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Resistance of Chickpea (*Cicer arietinum* L.) Varieties to Gram Pod Borer (*Helicoverpa armigera*) in a Controlled Environment

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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

The research was conducted within the controlled environment of the net house at the Faculty of Agriculture Science and Technology, AKS University, Satna (M.P.), during the *Rabi* season of 2023-24. Eight diverse chickpea (*Cicer arietinum* L.) genotypes, *viz*. JG-63, JG-130, L-2, JG-14, RAJ-128, Narendran-2, Annagiri and RVG-202, were systematically screened to evaluate their

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resistance to the gram pod borer (*Helicoverpa armigera*) under protected conditions. The study was meticulously designed using a Completely Randomized Design (CRD) with three replications to ensure robust statistical analysis. Throughout the critical vegetative, flowering and maturity stages, the larval population density of *H. armigera* was rigorously monitored across all genotypes at regular intervals. The comprehensive data analysis revealed that genotypes RAJ-128 and RVG-202 demonstrated superior resistance, exhibiting the lowest mean larval density of 0.25 and 0.29 larvae per 0.5 m², respectively, indicating their potential for integrated pest management in chickpea cultivation.

Keywords: Chickpea; gram pod borer; Helicoverpa armigera; larval density; resistance; resistant genotypes.

1. INTRODUCTION

Chickpea (*Cicer arietinum* L.) holds the position as the third most significant grain legume globally and stands as a premier pulse crop in India, both in terms of cultivation area and production output. In India alone, chickpea cultivation spans 9.21 million hectares, yielding a production of 8.88 million metric tons with a productivity rate of 995 kilograms per hectare [1]. Notably, the highest production of chickpea, amounting to 3,551 thousand tons, was recorded in Madhya Pradesh. Recognized as a valuable dietary resource, chickpea seeds boast significant proportions of proteins (18 to 22%), carbohydrates (52 to 70%), fats (4 to 10%), with essential minerals such as calcium, phosphorus, iron, and vitamins [2].

Furthermore, its straw holds considerable forage value. Despite its nutritional value, chickpea faces challenges from approximately 60 insect pests,[3] with half a dozen species considered economically detrimental, notably the gram pod borer, *Helicoverpa armigera* (Hübner) (Lepidoptera:Noctuidae), recognized as the key pest. The larvae of *H. armigera* inflict damage on chickpea flowers during early crop stages and subsequently target developing pods by penetrating them, resulting in direct yield reduction [4]. Yield losses in chickpea due to *H. armigera* have been reported extent of 26.01% to 40.08%, 10.53% to 39.14%, and up to 80% [5,6]. The pest, known for its adaptability, has swiftly developed resistance to various insecticides [7]. Host plant resistance (HPR) emerges as a pivotal component within integrated pest management strategies, offering substantial potential in managing *H. armigera* [8]. The utilization of resistant or tolerant chickpea varieties presents an economically viable, ecologically sound approach, harmonizing with other IPM methodologies [9-13]. Additionally, resistant chickpea plants exhibit non-preference for oviposition and larval feeding by *H. armigera*. In the current experiment, eight promising chickpea genotypes underwent screening against *H. armigera* under protected conditions.

2. MATERIALS AND METHODS

The experiment was conducted in the net house (Fig. 1) of the Faculty of Agriculture Science and Technology at AKS University, Satna (M.P.), situated at 24° 34’ North latitude and 80° 49’ East longitude, with an altitude of 324 meters above sea level. The experiment employed a Completely Randomized Design (CRD) featuring eight genotypes *viz*., JG-63, JG-130, L-2, JG-14, RAJ-128, Narendran-2, Annagiri and RVG-202 - each replicated three times. These genotypes were assessed for their response to *H. armigera*. Throughout the crop's growth season, the larval density of *H. armigera* on various genotypes was recorded weekly. Varietal preference was determined based on the mean larval density across all observations during each stage of crop development. The larval density across different genotypes underwent analysis of variance at a significance level of 5% to delineate their relative susceptibility.

3. RESULTS AND DISCUSSION

The mean larval population of *Helicoverpa armigera* recorded on eight genotypes of chickpea at vegetative, flowering, and maturity stages is presented in Table 1.

Larval density during the vegetative stage: The average population (refer to Table 1 and Fig. 2) of *H. armigera* ranged from 0.18 (RAJ-128) to 10.75 (L-2) larvae per 0.5 m^2 during the vegetative phase of the crop. Data revealed the lowest mean larval population in genotype RAJ-128 (0.18 larvae per 0.5 m^2), which was statistically comparable with RVG-202 and Narendran-2 (0.22 and 0.26 larvae per 0.5 m^2, respectively).

