26 - 50	TSP-16-9, TSP-16-5, ST-14, Local
4	51 - 75	-
5	76 - 100	-

The result of tuberization depth showed that no germplasm was shallow-rooted, six germplasm TSP-16-3, TSP-16-5, TSP-16-6, TSP-16-9, Local, ST–14 were medium rooted, whereas only two germplasm were deep rooted TSP-16-7, TSP-16-10 (Table-5). It revealed that the germplasm in which tuberization started at more soil depth suffered less weevil infestation than those where tuberization started just below the soil surface. Leuschner (1979) reported that deep tuberization was the major contributing factor to low damage as in the case of clones TIS 1419 and TIS 2079 and bigger tubers of TIS 1479 contribute to more exposure compared to TIS 2079 and are more susceptible to damage. Mansaray *et al*. (2013) [1] reported that varieties Simama and Sinia which set their roots on top soils rendering them exposed to weevils attack and variety Gudugudu which was deep-rooted making it hard for the weevils to access roots. The results on tuberization depth were also in conformity with the findings of Mishra (1983) [11] and Mishra *et al*. (2006) [12].

Table 5: Categorization of sweet potato germplasm baesd on tuberization depth during *Kharif*, 2021

S. No.	Grade	Range (cm)	Germplasm
1.	Shallow rooted	5	-
2.	Medium rooted	5-10	TSP-16-3, TSP-16-5, TSP-16-6, TSP-16-9, Local, ST - 14
3.	Deep rooted	> 10	TSP-16-7, TSP-16-10

The vine thickness of different germplasm ranged from 1.42 cm to 2.16 cm with minimum and maximum in the germplasm ST-14 and TSP-16-7, respectively (Table-6). It indicated that the germplasm having a thick vine exhibited minimum tuber infestation while the germplasm having a thin vine recorded maximum tuber infestation while the remaining germplasm exhibited intermediate positions between the two. It indicated that thin vine facilitated egg-laying to the adults as well as downward movement of the grub in the tuber due to loosely arranged vascular bundle in the vines and thus provided the least resistance to the pest. Reddy (2020) reported that the vine thickness of various genotypes of sweet potato varied from 1.0 cm to 2.13 cm with minimum and maximum in the genotypes V5-440127 and V8-TSP-16-3, respectively. Singh *et al*. (1987) [18] also found a negative correlation between the thickness of vine and weevil infestation.

Table 6: Vine thickness of different germplasm of sweet potato during *Kharif*, 2021

S. No.	Germplasm	Thickness (cm)
1.	TSP-16-3	1.56
2.	TSP-16-5	1.50
3.	TSP-16-6	1.52
4.	TSP-16-7	2.16
5.	TSP-16-9	1.55
6.	TSP-16-10	1.58
7.	ST-14	1.42
8.	Local	1.52

The highest dry matter percentage was recorded in the case of the TSP-16-7 germplasm (42.33) and the lowest in TSP-16-5(30.29) (Table-7). This result confirms the findings of Mansaray *et al*. (2015) who observed that the percentage of dry matter vary significantly ($P< 0.05$) across sweet potato cultivar with slipot 4 recording the highest dry matter content followed by slipot 3 while slipot 2 recorded the least across the two cropping season. Furthermore, a strong significant negative correlation ($r = -0.91$, $P = 0.0001$) was recorded between dry matter content and the number of tubers damaged by the sweet potato weevil. It showed that increased dry matter content of cultivar results in a decrease in susceptibility of that cultivar to *C. puncticollis*as in the case for slipot 4. Singh *et al*. (1993) studied on dry matter content of various cultivars, variety Cross-4 showed the highest dry matter content (34.19%) in vines and also revealed the maximum infestation (41.28%) but the tubers possessed the lowest dry matter content (24.32%). Antiaobong and Bassey (2008) [2] stated that high dry matter content was among the important factors for the selection of sweet potatoes and serves as an indicator of the adaptability of the crop to local conditions.

