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FIELD SCREENING OF SUGARCANE CLONES AGAINST THE INTERNODE BORER, *Chilo sacchariphagus indicus*

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AUTHORS' CONTRIBUTIONS
This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Reaction of Advanced Yield Trial (AYT) clones were screened for their resistance reaction against internode borer, INB *Chilo sacchariphagus indicus* at Sugarcane Research Station, Tamil Nadu Agricultural University, Cuddalore, Tamil Nadu during December, 2019-20 and May, 2020-21. Results revealed, out of 30 AYT clones and a standard variety CoC 24 the mean percent internode borer, *Chilo sacchariphagus indicus* damage was ranged from the minimum of 2.1 (C 15645) percent to the maximum of 43 (C 15181) percent. In the advanced yield trial (AYT) (29) clones are less susceptible to internode borer, *Chilo sacchariphagus indicus*. The clone C 15004 was moderately susceptible (MS) during 2019-20 seeing for INB resiotance.

In another screening experiment during 2019 July there were 20 Advanced yield trial (AYT-II) clones and two standard varieties were studied for INB resistance and infestation intensity. The mean percent INB damage was ranged from 2.4 (C 16353) to the maximum of 52.5 (C 16122). Out of 20 AYT-II clones, nineteen clones viz., C 16415, C 16276, C 16021, C 16335, C 16183, C 16035, C 16418, C 16086, C 16282, C 16331, C 16338, C 16031, C 16034, C 16097, C 16038, C 16108, C 16137, C 16353 and C 16270 and the standard varieties Co 86032 and CoC 25 were under Less susceptible grade (LS). The mean percent internode borer, *Chilo sacchariphagus indicus* infestation intensity was ranged from the minimum of 12 (C 16035) to the maximum of 66.8 (C 16335). During 2020-21, May month advanced yield trial (AYT) sugarcane clones (22) and three standard varieties, put together 25 entries were planted in Randomized Block Design with two replications against the internode borer, *Chilo sacchariphagus indicus*. The observations on the sugarcane internode borer damage was followed as done in 2019-20 season experiment. Out of 25 entries, 18 clones were less susceptible to internode borer. Less susceptible clones are: C2016-031, C2016-035, C2016-038, C2016-069, C2016-086, C2016-097, C2016-108, C2016-122, C2016-183, C2016-261, C2016-270, C2016-282, C2016-304, C2016-331, C2016-337, C2016-338, C2016-415, C2016-418 and a standard variety Co 86032.

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Keywords: *Sugarcane; Advanced yield trial clones; internode borer; Chilo sacchariphagus indicus screening.*

1. INTRODUCTION

Sugarcane (*Saccharum* spp) is one of the important commercial crops cultivated throughout the world in 110 countries with tropical subtropical conditions. It is the primary source for manufacturing crystal sugar which is a predominant commodity in the global food industry. Besides, the production of crystal sugar as a main product, ethanol, bagasse, pressmud and co-generation of power are the other useful by-products. Presently, sugarcane is also looked upon as a feedstock for biofuels and would be one of the major sources of energy for the future. Sugarcane is attacked by a range of insects including tissue borers, sucking pests and cane grubs [1]. Losses due to these pests are estimated to be around 10% [2, 3]. Sugarcane borers make holes, tunnels in internodes due to which food supply to aerial parts of stem and leaves stops and also pave ways for certain diseases [4,5]. Keeping in view the importance of sugarcane and huge damage caused by different borers, experiments were carried out to study the resistance reaction of different Advanced Yield Trial clones and the standard varieties against internode borer, *Chilo sacchariphagus indicus* during 2019-20 and 2020-21. The results are consistent with the objectives of resistance reactions against internode borer, *Chilo sacchariphagus indicus*. Each clone is different in its physiological attribute as it had undergone different crossing process of the sugarcane breeder. They are all different progenies. The clones of 2019-20 and 2020-21 are resultant projenies of the breeder and need not be compared Clones of 2019-20 and clones of 2020-21 both are separate entity.