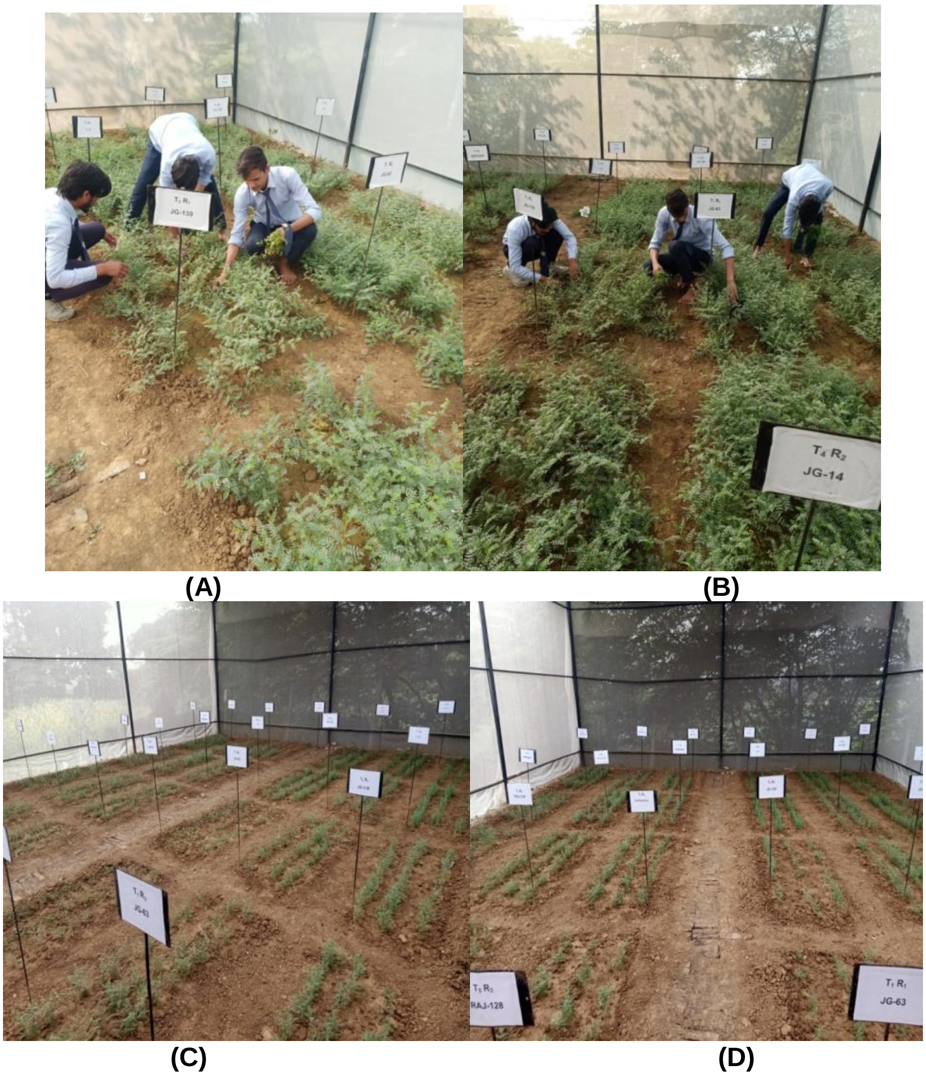

Fig. 1. Observations recorded (A and B) of field layout (C and D) for *H. armigera* on different genotypes of chickpea under protected conditions

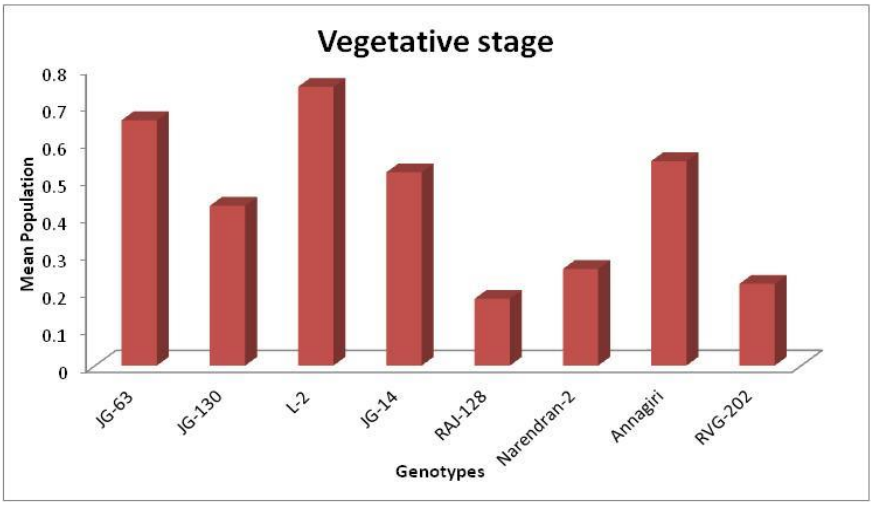

Fig. 2. Mean larval population of *H. armigera* on chickpea genotypes at vegetative stage

