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RESEARCH ARTICLE

Comparative Study of Sapota Varieties and Hybrids for Tolerance and Susceptibility against Seed Borer (*Trymalitis margarias* Meyrick)

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Abstract

The performance of 23 sapota varieties/hybrids was tested for their ability to withstand seed borer *Trymalitis margarias* Meyrick at Fruit Research Station, Navsari Agricultural University, Gandevi, Gujarat. The varietal deviation for five consecutive years (2015-16 to 2019-20) showed that Kirthibarthi had a higher fruit infestation of 7.47% than the standard check Kalipatti (6.89%), as well as being more sensitive to DHS-2 (6.58%), CO-2 (6.56%), and Cricket balls (5.89%). In contrast, Chala collection-1, Chala collection-3, Chala collection-2, Zumakhiya, CO-3 and CO-1, all exhibited infestation level less than 4%. Fruit damage intensity was highest during the initial phase of fruit harvesting in December, reaching 8.64, 7.94, and 7.67% in Kirthibarthi, Kalipatti, and CO-2, respectively. Nonetheless, DHS-2 (8.54%) and Cricket ball (6.97%) suffered the most damage in February during the middle phase of fruit harvesting. However, a non-significant correlation was revealed between seed morphology *viz.*, length, width and thickness, as well as eight biochemical contents of the seed and pest infestation. Due to late flowering and ultimately fruiting initiation, escape-type resistance was seen in less damaged sapota varieties/hybrids.

Keywords: Hybrids, Sapota, Seed borer, *Trymalitis margarias*, Varieties

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Introduction

Sapota is a crucial tropical fruit in India, with South Gujarat districts of Navsari, Valsad, and Surat accounting for nearly half of the state's sapota production (Anonymous, 2018). Pest interference during the peak flowering and fruiting phase is mainly a concern with the productivity of sapota due to long, asymmetrical and overlapping flowering and fruiting bearing patterns. About 33 insect pests in India and 23 in Gujarat are responsible for significant losses in sapota yield and quality, among different factors (Bisane *et al.,* 2018). Among pests affecting sapota, seed borer, *Trymalitis margarias* Meyrick (Lepidoptera: Tortricidae) has emerged as a serious threat, particularly at the peak fruiting stage. This pest directly damage the seeds, causing deterioration in fruit quality, which affects both domestic sales and export potential. The seed borer is an exotic pest, first detected in India 2000 (Patel, 2001) and now established in major sapota-growing regions, including Gujarat, Maharashtra, Tamil Nadu, Karnataka, and Chhattisgarh (Bisane *et al.,* 2018). The pest caused a significant 40% fruit damage after its initial detection in 2003-04 (AICRP Report, 2004), and continues to cause up to 15% fruit loss in parts of

Gujarat (Bisane, 2016;Bisane and Naik, 2021). Among other regions, fruit loss of 5-10% was noted during December-February in Tamil Nadu (AICRP Report, 2015 and 2016), as well as higher infestation between 30-50% reported from different parts of Karnataka (Kalpana, 2003; Jayanthi and Verghese, 2007 and Patil *et al.,* 2020).

In Gujarat, the Kalipatti variety is preferred by growers for its quality and taste; however, there is a lack of research on how different sapota varieties perform in terms of resistance to seed borer damage. The study aims to fill the knowledge gap regarding varietal resistance/susceptibility to seed borer, which could help mitigate the pest's impact and improve sapota production in affected regions. The findings could guide growers in selecting resistant varieties and contribute to reducing fruit losses due to this pest.

Materials and Methods

The research aims to explore and compare the resistance/susceptibility of various sapota varieties/hybrids to seed borer, *T. margarias* in South Gujarat context was carried out for five consecutive years from 2015-16 to 2019-20 in germplasm plot of ICAR-AICRP (Fruits), Fruit Research Station, Navsari Agricultural University, Gandevi, Gujarat (20.807545° N 73.022260° E). The pest seasonal occurrence based on fruit damage on 23 varieties/hybrids of sapota with many have IC numbers *viz*., PKM-1 (IC-395173), PKM-2 (IC-395184), PKM-3 (IC-395181), PKM-4, PKM-5, CO-1 (IC-395166), CO-2 (IC-395167), CO-3 (IC-395182), DHS-1 (IC-395174), DHS-2 (IC-395183), Murabba (IC-614619), Mohangoottee (IC-395157), Zumakhiya (IC-395159), Bhuripatti, Pilipatti (IC-395155), Cricket ball, (IC-395153) Singapore (IC-395178), Kirthibirthi (IC-395160), Paria Collection, Chala collection-1, Chala collection-2, Chala collection-3 and Kalipatti (IC-395179) was screened on three replicated trees planted at normal 10 m × 10 m spacing. The varieties/hybrids depicting PKM series developed at HC & RI, TNAU, Periyakulam; CO series at TNAU, Coimbatore (Tamil Nadu) and naming DHS developed at UHS, Bagalkot (Karnataka), while others are selected local collections from Navsari and Valsad districts of Gujarat. Kalipatti is considered a standard check to test the differences among them. The trial plot was kept free from any insecticidal spray during the screening phase.

In the sapota orchard, 100 fruits of each variety/hybrid from each tree were selected at every harvesting scheduled from November to April for the incidence of seed borer. The damaged fruits were counted out of 100 fruits to calculate per cent of fruit infestation. The average damage of all six month-wise observations was statistically analyzed in a random block design with three replications (one tree as one replication). Both yearly average and peak damage intensity were considered to decide the tolerance and susceptibility level. Also, the damage difference response of different varieties/hybrids over Kalipatti was calculated to check the susceptibility/ tolerance level.

$$\% \text{ Variation} = \frac{\% \text{ Damage in variety} - \% \text{ Damage in standard check}}{\% \text{ Damage in standard check}} \times 100$$

The fruit damage of different sapota varieties/hybrids was used to categorise the susceptibility/resistance scale against seed borer into six groups. For this purpose, the average per cent fruit damage value of individual varieties/hybrids (Xi) was compared with the grand mean per cent value of all varieties/hybrids (X) and standard deviation (SD) by using the following statistical formula (Gupta and Kapoor, 1997).