2. MATERIALS AND METHODS

During 2019-20, 30 Advanced Yield Trial (AYT) clones and a standard variety CoC 24 were planted at Sugarcane Research Station, Cuddalore in two replications under Randomized Block Design. The reactions of these clones with standard cultivar (CoC 24) against internode borer, *Chilo sacchariphagus indicus* was evaluated. In each clone variety 5 clumps of sugarcane plants were observed for internode borer infested canes and the total cane, the mean percent internode borer damage was assessed during 5th (150 days after planting) 7th (210 days after planting) and 9th (270 days after planting) month. Infestation intensity was worked out based on the total number of infested nodes and the total number of nodes per cane in one experiment during 2019-20. The mean percent infestation intensity was worked out. Thus screening assessment was done by counting and its percentage.

During 2020-21, May month advanced yield trial (AYT) sugarcane clones (22) and three standard varieties, put together 25 entries were planted in Randomized Block Design with two replications against the internode borer, *Chilo sacchariphagus indicus*. The observations on the sugarcane internode borer damage was followed as done in 2019-20 season experiment.

3. RESULTS AND DISCUSSION

3.1 Reaction of AYT Sugarcane Clones against Internode Borer, *Chilo sacchariphagus indicus*

In 30 AYT clones and a standard variety CoC 24 the mean percent internode borer, *Chilo sacchariphagus indicus* damage was ranged from the minimum of 2.1 (C 15645) percent to the maximum of 43 (C 15181) percent. 28 clones were less susceptible to internode borer, *Chilo sacchariphagus indicus* (Table 1). The percent internode borer damage was the mean of 5th (150 days after planting) 7th (210 days after planting) and 9th (270 days after planting) month.

In another field screening, 20 clones with two standard varieties were screened for their resistance reaction against internode borer, *Chilo sacchariphagus indicus* at the time of harvest during 2019-20. The mean percent INB damage was ranged from 2.4 (C 16353) to the maximum of 52.5 (C 16122). Nineteen clones viz., C 16415, C 16275, C 16021, C 16334, C 16183, C 16035, C 16418, C 16086, C 16282, C 16331, C 16338, C 16031, C 16034, C 16097, C 16038, C 16108, C 16137, C 16353 and C 16270 and the standard varieties Co 86032 and CoC 25 were under Less Susceptible (LS) grade (Table 2) (Fig. 1).

3.2 Infestation Intensity

The mean percent internode borer *Chilo sacchariphagus indicus* infestation intensity was ranged from the minimum of 12 (C 16035) to the maximum of 66.8 (C 16335) during 2019-20 (Table 3). The infestation intensity was assessed only in the clonal evaluation of advanced yield trial (I) during 2019-20 ie. in clones starting from C 16122 to C 16270 and in the standard varieties *viz*., Co 86032 and CoC 25.

Reaction of AYT (2020-21, May) clones varieties / against internode borer, *Chilo sacchariphagus indicus,* 22 clones of AYT (2020-21) and 3 standard

varieties viz., Co 86032, CoC 25 and CoC 13339 were assessed. The mean percent internode borer damage was ranged from 21.3 (C2016-035) to the maximum of 48.4 (C2016-276). Out of 22 AYT (2020-21) clones 18 clones and one standard variety, Co 86032 are Less Susceptible. Less susceptible clones are: C2016-031, C2016-035, C2016-038, C2016-069, C2016-086, C2016-097, C2016-108, C2016-122, C2016-183, C2016-261, C2016-270, C2016-282, C2016-304, C2016-331, C2016-337, C2016-338, C2016-415, C2016-418 and a standard variety Co 86032 (Table 4).

Four AYT (2020-21) clones are Moderately Susceptible (MS) and two standard varieties *viz.,* CoC 25 and CoC 13339 were also Moderately Susceptible (MS). The Moderately Susceptible (MS) AYT (2020-21) clones are C2016-021, C2016-276, C2016-335, and C2016-353. The results are consistent with the objectives of resistance reactions against internode borer, *Chilo sacchariphagus indicus*. Each clone is different in its physiological attribute as it had undergone different crossing process of the sugarcane breeder. They are all different progenies. The clones of 2019-20 and 2020-21 are resultant projgenies of the breeder and need not be compared. Clones of 2019-20 and clones of 2020-21 both are separate entity.