Table 7: Percentage dry matter content of different sweet potato Germplasm against sweet potato weevil (*Cylas formicarius* Fab.) during *Kharif*, 2021

S. No.	Germplasm	Dry matter content (%)
1.	TSP-16-3	36.29
2.	TSP-16-5	30.29
3.	TSP-16-6	36.06
4.	TSP-16-7	42.33
5.	TSP-16-9	32.03
6.	TSP-16-10	39.93
7.	ST-14	32.76
8.	Local	40.18
S.Em(±)		1.343
C.D. (5%)		4.073

The vine infestation and tuber infestation were minimum in germplasm TSP-16-7 which recorded the highest marketable tuber yield of 24.86 t ha^{-1} (Table-8). Whereas vine infestation and tuber infestation were maximum in germplasm ST-14 which recorded a marketable tuber yield of 13.82 t ha^{-1}. Singh and Sharma (2003) [20], found that there was a positive relationship between vine and tuber damage percentage and marketable tuber yield. Desai *et al*. (2013) [7] found that the tubers of genotype CIP SWA-2 had lower tuber damage (3.54%) with tuber yield of 22.35 t ha^{-1} in comparison to genotype ST-14 in which tuber damage was 4.21% and tuber yield of 18.69 t ha^{-1}.The present findings were also strongly supported by Singh *et al*. (1987) [18] and Mishra *et al*. (2006) [12].

Table 8: Performance of sweet potato Germplasm based on vine infestation (%), mean tuber infestation (%), weevil incidence (%) and marketable tuber yield (t/ha) against sweet potato weevil (*Cylas formicarius* Fab.) during *Kharif*, 2021

S. No.	Germplasm	Vine infestation (%)	Mean tuber infestation (%)	Weevil Incidence (%)	Marketable tuber yield (t/ha)
1.	TSP-16-3	21.73	14.13	21.93	11.64
2.	TSP-16-5	31.53	18.71	26.65	0.80
3.	TSP-16-6	24.45	17.70	22.15	10.51
4.	TSP-16-7	14.43	10.87	11.25	24.86
5.	TSP-16-9	25.51	15.49	25.49	0.67
6.	TSP-16-10	18.95	12.27	13.08	20.07
7.	ST-14	38.51	28.53	38.01	13.82
8.	Local	34.50	24.38	35.26	15.89
S.Em(±)		0.992	1.229	1.804	1.141
C.D. (5%)		3.009	3.727	5.471	3.460

The lowest weevil incidence (11.25%) was observed in germplasm TSP-16-7 which recorded the highest marketable tuber yield of 24.86 t ha^{-1}(Table-9). Whereas mean per cent weevil incidence was the highest (38.01) in germplasm ST-14 which recorded the lowest marketable tuber yield of 13.82 t ha^{-1} as compared with local which recorded mean per cent weevil incidence as 35.26 per cent and marketable tuber yield as 15.89 t ha^{-1}. Allolli *et al.* (2012) [1] reported that per cent weevil infestation varied with different genotypes, the highest being in HUB-1 (53.72), while the lowest infestation was recorded in HUB-12 (9.88). Thriveni *et al.* (2019) [24] reported that the lowest per cent of weevil incidence was noticed in TSP-16-3 on 4 and 8 DAS (5.05 and 13.20, respectively).

Table 9: Categorization of sweet potato Germplasm into different resistant / susceptible groups during *Kharif*, 2021

Grade	Percent incidence	Reaction	Germplasm
0	0	Highly resistant	-
1	1-20	Resistant	TSP-16-7, TSP-16-10
2	20-40	Moderately resistant	TSP-16-3, TSP-16-5, TSP-16-6, TSP-16-9, ST-14, Local
3	40-60	Moderately Susceptible	-
4	60-80	Susceptible	-
5	80	Highly susceptible	-

Acknowledgments

Authors express sincere thanks to the Head, Department of Entomology; Dean, Rajasthan College of Agriculture and Director of Research, MPUAT, Udaipur for providing necessary facilities and encouragement for research.