Category		Scale formula
Highly Resistant	HR	$Xi \leqslant (X - 2\,SD)$
Resistant	R	$(X - SD) \geqslant Xi > (X - 2\,SD)$
Moderately Resistant	MR	$X \geqslant Xi > (X - SD)$
Moderately Susceptible	MS	$X < Xi \leqslant (X + SD)$
Susceptible	S	$(X + SD) < Xi \leqslant (X + 2\,SD)$
Highly Susceptible	HS	$Xi > (X + 2\,SD)$

For correlation matrix analysis for seed morphology, 10 seeds were sampled randomly from ripened fruits of different varieties/hybrids and measured for length, width, and thickness. Additionally, the standard deviation was computed in order to evaluate the relevance. The eight biochemical contents *viz*., crude protein, total carbohydrate, reducing sugar, non-reducing sugar, total soluble sugar, crude fibre, total phenol, and lipid from seed, were quantified at Food Quality Testing Laboratory, N. M. College of Agriculture, NAU, Navsari to confirm a correlation with fruit damage.

Results

The freshly hatched larvae of seed borer, *T. margarias* build pathways through the fruit pulp and bore holes in

the marble-sized fruit's surface. Infested fruits do not exhibit any outward signs of seed borer damage. The only indication of pest damage is a tiny exit hole, and the mature larvae escape from the infested fruit after finishing feeding on the seed cotyledon (Bisane, 2016). Table 1 to 4 shows the results of five consecutive fruit harvesting seasons' worth of sapota varieties/hybrids evaluation against the seed borer.

During the first year (2015-16), Kirthibarthi (9.23%), CO-2 (8.91%), and DHS-2 (7.26%) had substantially higher annual average fruit damage than Kalipatti (6.72%) and exhibited 8.01–37.29% more susceptibility response (Table 1). However, Chala collection-1, PKM-4 Chala collection-3, and Singapore all found lower mean fruit damage than 4% and had 41.27–58.04% lower vulnerability reactions than Kalipatti. Kirthibarthi (13.56%) and CO-2 (11.94%) had the most fruit damage in November, whereas Kalipatti (10.33%) had the most fruit infestation in December at the beginning of fruit harvesting. In contrast, DHS-2 (12.67%) experienced the most serious damage in February, which was the middle of the fruit harvest.

During the succeeding second year of 2016-17 (Table 1), the higher average fruit damage was recorded in DHS-2 (6.87%), Kirthibarthi (6.12%), Cricket ball (5.69%) than Kalipatti (5.31%) and these varieties/ hybrids had 7.11 to 29.42% more susceptibility response than Kalipatti. However, CO-3 (2.57%), Chala collection-1 (2.60%), CO-1 (2.78%), and Zumakhiya (3.02%) had the minimum mean fruit loss with 43.14-51.64% less susceptibility response than Kalipatti. During April, fruit damage intensity reached its highest in DHS-2 (9.88%), Murabba (8.33%) and DHS-1 (8.08%) at the end of fruit harvesting. While Kirthibarthi (6.67%) had the highest fruit damage in November, and Kalipatti (6.00%) in December at the early fruiting stage.

In the subsequent third year of 2017-18 (Table 2), the yearly mean higher fruit loss was recorded in Kirthbarthi (6.96%) than Kalipatti (6.22%) and also statistically similar to Cricket ball (5.99%), DHS-2 (5.75%) and CO-2 (5.69%). Here, Kirthbarthi was found nearly 11.78% more susceptible than Kalipatti; however, Cricket ball, DHS-2 and CO-2 were only 3.81-8.54% less susceptible. However, the mean lower fruit damage was recorded in Chala collection-3 (2.41%), Chala collection-1 (2.45%), PKM-3 (2.71%), CO-3 (2.75%) and CO-1 (2.82%), which showed 54.74 to 61.27% less receptiveness reaction over Kalipatti. Unlike the earlier two seasons, the fruit damage reached its highest in December only during 2017-18 in susceptible varieties/hybrids *viz.*, Kirthbarthi (8.33%), Kalipatti (7.00%), CO-2 (6.57%), Cricket ball (6.56%) and DHS-2 (6.33%) at the initial phase of fruit harvesting.

In 2018-19 (IV year), seed borer caused higher fruit damage in Kalipatti (8.39%), after that in Kirthibharti (7.42%), DHS-2 (6.53%), CO-2 (6.16%) and Paria collection (6.03%) and were only 11.57-28.15% less susceptible than Kalipatti (Table 2). While the lower damage of marketable fruits was observed in Chala collection-2 (1.63%), Chala collection-3 (2.09%), CO-3 (2.26%) and Chala collection-1 (2.38%) and showed 71.65 to 80.53% less receptiveness reaction over Kalipatti. The maximum infestation was observed during December in Kalipatti (9.44%), Kirthibharti (9.15%), CO-2 (8.52%) and Paria collection (7.33%), as well as during February in DHS-2 (8.43%).

In the fifth year (2019-20), the average fruit damage was higher in CO-2 (7.88%), closely by Kalipatti (7.80%), Kirthibharti (7.64%), Cricket Ball (6.57%), DHS-2 (6.50%), and Paria collection (6.40%) (Table 3). Among them, CO-2 was found to be 0.97% more susceptible than Kalipatti; however, Kirthibharti, Cricket Ball, DHS-2, and Paria collection exhibited only 2.05-18.01% less susceptibility, performing similarly to the standard check. In contrast, the lower damage was observed in Chala Collection-2 (2.08%), Chala Collection-1 (2.25%), Chala Collection-3 (2.34%), Zumakhiya (2.65%), and Singapore (2.78%) and demonstrated significantly lower receptiveness of 64.42-73.35% than Kalipatti. Peak infestation was noted in February, particularly in Kirthibharti (10.68%), CO-2 (10.37%) and Cricket Ball (9.52%). Similarly, in March, Kalipatti (10.33%) and DHS-2 (8.58%) showed significant damage during the advanced fruiting phase.

In pooled data spanning five years (Table 3), Kirthibarthi had the highest average seed borer infestation (7.47%), followed by Kalipatti (6.89%). The varieties DHS-2 (6.58%), CO-2 (6.56%), Cricket ball (5.89%), and Paria collection (5.35%) also showed relatively high infestation, indicating their susceptibility to seed borer. Here, Kirthibarthi exhibited up to 8.48% higher susceptibility to seed borer compared to Kalipatti and closer to DHS-2 and CO-2, which showed decreased vulnerability with 4.45-4.77% lesser infestation rates compared to the standard check. Meanwhile, the Cricket ball and Paria collection were 14.53-22.34% less susceptible than Kalipatti. In contrast, varieties Chala collection-1 (2.50%), Chala collection-3 (2.75%), Chala collection-2 (2.94%), Zumakhiya (3.21%), CO-3 (3.24%), and CO-1 (3.30%) experienced significantly lower infestation levels, demonstrating better resilience to seed borer with overall 52.11 to 63.70% less susceptibility response than Kalipatti.