Agarwal [6] mentioned that solid cored varieties were generally less affected by *Chilo* spp. than that developed pith and cavity. Agarwal et al. [7] observed a great variation of stem borer incidence in different varieties. Koenar [8] mentioned that screening of resistant varieties against stalk borer was an effective and economic control measure. Macedo [9] tested 16 cane varieties against stalk borer attack and found that CB45-155, IAC 50-134 and CB56-155 varieties were highly resistant, whereas IAC52-150 and CP 51-22 were recorded least resistant.

Table 1. Reaction ofAYT-I sugarcane clones / varieties (2019- 20) against internode borer (INB), *Chilo sacchariphagus indicus*at sugarcane research station, Cuddalore, TamilNadu, South India

S.No.	Clones / Varieties	Mean percent damage level of internode borer	Damage rating
1.	C 15559	18.6	LS
2.	C 15603	11.4	LS
3.	C 15632	4.1	LS
4.	C 15639	14.5	LS
5.	C 15642	6.7	LS
6.	C 15645	2.1	LS
7.	C 15683	14.6	LS
8.	C 15708	11.4	LS
9.	C 15810	8.1	LS
10.	C 15827	18.3	LS
11.	C 15151	15.8	LS
12.	C 15157	21.3	LS
13.	C 15175	24.5	LS
14.	C 15176	28.0	LS
15.	C 15181	43.0	MS
16.	C 15192	31.0	MS
17.	C 15195	10.6	LS
18.	C 15210	6.2	LS
19.	C 15499	26.9	LS
20.	C 15525	24.7	LS
21.	C 15004	26.7	LS
22.	C 15006	16.5	LS
23.	C 15011	29.2	LS
24.	C 15021	18.7	LS
25.	C 15063	15.7	LS
26.	C 15079	21.4	LS
27.	C 15081	13.1	LS
28.	C 15086	21.9	LS
29.	C 15088	14.8	LS
30.	C 15095	8.4	LS
31.	CoC 24	14.2	LS

*Damage rating : Inter Node Borer, **INB damage (%)** **Grade,** 0-30% incidence - Less Susceptible (LS)*
30.1 – 50% incidence - Moderately Susceptible (MS), > 50.1% incidence - Highly Susceptible (HS)

Host plant resistance involves no additional costs, it is effective at all levels of pest infestation and effects are cumulative and long-lasting in reducing the pest population [10]. Anonymous [11] ranked the commercial CP varieties as CP 70-321, highly resistant, CP 65-357 and CP72-370 moderately resistant and CP76-331, CP72-356 and CP74-383 as susceptible to their response to borer attack.

Researchers have put resistance strategies three categories, non-preference, antibiosis and tolerance. Resistant varieties generally are protected by more than one of these (Roger and Yepsen, 1984). Anonymous [12] tested ten varieties against stem borer and found BF 162 was susceptible, whereas BL-4 was resistant. The varieties CP-67-412 and AEARC mutants 1002 and 2001 were found less susceptible to borer attack was compared to BL-4, PR-1000 and Co-547, amongst the 24 tested varieties against the sugarcane borers [10]. Rasul (1987) tested eight cane varieties against top and stem borer. He found that CPF (HF)-150 get minimum infestation as compared with CP-43/33.

In an experiment for resistant/susceptible of ten promising varieties against the borers, the variety CPF(HF) 160 was recorded more resistant to borer attack (Mushtaq *et al*., 1989). Twenty-five varieties of sugarcane were screened against the root and stem borer. The CP-66-473 was found to be most susceptible as compared to remaining varieties (Kakakhel, 1991).