Larval density during the flowering stage: During the flowering stage (Table 1 and Fig. 3)of the crop, the mean population of *H. armigera* varied from 0.56 (RVG-202) to 1.75 (Annagiri) larvae per 0.5 m^2. Genotype RVG-202 exhibited the lowest mean larval density of 0.56 larvae per 0.5 m^2, statistically comparable with genotypes RAJ-128 and Narendran-2 (0.64 and 0.68 larvae per 0.5 m^2, respectively).

Larval density during the maturity stage: At the maturity stage of the crop, the mean larval population of *H. armigera* ranged from 0.00 (RAJ-128) to 3.68 (JG-63) larvae per 0.5 m^2. Genotype RAJ-128 (0.00) followed by Narendran-2 and RVG-202 (both 0.02 larvae per 0.5 m^2) exhibited the lowest number of larvae and were statistically comparable. It has also been seen that resistant chickpea plants do not exhibit preference for oviposition or larval feeding by *H. armigera*. According to a study comparing the biological characteristics of *H. armigera* with the biochemical components of several chickpea genotypes, flavonoids significantly correlated negatively with the percentage of pod damage (Table 1 and Fig. 4).

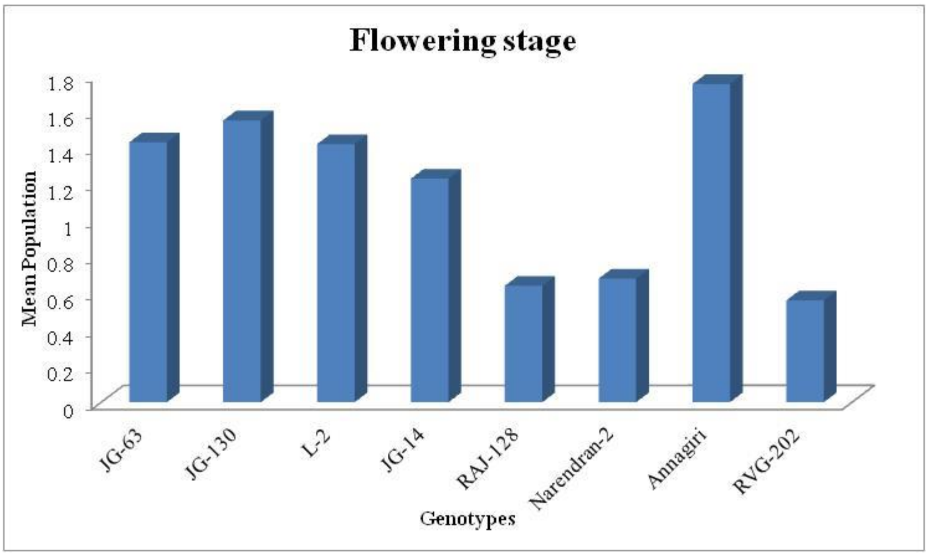

Fig. 3. Mean larval population of *H. armigera* on chickpea genotypes at flowering stage

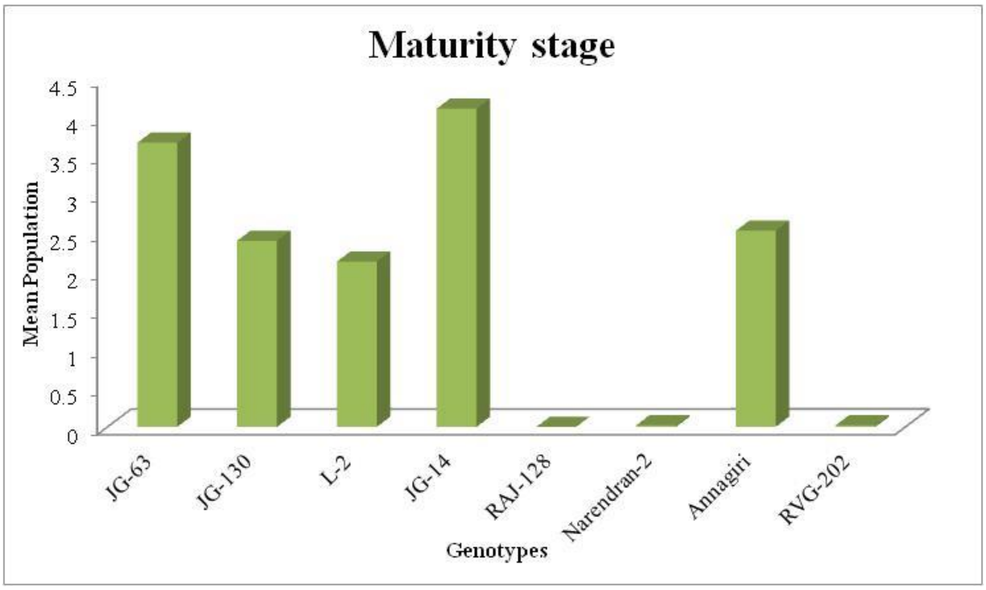

Fig. 4. Mean larval population of *H. armigera* on chickpea genotypes at maturity stage