Table 1: Performance of different varieties/hybrids of sapota against seed borer (I and II year)

Treat-ment	Varieties/ hybrids	(I year- 2015-16)					(II year- 2016-17)				
		Avg. % fruit damage*	Max. fruit damage (%)	Max. activity month	Min. fruit damage (%)	Per cent variation over Kalipatti	Avg. % fruit damage*	Max. fruit damage (%)	Max. activity month	Min. fruit damage (%)	Per cent variation over Kalipatti
T_1	PKM-1	4.80 (2.28)	6.33	December	3.33	-28.56	4.72 (2.26)	7.08	April	3.24	-11.05
T_2	PKM-2	4.37 (2.17)	5.68	November	2.50	-35.05	3.79 (2.06)	5.22	January	2.80	-28.59
T_3	PKM-3	4.14 (2.13)	6.39	November	2.61	-38.43	3.95 (2.05)	7.66	April	2.44	-25.61
T_4	PKM-4	3.50 (1.98)	4.57	November	2.80	-47.97	3.74 (2.00)	7.90	April	1.89	-29.53
T_5	PKM-5	4.43 (2.21)	5.87	November	3.73	-34.07	3.58 (1.99)	5.85	April	2.30	-32.54
T_6	CO-1	4.61 (2.20)	7.00	December	2.53	-31.40	2.78 (1.80)	3.19	December	2.33	-47.70
T_7	CO-2	8.91 (3.00)	11.94	November	3.11	32.51	4.16 (2.14)	5.46	November	2.50	-21.60
T_8	CO-3	4.91 (2.26)	7.67	December	2.78	-26.90	2.57 (1.73)	3.17	December	1.98	-51.64
T_9	DHS-1	4.44 (2.19)	5.64	November	2.17	-33.92	3.84 (2.02)	8.08	April	2.05	-27.59
T_{10}	DHS-2	7.26 (2.71)	12.67	February	3.33	8.01	6.87 (2.69)	9.88	April	4.00	29.42
T_{11}	Murabba	4.50 (2.19)	7.33	December	2.50	-33.04	4.88 (2.27)	8.33	April	2.17	-8.01
T_{12}	Mohangootee	4.74 (2.24)	7.67	November	2.90	-29.41	4.03 (2.07)	6.63	April	1.70	-24.10
T_{13}	Zumakhiya	4.05 (2.09)	5.67	April	2.24	-39.76	3.02 (1.86)	4.33	April	2.17	-43.14
T_{14}	Bhuripatti	4.06 (2.09)	6.33	December	2.07	-39.57	3.64 (2.02)	4.84	December	2.78	-31.34
T_{15}	Pilipatti	4.68 (2.24)	7.10	December	2.55	-30.38	3.25 (1.92)	4.35	January	2.24	-38.79
T_{16}	Cricket ball	5.99 (2.48)	8.61	December	2.61	-10.88	5.69 (2.47)	6.06	December	5.22	7.11
T_{17}	Singapore	3.95 (2.07)	4.89	April	2.19	-41.27	3.83 (2.04)	5.42	April	1.67	-27.81
T_{18}	Kirthibarthi	9.23 (3.05)	13.56	November	4.67	37.29	6.12 (2.56)	6.67	November	5.00	15.27
T_{19}	Paria coll.	4.61 (2.21)	6.92	November	1.96	-31.48	4.90 (2.30)	6.52	April	3.11	-7.76
T_{20}	Chala coll.-1	2.82 (1.80)	3.17	December	2.22	-58.04	2.60 (1.74)	3.98	December	1.90	-51.01
T_{21}	Chala coll.-2	4.26 (2.14)	5.60	December	2.45	-36.61	3.53 (1.99)	4.60	February	2.62	-33.44
T_{22}	Chala coll.-3	3.62 (1.99)	4.80	April	2.74	-46.16	3.30 (1.93)	5.05	April	2.21	-37.75
T_{23}	Kalipatti	6.72 (2.64)	10.33	December	3.00	--	5.31 (2.41)	6.00	December	4.33	--
CD	T	0.21	--	--	--	--	0.16	--	--	--	--
at	M	0.11	--	--	--	--	0.08	--	--	--	--
5%	TxM	0.51	--	--	--	--	0.39	--	--	---	-
CV%		13.90	--	--	--	--	11.47	--	--	--	--

* Figures in parenthesis are (x+0.5) square root transformed values. T = Treatments, M = Month.

Table 2: Performance of different varieties/hybrids of sapota against seed borer (III and IV year)