Khanzada (2002) screened fifty varieties of sugarcane for their relative degree of tolerance and susceptibility against top and stem borer attack. He found that highly significant variations due to borer damage were recorded for cultivars. None of the varieties recorded was immune to the borer attack. Kumbhar *et al*. [4] screened mid late maturing varieties/Germplasms of sugarcane against borer pests in Pusa, Bihar. The study revealed the plassey borer infestation in varieties CoSe 92423 and CoP 9301, and pink borer infestation in variety CoSe 92423and germplasms CoSe 08452 and CoSe 08451 was recorded in the range 0.03 to 0.89 percent.

Table 2. Reaction of AYT-II sugarcane clones / varieties (2019 – 20) against internode borer, *Chilo sacchariphagus indicus* at sugarcane research station, Cuddalore, TamilNadu, South India

S.No.	AYT-I Clone / Varieties	Mean INB incidence (%)	Damage Rating
1.	C 16122	52.5	HS
2.	CO 86032	16.4	LS
3.	C 16415	19.0	LS
4.	C 16276	7.2	LS
5.	C 16021	10.3	LS
6.	C 16335	15.9	LS
7.	C 16183	15.8	LS
8.	C 16035	4.8	LS
9.	C 16418	17.1	LS
10.	C 16086	12.0	LS
11.	C 16282	12.8	LS
12.	C 16331	11.9	LS
13.	C 16338	22.2	LS
14.	C 16031	15.4	LS
15.	C 16034	14.6	LS
16.	CoC 25	9.4	LS
17.	C 16097	3.8	LS
18.	C 16038	9.9	LS
19.	C 16108	7.8	LS
20.	C 16137	5.8	LS
21.	C 16353	2.4	LS
22.	C 16270	10.2	LS

Damage rating : Inter Node Borer(INB)

INB Damage (%) Grade

0-30% incidence - Less Susceptible (LS)

30.1 – 50% incidence - Moderately Susceptible (MS)

> 50.1% incidence - Highly Susceptible (HS)

Table 3. Reaction of AYT-II sugarcane clones / varieties (2019-20) against internode borer, *Chilo sacchariphagus indicus* infestation intensity at Sugarcane Research Station, Cuddalore, TamilNadu, South India

S.No.	AYT-I Clone / Variety Code	Mean Percent Infestation Intensity of INB attack
1.	C 16122	41.5
2.	CO 86032	38.0
3.	C 16415	35.3
4.	C 16276	32.9
5.	C 16021	36.0
6.	C 16335	66.8
7.	C 16183	39.4
8.	C 16035	12.0
9.	C 16418	47.2
10.	C 16086	44.4
11.	C 16282	22.5
12.	C 16331	49.4
13.	C 16338	42.1
14.	C 16031	29.9
15.	C 16034	30.4
16.	CoC 25	31.6
17.	C 16097	27.1
18.	C 16038	40.1
19.	C 16108	48.1
20.	C 16137	37.5
21.	C 16353	53.7
22.	C 16270	47.6

Table 4. Reaction of AYT-I sugarcane clones / varieties (2020-21) against internode borer, *Chilo sacchariphagus indicus* at sugarcane research station, Cuddalore

S.No.	Clone / Variety Code	Mean % incidence	Resistance Grade
1.	C 2016 – 021	38.6	MS
2.	C 2016 –031	25.9	LS
3.	C 2016 –035	21.3	LS
4.	C 2016 –038	27.5	LS
5.	C 2016 –069	28.8	LS
6.	C 2016 –086	26.9	LS
7.	C 2016 –097	28.2	LS
8.	Co 86032	29.9	LS
9.	C 2016 –108	27.2	LS
10.	C 2016 –122	26.0	LS
11.	C 2016 –183	28.3	LS
12.	C 2016 –261	26.6	LS
13.	C 2016 –270	25.9	LS
14.	CoC 25	35.0	MS
15.	C 2016 –276	48.4	MS
16.	C 2016 –282	25.4	LS
17.	C 2016 –304	22.8	LS
18.	C 2016 –331	28.4	LS
19.	C 2016 –335	31.9	MS
20.	CoC 13339	32.0	MS
21.	C 2016 –337	29.8	LS
22.	C 2016 –338	24.5	LS
23.	C 2016 –353	39.2	MS
24.	C 2016 –415	27.6	LS
25.	C 2016 –418	23.0	LS