References

1. Allolli TB, Imamsaheb SJ, Soumya Shetty, Athani SI. Evaluation of different sweet potato [*Ipomoea batatas* (L.) Lam] genotypes for growth yield and sweet potato weevil Incidence. The Asian Journal of Horticulture. 2012;7(2):281-286.
2. Antiaobong EE, Bassey EE. Constraints and prospects of sweet potato (*Ipomoea batatas* (L) Lam) production in humid environment of southeastern Nigeria. Proceedings of the Second African Regional Conference on Sustainable Agriculture, held at the Governor's office Annex, Uyo, Nigeria. 2008;2(3):68-72.
3. Benjamin ACB. Sweet potato: a review of its past, present and future role in human nutrition. Advances in Food and Nutrition Research. 2007;52:1-59. doi:10.1016/S1043-4526(06)52001-7.
4. Chalfant RB, Jansson RK, Seal DR, Schalk JM. Ecology and management of sweet potato insects. Annual review of entomology. 1990;35(1):157-180.
5. CIP. CIP Annual Report 2017. Harnessing potato and sweet potato's power for food security, nutrition and climate resilience. Lima, Peru. International Potato Center, 2018, 14 p.
6. Cockerham KL, Harrison PK. New sweet potato seedlings that appear resistant to sweet potato weevil attack. Journal of Economic Entomology. 1952;45:132.
7. Desai KD, Saravaiya SN, Patel NB, Padhiar BV, More SJ, Tekale GS. Evaluation of orange-fleshed sweet potato genotypes (*Ipomoea batatas*L.) under south Gujarat conditions. Journal of Root Crops. 2013;39(2):232-233.
8. Leuschner K. Screening for sweet potato weevil resistance. Proc. International Society for Tropical Root Crops. 1979;5:25-30.
9. Loebenstein G, Thottappilly G. The Sweetpotato: Book. Springer Publisher. January, 2009. DOI: 10.1007/978-1-4020-9475-0. ISBN: 978-1-4020-9474-3.
10. Mansaray A, Sundufu AJ, Yilla K, Fomba SN. Evaluation of cultural control practices in the management of sweet potato weevil (*Cylaspuncticollis*) Boheman (Colepotera: Curculionidae). *Q Science Connect*, 2013, 44: doi: 10.5339/connect.2013.44.
11. Mishra AK. Bionomics, host resistance, and control of sweet potato weevil (*Cylasformicalis* Fab.), M.Sc. (Agri.) Thesis, Rajendra Agricultural University, Pusa, India, 1983.
12. Mishra AK, Singh SPN, Pandey IB, Singh RS. Effect of agronomic components and mass trapping for the management of sweet potato weevil (*Cylasformicalis* Fab.). Journal of Root Crops. 2006;32(2):180-186.
13. Netam RS, Netam CR, Nanda HC, Kumar S. Screening of sweet potato germplasm for weevil (*Cylas formicarius*) under rainfed condition of Bastar.

International Journal of Plant Protection. 2008;1(2):73-75.
14. Prakash P, Kishore, Avinash, Roy, Devesh, Debdutt B. Economic analysis of sweet potato farming and marketing in Odisha. Journal of Root Crops. 2016;42(2):163-167
15. Prakash P, Kishore, Avinash, Roy, Devesh, Behurac, Debdutt, Immanuela, Sheela. Biofortification for reducing hidden hunger: A value chain analysis of sweet potato in Odisha, India. Agricultural Economics Research Review. 2017;30(2):201-211.DOI: 10.5958/0974-0279.2017.00042.8.
16. Rajamma P. Effect of some organic materials on the control of sweet potato weevil *Cylas formicarius* Fab. Journal of Root Crops. 1982;8(1-2):64-65.
17. Reddy ND. Studies on population dynamics, varietal screening and management of sweet potato weevil (*Cylas formicarius*) M.Sc. Thesis in Entomology, Dr. Rajendra Prasad Central Agricultural University Pusa (Samastipur), 2020.
18. Singh B, Yazdani M, Hameed SF. Source of resistance to *Cylas formicarius* (Fab) in sweet potato. Indian Journal of Entomology. 1987;49(3):414-419.
19. Singh B, Yazdani SS, Singh R. Relationship between biochemical constituents of sweet potato cultivars and resistance to weevil (*Cylas formicarius* Fab.) damage. Journal of Entomological Research. 1993;17:283-288.
20. Singh VK, Sharma RC. Varietal susceptibility of sweet potato germplasm against sweet potato weevil, *Cylas formicarius*. Indian Journal of Entomology. 2003;65(1):24-27.
21. Smit NEJM. Integrated Pest Management for Sweetpotato in Eastern Africa. (Thesis Land bouwuniversiteit Wageningen), 1997.
22. Strong LA. Report of the Chief of the Bureau of Entomology and Plant Quarantine, U.S. Dept. Agr., Washington, DC, 1936. 84 pp.
23. Sutherland JA. Damage by *Cylas formicarius* Fab. To sweet potato vines and tubers, and the effect of infestations on total yield in Papua New Guinea. International Journal of Pest Management. 1986;32(4):316-323.
24. Thriveni N, RamachandraNaik K, Laxman Kukanoor, Mnjula Karadiguddi, Deepa Terdal, Kamble CS. Studies on keeping quality and proximate composition of different orange fleshed sweet potato (*Ipomoea batatas* L.) genotypes under ambient storage. Journal of Pharmacognosy and Phytochemistry. 2019;8(5):692-696.