Treat-ment	Varieties/ hybrids	(III year- 2017-18)					(IV year- 2018-19)				
		Avg. % fruit damage*	Max. fruit damage (%)	Max. activity month	Min. fruit damage (%)	Per cent variation over Kalipatti	Avg. % fruit damage*	Max. fruit damage (%)	Max. activity month	Min. fruit damage (%)	Per cent variation over Kalipatti
T_1	PKM-1	3.62 (2.00)	5.11	April	2.25	-41.90	4.12 (2.13)	5.14	April	2.73	-50.84
T_2	PKM-2	3.21 (1.90)	4.67	April	1.83	-48.47	3.46 (1.97)	4.68	March	2.50	-58.68
T_3	PKM-3	2.71 (1.77)	4.19	April	2.11	-56.41	2.85 (1.80)	3.93	April	1.98	-66.07
T_4	PKM-4	3.25 (1.86)	5.21	April	1.57	-47.80	3.05 (1.85)	3.67	April	1.94	-63.65
T_5	PKM-5	3.43 (1.90)	5.31	April	1.59	-44.89	2.87 (1.74)	4.82	March	0.95	-65.76
T_6	CO-1	2.82 (1.79)	3.83	December	1.85	-54.74	2.65 (1.72)	3.93	December	1.94	-68.43
T_7	CO-2	5.69 (2.47)	6.57	December	4.39	-8.54	6.16 (2.56)	8.52	December	5.24	-26.52
T_8	CO-3	2.75 (1.72)	4.46	March	1.31	-55.83	2.26 (1.59)	3.38	December	1.08	-73.09
T_9	DHS-1	3.56 (1.99)	4.58	April	2.58	-42.87	3.86 (2.06)	5.23	February	2.34	-54.00
T_{10}	DHS-2	5.75 (2.49)	6.33	December	4.67	-7.59	6.53 (2.63)	8.43	February	0.00	-22.16
T_{11}	Murabba	4.16 (2.14)	5.22	December	2.50	-33.09	4.37 (2.18)	6.27	February	2.69	-47.88
T_{12}	Mohangootee	4.37 (2.18)	6.22	December	3.00	-29.79	4.14 (2.13)	4.90	February	2.98	-50.67
T_{13}	Zumakhiya	3.63 (2.01)	4.22	March	2.93	-41.62	2.72 (1.76)	3.43	March	1.47	-67.57
T_{14}	Bhuripatti	4.10 (2.13)	5.56	December	3.25	-34.07	3.53 (1.99)	4.45	December	2.33	-57.96
T_{15}	Pilipatti	4.11 (2.14)	5.00	December	3.31	-33.96	3.83 (2.05)	5.26	December	3.07	-54.37
T_{16}	Cricket ball	5.99 (2.54)	6.56	December	5.33	-3.81	5.21 (2.30)	6.41	December	4.55	-37.92
T_{17}	Singapore	4.19 (2.15)	5.67	April	2.83	-32.69	3.77 (2.04)	4.48	March	2.52	-55.10
T_{18}	Kirthibarthi	6.96 (2.72)	8.33	December	5.97	11.78	7.42 (2.80)	9.15	December	6.45	-11.57
T_{19}	Paria coll.	4.82 (2.29)	6.22	December	3.67	-22.51	6.03 (2.54)	7.33	December	5.14	-28.15
T_{20}	Chala coll.-1	2.45 (1.67)	3.69	December	1.37	-60.63	2.38 (1.67)	3.55	March	1.56	-71.65
T_{21}	Chala coll.-2	3.20 (1.84)	4.81	December	2.17	-48.66	1.63 (1.36)	2.27	March	0.61	-80.53
T_{22}	Chala coll.-3	2.41 (1.61)	4.44	April	1.43	-61.27	2.09 (1.48)	3.56	March	1.03	-75.05
T_{23}	Kalipatti	6.22 (2.58)	7.00	December	5.33	--	8.39 (2.96)	9.44	December	6.56	--
CD	T	0.22	--	--	--	--	0.26	--	--	--	--
at	M	0.11	--	--	--	--	0.13	--	--	--	--
5%	TxM	NS	--	--	--	--	NS	--	--	--	--
	CV%	16.21	--	--	--	--	19.16	--	--	--	--

* Figures in parenthesis are (x+0.5) square root transformed values. T = Treatments, M = Month.

Table 3: Performance of different varieties/hybrids of sapota against seed borer (V year and Pooled)

Treat-ment	Varieties/ hybrids	(V year- 2019-20)					5 years pooled				
		Avg. % fruit damage*	Max. fruit damage (%)	Max. activity month	Min. fruit damage (%)	Per cent variation over Kalipatti	Avg. % fruit damage*	Max. fruit damage (%)	Max. activity month	Min. fruit damage (%)	Per cent variation over Kalipatti
T_1	PKM-1	3.80 (2.03)	5.71	March	1.45	-51.32	4.21 (2.14)	5.14	April	3.31	-38.85
T_2	PKM-2	3.07 (1.83)	4.64	April	1.14	-60.71	3.58 (1.99)	4.36	March	3.01	-48.05
T_3	PKM-3	4.65 (2.21)	8.59	April	2.38	-40.45	3.66 (1.99)	5.53	April	2.72	-46.89
T_4	PKM-4	3.64 (2.02)	4.75	February	2.33	-53.29	3.44 (1.94)	4.74	April	2.46	-50.12
T_5	PKM-5	4.58 (2.23)	6.33	April	3.38	-41.36	3.78 (2.01)	5.09	April	2.82	-45.16
T_6	CO-1	3.64 (2.01)	4.92	February	2.33	-53.33	3.30 (1.90)	4.38	December	2.59	-52.11
T_7	CO-2	7.88 (2.86)	10.37	February	4.03	0.97	6.56 (2.61)	7.67	December	5.83	-4.77
T_8	CO-3	3.71 (2.02)	5.02	April	2.53	-52.44	3.24 (1.87)	3.78	December	2.62	-52.97
T_9	DHS-1	3.99 (2.09)	4.92	February	2.37	-48.92	3.94 (2.07)	4.92	April	2.68	-42.85
T_{10}	DHS-2	6.50 (2.60)	8.58	March	3.06	-16.69	6.58 (2.62)	8.54	February	5.38	-4.45
T_{11}	Murabba	3.29 (1.90)	5.24	February	1.39	-57.83	4.24 (2.13)	4.94	December	3.19	-38.42
T_{12}	Mohangootee	2.95 (1.83)	4.33	February	1.45	-62.15	4.05 (2.09)	4.85	December	2.98	-41.25
T_{13}	Zumakhiya	2.65 (1.70)	4.42	February	0.67	-66.04	3.21 (1.88)	3.99	April	2.62	-53.34
T_{14}	Bhuripatti	3.51 (1.96)	4.58	February	2.22	-55.04	3.77 (2.04)	4.74	December	3.27	-45.29
T_{15}	Pilipatti	3.68 (1.98)	5.24	April	1.22	-52.85	3.91 (2.07)	4.42	December	3.44	-43.25
T_{16}	Cricket ball	6.57 (2.62)	9.52	February	3.79	-15.82	5.89 (2.48)	6.97	February	5.08	-14.53
T_{17}	Singapore	2.78 (1.76)	4.43	February	1.22	-64.42	3.70 (2.01)	4.60	April	2.67	-46.26
T_{18}	Kirthibarthi	7.64 (2.81)	10.68	February	3.79	-2.05	7.47 (2.79)	8.64	December	6.35	8.48
T_{19}	Paria coll.	6.40 (2.54)	8.59	April	2.06	-18.01	5.35 (2.38)	6.02	December	4.45	-22.34
T_{20}	Chala coll.-1	2.25 (1.64)	2.79	February	1.86	-71.13	2.50 (1.7)	2.97	December	2.26	-63.70
T_{21}	Chala coll.-2	2.08 (1.48)	3.25	February	1.31	-73.35	2.94 (1.76)	3.47	February	2.40	-57.32
T_{22}	Chala coll.-3	2.34 (1.56)	3.02	February	1.79	-69.99	2.75 (1.72)	3.65	April	2.22	-60.02
T_{23}	Kalipatti	7.80 (2.83)	10.33	March	3.31	--	6.89 (2.69)	7.94	December	6.04	--
CD	T	0.26	--	--	--	--	0.10	--	--	--	--
at	M	0.13	--	--	--	--	0.05	--	--	--	--
5%	Y	--	--	--	--	--	0.05	--	--	--	--
	TxM	NS	--	--	--	--	0.25	--	--	--	--
	TxY	--	--	--	--	--	0.22	--	--	--	--
	MxY	--	--	--	--	--	0.11	--	--	--	--
	TxMxY	--	--	--	--	--	NS	--	--	--	--
CV%		18.59	--	--	--	--	16.11	--	--	--	--

* Figures in parenthesis are (x+0.5) square root transformed values. T = Treatments, M = Month.