Damage rating – Internode borer,Chilo sacchariphagus indicus, 0-30% incidence : Less Susceptible (LS), 30.1 – 50% incidence : Moderately Susceptible (MS), > 50% : Highly Susceptible (HS)

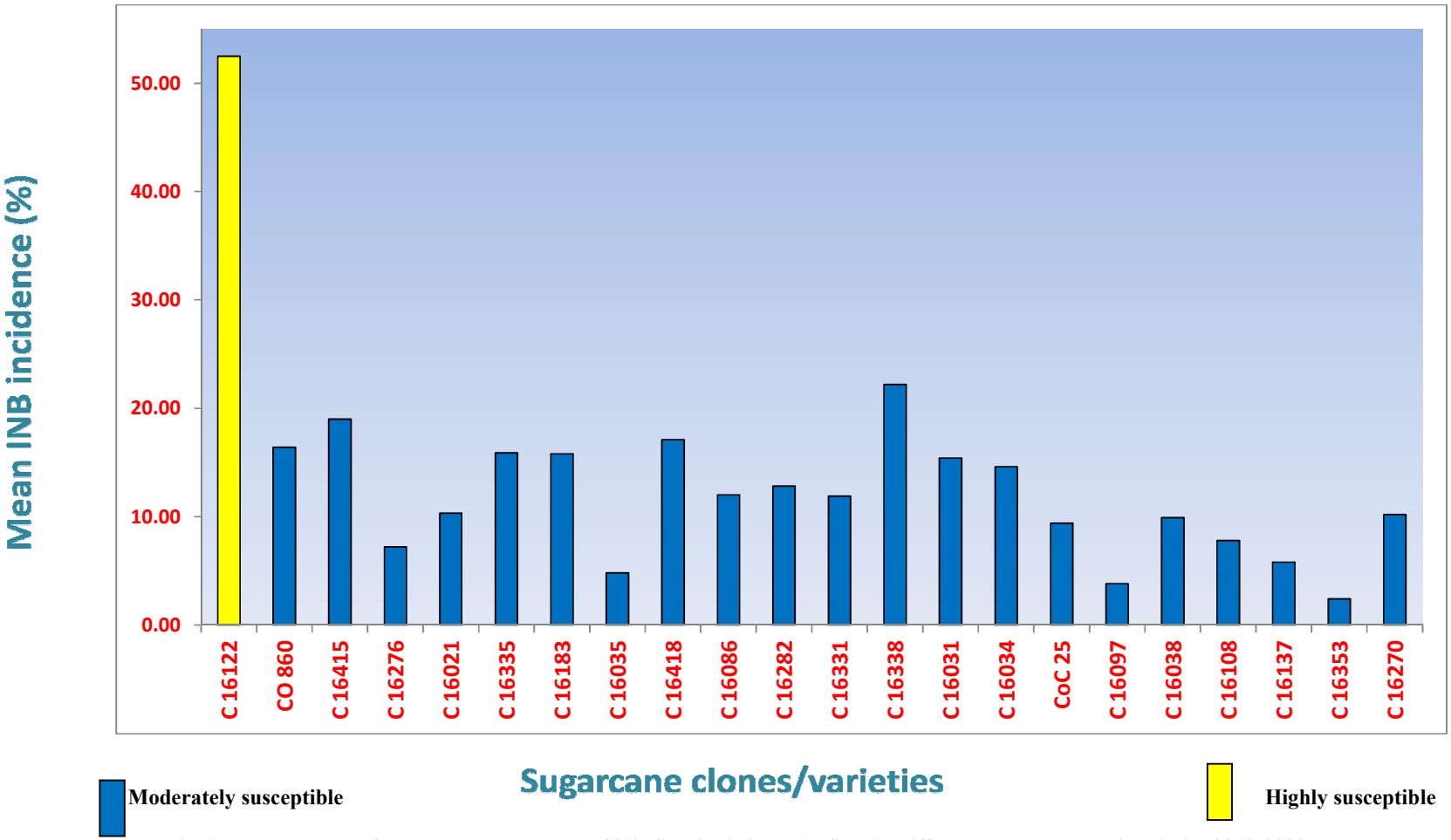

Fig. 1. Damage level of Inernode borer (INB), *Chilo Sacchariphagus indicus* in different AYT-I clones / varieties 2019-2020