December had the highest fruit damage intensity during the initial phase of fruit harvesting. Damage levels peaked in Kirthibarthi (8.64%), Kalipatti (7.94%), CO-2 (7.67%), and Paria collection (6.02%) (Table 4).

For DHS-2 (8.54%) and Cricket ball (6.97%), peak damage was recorded in February, aligning with the middle of the harvest season. The higher infestation due to seed borer was recorded mostly in December and a few in April among all varieties/hybrids (Table 5). In December, a maximum of 11 varieties/hybrids were

Table 4: Month-wise performance of different varieties/hybrids of sapota against seed borer (5 years pooled)

Treatment	Varieties/ hybrids	Per cent Fruit damage (5 years pooled)					
		Nov.	Dec.	Jan.	Feb.	March	April
T_1	PKM-1	3.31 (1.90)	3.70 (2.01)	3.95 (2.09)	4.18 (2.15)	4.99 (2.33)	5.14 (2.35)
T_2	PKM-2	3.02 (1.82)	3.01 (1.84)	3.33 (1.93)	3.94 (2.08)	4.36 (2.19)	3.81 (2.05)
T_3	PKM-3	3.28 (1.90)	2.95 (1.84)	2.72 (1.77)	3.30 (1.92)	4.17 (2.13)	5.53 (2.39)
T_4	PKM-4	2.46 (1.65)	3.06 (1.87)	3.01 (1.84)	3.42 (1.97)	3.92 (2.08)	4.74 (2.23)
T_5	PKM-5	2.82 (1.71)	3.32 (1.89)	3.39 (1.92)	3.71 (2.03)	4.34 (2.18)	5.09 (2.34)
T_6	CO-1	3.11 (1.84)	4.38 (2.17)	3.67 (1.98)	3.19 (1.90)	2.59 (1.72)	2.85 (1.80)
T_7	CO-2	6.43 (2.58)	7.67 (2.82)	6.49 (2.61)	6.80 (2.61)	6.15 (2.55)	5.83 (2.48)
T_8	CO-3	3.01 (1.78)	3.78 (1.99)	3.39 (1.90)	3.15 (1.89)	3.49 (1.96)	2.62 (1.69)
T_9	DHS-1	3.36 (1.93)	4.00 (2.09)	2.68 (1.76)	4.00 (2.09)	4.66 (2.26)	4.92 (2.30)
T_{10}	DHS-2	5.66 (2.44)	6.74 (2.67)	5.38 (2.39)	8.54 (2.98)	6.67 (2.65)	6.50 (2.60)
T_{11}	Murabba	3.89 (2.03)	4.94 (2.29)	3.19 (1.89)	4.09 (2.11)	4.92 (2.32)	4.42 (2.17)
T_{12}	Mohangootee	4.39 (2.14)	4.85 (2.27)	2.98 (1.84)	3.43 (1.95)	4.40 (2.2)	4.23 (2.13)
T_{13}	Zumakhiya	2.62 (1.67)	3.43 (1.93)	2.69 (1.77)	2.96 (1.84)	3.60 (2.01)	3.99 (2.09)
T_{14}	Bhuripatti	3.55 (1.96)	4.74 (2.26)	3.57 (2.01)	3.27 (1.92)	3.61 (2.00)	3.88 (2.07)
T_{15}	Pilipatti	3.62 (1.97)	4.42 (2.17)	4.16 (2.14)	3.53 (1.99)	3.44 (1.97)	4.28 (2.16)
T_{16}	Cricket ball	5.40 (2.40)	6.88 (2.64)	5.50 (2.39)	6.97 (2.71)	5.08 (2.34)	5.49 (2.42)
T_{17}	Singapore	3.32 (1.90)	4.13 (2.11)	2.67 (1.76)	3.57 (1.99)	3.92 (2.09)	4.60 (2.23)
T_{18}	Kirthibarthi	7.39 (2.74)	8.64 (3.00)	7.86 (2.85)	7.50 (2.81)	7.10 (2.73)	6.35 (2.60)
T_{19}	Paria coll.	4.71 (2.23)	6.02 (2.53)	4.45 (2.19)	5.70 (2.46)	5.26 (2.34)	5.95 (2.51)
T_{20}	Chala coll.-1	2.26 (1.63)	2.97 (1.84)	2.53 (1.72)	2.27 (1.64)	2.41 (1.66)	2.56 (1.74)
T_{21}	Chala coll.-2	2.99 (1.76)	3.12 (1.79)	2.40 (1.62)	3.47 (1.89)	2.71 (1.73)	2.94 (1.79)
T_{22}	Chala coll.-3	2.22 (1.55)	2.65 (1.69)	2.38 (1.62)	2.37 (1.63)	3.26 (1.87)	3.65 (1.95)
T_{23}	Kalipatti	6.04 (2.53)	7.94 (2.89)	6.40 (2.61)	7.13 (2.73)	6.80 (2.65)	7.01 (2.71)
Avg. % fruit damage of the month		3.86	4.67	3.86	4.37	4.43	4.63
CD at 5%	T	0.26	0.25	0.26	0.23	0.24	0.24
	M	0.12	0.12	0.12	0.10	0.11	0.11
	TxM	0.58	0.57	0.58	0.50	0.53	0.54
CV%		17.92	15.97	17.66	14.61	15.15	15.26

* Figures in parenthesis are (x+0.5) square root transformed values. T = Treatments, M = Month.

Table 5: Month-wise trend of seed borer fruit damage in different varieties/hybrids of sapota

Year/Months	Nov.	Dec.	Jan.	Feb.	March	April
2015-16	9	10	-	1	-	3
2016-17	2	6	2	1	-	12
2017-18	-	13	-	-	2	8
2018-19	-	9	-	4	7	3
2019-20	-	-	-	14	3	6
Avg.	-	11	-	3	1	8

Note: Figures in tables indicate no. of varieties/hybrids with peak damage.

infested by seed borer, as well as 8 in April. Other months have less damage intensity. This type of trend was also noted in year-wise screening data, except for 2019-20.

Compared to previous years, a wide variety experienced peak fruit damage later, in March-April, due to a delayed onset of the fruiting season. In month-wise and year-wise fruit damage over the five years, there were significant variations noted, as well as in the mean values across six months of observations. As well, no significant interaction effects were detected when comparing data from 2017-18 to 2019-20. However, the interaction outcome was significant during 2015-16 and 2016-17. The reason for this mismatch could be that the first two years had a higher infestation of seed borer with substantial variation across varieties/hybrids, but the succeeding three years had a decrease in pest incidence, resulting in less dissimilarity.

The outcome of categorization of different varieties/hybrids of sapota based on mean fruit damage by seed borer is depicted in Table 6. In pooled grouping, none of the varieties/hybrids were found highly resistant; however, Chala collection-1 and 3 were ranked as resistant, while 15 varieties/ hybrids were grouped as moderately susceptible. Paria collection was enlisted under the moderately susceptible category, whereas CO-2, DHS-2, Cricket ball and standard check- Kalipatti were enlisted in the susceptible and Kirthibarthi under the highly susceptible category. Like, the scaling classification

Table 6: Categorization of different varieties/hybrids of sapota based on average fruit damage due to seed borer

Scale	2015-16	2016-17	2017-18	2018-19	2019-20	Pooled
Highly Resistant (HR)	--	--	--	--	--	--
Resistant (R)	Chala coll.-1	CO-1, CO-3, Chala coll.-1	PKM-3, CO-3, Chala coll.-1, Chala coll.-3	CO-3, Chala coll.-2 Chala coll.-3	Chala coll.-1, Chala coll.-2, Chala coll.-3	Chala coll.-1, Chala coll.-3
Moderately Resistant (MR)	PKM-1, PKM-2, PKM-3, PKM-4, PKM-5, CO-1, CO-3, DHS-1, Murabba, Mohangootee, Zumakhiya, Bhuripatti, Pilipatti, Singapore, Paria coll., Chala coll.-2, Chala coll. 3	PKM-2, PKM-3, PKM-4, PKM-5, DHS-1, Mohangootee, Zumakhiya, Bhuripatti, Pilipatti, Singapore, Chala coll.-2, Chala coll.-3	PKM-1, PKM-2, PKM-4, PKM-5, CO-1, DHS-1, Zumakhiya, Chala coll. 2	PKM-2, PKM-3, PKM-4, PKM-5, CO-1, DHS-1, Zumakhiya, Bhuripatti, Pilipatti, Singapore, Chala coll.-1	PKM-1, PKM-2, PKM-4, CO-1, CO-3, DHS-1, Murabba, Mohangootee, Zumakhiya, Bhuripatti, Pilipatti, Singapore	PKM-1, PKM-2, PKM-3, PKM-4, PKM-5, CO-1, CO-3, DHS-1, Murabba, Mohangootee, Zumakhiya, Bhuripatti, Pilipatti, Singapore, Chala coll.-2
Moderately Susceptible (HS)	Cricket ball	PKM-1, CO-2, Murabba, Paria coll.	Murabba, Mohangootee, Bhuripatti, Pilipatti, Singapore, Paria coll.	PKM-1, Murabba, Mohangootee, Cricket ball	PKM-3, PKM-5	Paria coll.
Susceptible (S)	DHS-2, Kalipatti	Cricket ball, Kirthibarthi, Kalipatti	CO-2, DHS-2, Cricket ball, Kalipatti	CO-2, DHS-2, Kirthibarthi, Paria coll.	CO-2, DHS-2, Cricket ball, Kirthibarthi, Paria coll., Kalipatti	CO-2, DHS-2, Cricket ball, Kalipatti
Highly Susceptible(HS)	CO-2, Kirthibarthi	DHS-2	Kirthibarthi	Kalipatti	--	Kirthibarthi

with respect to peak fruit damage is presented in Table 7. Here in pooled data, none of the varieties/hybrids were found highly resistant, while Chala collection-1, 2 and 3 were grouped under the resistant category, and 13 varieties/hybrids were categorised in moderately resistant and PKM-3 and Paria collection in moderately susceptible. CO-2, Cricket ball and Kalipatti were classified as susceptible varieties while DHS-2 and Kirthibarthi come under the highly susceptible category. Under individual years cataloguing under average and peak damage, nearly the same trend was seen in the ranking, and a slight disparity may be due to the crop phenology impact.

The data on bud morphology (Table 8) and eight biochemical contents (Table 9) were measured, and a correlation matrix was assessed with seed damage for

Table 7: Categorization of different varieties/hybrids of sapota based on peak fruit damage due to seed borer

Scale	2015-16	2016-17	2017-18	2018-19	2019-20	Pooled
Highly Resistant (HR)	--	--	--	--	--	--
Resistant (R)	Chala coll.-1	CO-1, CO-3, Chala coll.-1	PKM-3, CO-1, Zumakhiya, Chala coll.-1	Chala coll.-2	Chala coll.-1, Chala coll.-2, Chala coll.-3	Chala coll.-1, Chala coll.-2, Chala coll.-3
Moderately Resistant (MR)	PKM-1, PKM-2, PKM-3, PKM-4, PKM-5, CO-1, DHS-1, Zumakhiya, Bhuripatti, Pilipatti, Singapore, Paria coll., Chala coll.-2, Chala coll.-3	PKM-2, PKM-5, CO-2, Zumakhiya, Bhuripatti, Pilipatti, Singapore, Chala coll.-2, Chala coll.-3	PKM-1, PKM-2, PKM-4, PKM-5, CO-3, DHS-1, Murabba, Pilipatti, Chala coll.-2, Chala coll.-3	PKM-1, PKM-2, PKM-3, PKM-4, PKM-5, CO-1, CO-3, DHS-1, Mohangootee, Zumakhiya, Bhuripatti, Pilipatti, Singapore, Chala coll.-1, Chala coll.-3	PKM-1, PKM-2, PKM-4, CO-1, CO-3, DHS-1, Murabba, Mohangootee, Zumakhiya, Bhuripatti, Pilipatti, Singapore	PKM-1, PKM-2, PKM-4, PKM-5, CO-1, CO-3, DHS-1, Murabba, Mohangootee, Zumakhiya, Bhuripatti, Pilipatti, Singapore
Moderately Susceptible (HS)	CO-3, Murabba, Mohangootee, Cricket ball	PKM-1, Mohangootee, Cricket ball, Kirthibarthi, Paria coll., Kalipatti	DHS-2, Mohangootee, Bhuripatti, Singapore, Paria coll.	Murabba, Cricket ball	PKM-5, DHS-2, Paria coll.	PKM-3, Paria coll.
Susceptible (S)	CO-2, Kalipatti	PKM-3, PKM-4, DHS-1, Murabba	CO-2, Cricket ball, Kalipatti	CO-2, DHS-2, Kirthibarthi, Paria coll.	PKM-3, CO-2, Cricket ball, Kirthibarthi, Kalipatti	CO-2, Cricket ball, Kalipatti
Highly Susceptible (HS)	DHS-2, Kirthibarthi	DHS-2	Kirthibarthi	Kalipatti	--	DHS-2, Kirthibarthi