Gulzar et al. [1] in their review stated that the two main sugarcane varieties of sugarcane grown in Reunion are R570 and R579, which have different susceptibilities to *Chilo sacchariphagus* [13].

German Vargas *et al*. [14] reported in his review that the current commercial cultivars exhibit a wide range of variation in susceptibility to sugarcane stem borer, *Diatraea indigenella* attack in Columbia [15], the development and release of varieties with good levels of resistance to borers could make an important contribution to IPM programs in the country [16-19]. Crepin Bi Pene et al. [20] reported that except for variety SP 71-8210, all main sugarcane varieties grown were only heavy infestation in Ferke^{-1} in Northern Ivory Coast against the stem borer *Eldana saccharina* W) infestation outbreak.

Among the different management strategies, the use of tolerant genotype is one of the important components of Integrated Pest Management (IPM). So different genotypes have been screened under natural conditions to identify the less susceptible genotypes to internode borer. The morphological and biochemical parameters form the basis of mechanism of resistance [21]. Awarding to the morphological characters of different genotypes on internode borer incidence revealed that the sugarcane internode borer incidence was highly influenced by cane length, nature of leaf sheath, nature of leaves, length and girth of vulnerable portion. Among the morphological parameters cane length (r=0.43), length of vulnerable portion (r=0.73) and girth of vulnerable portion (r=0.78) had positive correlation with internode borer incidence INB incidence was positively correlated with total sugars, reducing sugars and total protein and negatively correlated with phenols, cellulose and tannin [21].

Aristya et al. [22] studied the screening and characterization of molecular markers for sugarcane stem borer (*Saccharum officinarum* L) resistance genes for stem borer attacks in 22 sugarcane cultivars and characterized SacBB14 as among the resistance gene markers in sugarcane. The study revealed the production of 3 primer designs.

4. CONCLUSION

Field studies were conducted to study their reaction of resistance to internode borer in 30 Advanced Yield Trial clones of 2019-20 planted during Dec, 2019 to resistance of internode borer, *Chilo sacchariphagus indicus* revealed, 28 clones are less susceptible to internode borer, *Chilo sacchariphagus indicus*. Clones viz., C15181 and C15192 were Moderately Susceptible (MS). In the another field screening of AYT clones of 2019-20, nineteen clones *viz*., C16415, C16275, C16021, C 16335, C16183, C16035, C 16418, C 16086, C 16282, C 16331, C 16338, C 16031, C 16034, C 16097, C 16038, C 16108, C 16137, C 16353 and C 16270 and the standard varieties viz., Co 86032 and CoC 25 were under Less Susceptible (LS). Infestation intensity study was done only in 20 clones of AYT (2019-20) planted during May 2020. The mean percent internode borer infestation intensity was ranged from the minimum of 12 (C 16035) to the maximum of 53.7(C 16353). During 2020-21 out of 22 AYT clones 18 clones were less susceptible to internode borer. Less susceptible clones are: C2016-031, C2016-035, C2016-038, C2016-069, C2016-086, C2016-097, C2016-108, C2016-122, C2016-183, C2016-261, C2016-270, C2016-282, C2016-304, C2016-331, C2016-337, C2016-338, C2016-415, C2016-418 and a standard variety Co 86032. The mean percent internode borer incidences ranged from the minimum of 21.3 (C2016-035) to the maximum of 48.4 (C2016-276) in the AYT clones screened during 2020-2021.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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