Table 8: Morphological parameters of seed in different varieties/hybrids of sapota

Treatment	Varieties/ hybrids	Avg. seed length (mm $\pm$ SD)	Avg. seed width (mm $\pm$ SD)	Avg. seed thickness (mm $\pm$ SD)
T_1	PKM-1	19.94 $\pm$ 0.85	10.63 $\pm$ 0.38	5.71 $\pm$ 0.63
T_2	PKM-2	20.60 $\pm$ 0.88	11.99 $\pm$ 0.89	5.80 $\pm$ 0.47

T_3	PKM-3	19.11 ± 3.09	11.74 ± 0.5	6.02 ± 0.74
T_4	PKM-4	21.27 ± 1.33	10.34 ± 0.88	5.86 ± 0.63
T_5	PKM-5	17.05 ± 1.11	8.84 ± 0.74	4.63 ± 0.35
T_6	CO-1	21.34 ± 1.35	12.04 ± 0.68	6.17 ± 0.44
T_7	CO-2	18.55 ± 2.78	9.98 ± 00.64	4.79 ± 0.32
T_8	CO-3	19.26 ± 1.17	11.81 ± 0.67	6.05 ± 0.48
T_9	DHS-1	20.54 ± 0.90	11.14 ± 0.86	5.77 ± 0.44
T_{10}	DHS-2	22.81 ± 0.78	11.34 ± 0.53	5.80 ± 0.27
T_{11}	Murabba	19.94 ± 1.56	11.05 ± 0.81	5.64 ± 1.02
T_{12}	Mohangootee	19.92 ± 1.26	10.14 ± 0.90	5.40 ± 0.40
T_{13}	Zumakhiya	20.12 ± 1.73	10.73 ± 0.94	5.97 ± 0.87
T_{14}	Bhuripatti	20.99 ± 1.19	10.59 ± 0.69	5.32 ± 0.34
T_{15}	Pilipatti	20.89 ± 0.76	11.24 ± 0.94	5.56 ± 0.61
T_{16}	Cricket ball	19.45 ± 0.95	10.31 ± 0.96	5.82 ± 0.58
T_{17}	Singapore	21.59 ± 0.73	11.61 ± 0.53	6.34 ± 0.58
T_{18}	Kirthibarthi	19.50 ± 0.60	9.83 ± 0.36	5.14 ± 0.42
T_{19}	Paria coll.	19.34 ± 1.09	10.65 ± 0.58	5.42 ± 0.31
T_{20}	Chala coll.-1	20.88 ± 0.93	11.63 ± 0.24	5.23 ± 0.40
T_{21}	Chala coll.-2	20.62 ± 1.06	10.91 ± 0.58	5.59 ± 0.60
T_{22}	Chala coll.-3	19.98 ± 1.15	10.71 ± 0.77	5.43 ± 0.35
T_{23}	Kalipatti	22.06 ± 1.11	11.13 ± 1.56	5.73 ± 0.47

Table 9: Biochemical parameters of seed in different varieties/hybrids of sapota

Treatment	Varieties/ hybrids	Crude Protein (%)	Total Carbohydrate (%)	Reducing Sugar (%)	Non-reducing Sugar (%)	Total Soluble Sugar (%)	Crude Fibre (%)	Total Phenol (%)	Lipid (%)
T_1	PKM-1	1.06	74.76	1.35	7.02	8.36	13.00	0.21	11.45
T_2	PKM-2	1.60	75.01	0.14	7.63	7.77	15.12	0.12	10.80
T_3	PKM-3	0.68	78.55	0.48	8.17	8.66	11.20	0.21	14.85
T_4	PKM-4	1.43	65.27	0.78	6.48	7.27	19.56	0.16	8.40
T_5	PKM-5	0.93	86.25	0.06	6.23	6.29	12.76	0.15	14.00
T_6	CO-1	1.72	77.46	0.68	7.72	8.41	13.66	0.32	11.70
T_7	CO-2	1.65	82.40	0.52	6.23	6.75	13.96	0.18	12.30
T_8	CO-3	0.75	77.36	0.43	10.53	10.96	14.96	0.14	13.45
T_9	DHS-1	0.83	89.77	0.08	7.43	7.51	13.23	0.13	13.05
T_{10}	DHS-2	0.48	94.86	0.09	6.85	6.94	14.41	0.13	11.10
T_{11}	Murabba	0.59	73.76	0.20	4.17	4.36	21.16	0.11	10.95
T_{12}	Mohangootee	0.71	69.37	0.29	5.64	5.93	13.92	0.17	11.10
T_{13}	Zumakhiya	2.70	85.45	0.47	6.52	6.99	14.60	0.11	36.40
T_{14}	Bhuripatti	0.58	41.35	0.33	6.47	6.80	15.20	0.11	13.20
T_{15}	Pilipatti	0.83	63.82	0.76	9.33	10.09	11.84	0.27	14.15
T_{16}	Cricket ball	2.04	69.27	0.26	7.07	7.33	16.88	0.14	13.90
T_{17}	Singapore	1.73	65.77	0.29	6.15	6.43	19.04	0.19	8.15
T_{18}	Kirthibarthi	0.99	64.17	0.32	7.08	7.40	14.22	0.20	13.55
T_{19}	Paria coll.	3.91	99.48	0.67	13.27	13.94	13.12	0.17	14.05
T_{20}	Chala coll.-1	0.68	79.55	0.15	8.29	8.45	12.90	0.12	12.60
T_{21}	Chala coll.-2	0.83	78.40	0.77	5.88	6.65	12.12	0.26	14.35
T_{22}	Chala coll.-3	0.87	64.82	2.76	11.06	13.82	15.50	0.32	15.10
T_{23}	Kalipatti	2.48	63.62	0.20	6.94	7.14	12.78	0.20	13.70

their significance. There was a non-significant correlation between seed length, width and thickness of different varieties/hybrids and seed damage with respect to average and peak infestation (Table 10). As well, a non-significant correlation was observed between seed borer damage and eight biochemical contents of seed *viz.*, crude protein, total carbohydrate, reducing sugar, non-reducing sugar, total soluble sugar, crude fibre, total phenol and lipid of different varieties/hybrids (Table 11). This indicates pest population may be influenced by ecological and phenological factors, as well as escape type resistance can be catalogued in less damaged sapota varieties/hybrids due to late flowering and subsequently fruiting initiation.

Discussion

In the past 20 years, relatively little study has been done on the screening of sapota varieties against seed borer throughout India since its detection in 2000; limited information exists, which has been conducted primarily in Gujarat. In earlier studies in South Gujarat, Kanade (2005) revealed that among the different varieties of

Table 10: Correlation matrix of seed morphology parameters of different varieties/hybrids of sapota with fruit damage by seed borer

Parameters	Fruit damage	Seed Length	Seed Width	Seed Thickness
Fruit damage	1	--	--	--
Seed Length	0.021 (0.030)#	1	--	--
Seed Width	-0.332 (-0.324)#	0.581**	1	--
Seed Thickness	-0.254 (-0.212)#	0.551**	0.739***	1

**Correlation is significant at 1% and * Correlation is significant at 5%.
Figures in parenthesis are correlation matrix analyzed for peak fruit damage and outside are correlation matrix analyzed for average fruit damage.

Table 11: Correlation matrix of biochemical parameters of different varieties/hybrids of sapota with fruit damage by seed borer

Parameter	Fruit damage	Crude Protein	Total Carbohydrate	Reducing Sugar	Non-reducing Sugar	Total Soluble Sugar	Crude Fiber	Total Phenol	Lipid
Fruit damage	1	--	--	--	--	--	--	--	--
Crude Protein	0.263 (0.196)#	1	--	--	--	--	--	--	--
Total Carbohydrate	0.066 (0.092)#	0.284	1	--	--	--	--	--	--
Reducing Sugar	-0.291 (-0.287)#	-0.015	-0.181	1	--	--	--	--	--
Non-reducing Sugar	-0.104 (-0.141)#	0.354	0.24	0.436*	1	--	--	--	--
Total Soluble Sugar	-0.164 (-0.194)#	0.302	0.162	0.628**	0.974**	1	--	--	--
Crude Fibre	-0.04 (-0.047)#	0.002	-0.285	-0.02	-0.339	-0.299	1	--	--
Total Phenol	-0.120 (-0.112)#	-0.016	-0.159	0.675**	0.293	0.423*	-0.311	1	--
Lipid	-0.133 (-0.147)#	0.339	0.201	0.065	0.062	0.07	-0.225	-0.125	1

** Correlation is significant at 1% and * Correlation is significant at 5%.
# Figures in parenthesis are correlation matrix analyzed for peak fruit damage and outside are correlation matrix analyzed for average fruit damage.

sapota, Kirthibarthi (7.74%), CO-2 (9.97%) and Singapore (11.24%) were found to be less infested by seed borer compared to DHS-1 (36.16%) and DHS-2 (32.60%), which differs with present with current results, but damage range is matching.

Seed borer damage under high-density plantations was examined by Khambhu and Bisane (2015) revealed that PKM-3, PKM-4, and CO-3 showed lower 1-2% fruit infestation, while Kalipatti and Cricket Ball recorded the highest fruit damage between 7 and 13% in November and December. Another study by Bisane and Naik (2016) found that, under normal spacing, seed borer fruit loss was lower in PKM-5, DHS-1, PKM-2, Bhuripatti, and PKM-1, ranging from 3 to 5%. In contrast, increased fruit infection, ranging from 8 to 17%, was seen in Kalipatti, Cricket Ball, and CO-2 during November-December. In order to assess sapota for seed borer, Patel (2020) examined the differences between varieties/hybrids in normal and high-density plantations. He showed that Kalipatti, DHS-2 and Cricket Ball had more damage, ranging from 5 to 7%, than PKM-4, PKM-3 and CO-3, which had infestations of less than 3%. In December, Kalipatti and Cricket Ball suffered the most fruit damage.

Looking to other locations for varietal differences, PKM-1 (4.58%) and DSH-1 (9.79%) are the least susceptible, and Kalipatti (18.76%) exhibited high susceptibility against seed borer in Karnataka (Patil and Kumari, 2023). In Tamil Nadu, PKM-1, PKM-2, PKM-1 and Kalipatti were less susceptible and in DHS-1, DHS-2, Kirthibarthi and PKM-4 were more vulnerable to seed borer (AICRP Report, 2019).

In morphological parameters, Kanade (2005) reported that the diameter of infested fruits of different sapota varieties did not play a significant role in pest infestation of the seed borer. While the bigger size of the seed in varieties like DHS-1 and DHS-2 provides sufficient food to the larva, which might be instinctively attracted to the pest. This outcome has some similarity with the present data. In another study, Karthik (2019) noted a significant positive correlation between fruit surface thickness and seed borer damage, but between TSS and total sugar, there was a non-significant positive correlation, which matches the present outcome.

Conclusion

According to the overall varietal evaluation data on sapota, Kirthibarthi, DHS-2, CO-2 and Cricket ball were equally vulnerable to seed borer with the commercial variety Kalipatti. December and April were the critical months for seed borer infestation. However, the tolerance response to seed borer exhibited by Chala collection-1, Chala collection-2, Chala collection-3, Zumakhiya, CO-1, and CO-3 may be due to the escaped nature brought on by the different peak harvesting phases in each variety. Furthermore, no conclusive connection was found between seed borer damage and seed morphology, as well as eight biochemical components. Additionally, one of the useful strategies in upcoming breeding programs will be the adoption of resistant or tolerant cultivars as parent hosts. According to the study, future research should focus on investigating the advanced biochemical properties or attributes of sapota types to better understand their resistance mechanisms against seed borer to maintain the economic impact of incidence on sapota quality.

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