Overall mean larval density of *Helicoverpa armigera* throughout the crop season: The seasonal mean population (Table 1 and Fig. 5) of *H. armigera* ranged from 0.25 (RAJ-128) to 1.96 (JG-14) larvae per 0.5 m^2. Data analysis revealed the lowest seasonal mean population density recorded in genotypes RAJ-128 and RVG-202 (0.25 and 0.29 larvae per 0.5 m^2, respectively), statistically comparable. Following were genotypes Narendran-2 and L-2 with seasonal mean population densities of 0.32 and 1.44 larvae per 0.5 m^2, respectively, also statistically comparable.

Percentage of pod damage: The average percentage of pod damage caused by *H. armigera* ranged from 4.48% to 15.21%, observed in genotypes Annagiri and JG-130, respectively. Genotypes Annagiri, RVG-202, and RAJ-128 exhibited the lowest pod damage percentages (4.48%, 5.32%, and 5.36%, respectively) and were statistically equivalent. Following were genotypes Narendran-2 and L-2 with pod damage percentages of 9.44% and 9.62%, respectively, also statistically equivalent (Table 1 and Fig. 6).

Yield: The mean seed yield (Table 1 and Fig. 7) of chickpea genotypes varied from 18.42 to 28.66 quintals per hectare (q/ha) in genotypes JG-63 and RVG-202, respectively. Genotype RVG-202 and RAJ-128 recorded the highest seed yields (28.66 and 28.25 q/ha, respectively), followed by genotypes L-2 and Annagiri (27.12 and 26.68 q/ha, respectively).

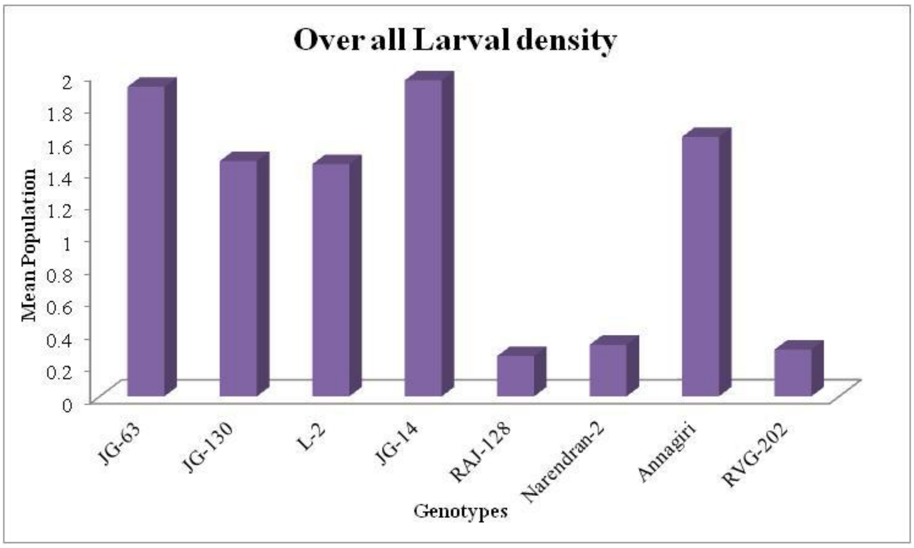

Fig. 5. Overall mean larval population of *H. armigera* on chickpea genotypes

Table 1. Mean larval density of *Helicoverpa armigera* during different crop stages, pod damage and yield of chickpea genotypes in *Rabi* 2023-24

S. No.	Genotypes	Mean larval density/0.5 m^2				Pod damage (%)	Yield q/ha.
		Vegetative stage	Flowering stage	Maturity stage	Average larval density		
1	**JG-63**	0.66	1.43	3.68	1.92	11.14	18.42
2	**JG-130**	0.43	1.55	2.41	1.46	15.21	24.12
3	**L-2**	0.75	1.42	2.14	1.44	9.62	27.12
4	**JG-14**	0.52	1.23	4.12	1.96	14.22	20.54
5	**RAJ-128**	0.18	0.64	0	0.25	5.36	28.25
6	**Narendran-2**	0.26	0.68	0.02	0.32	9.44	24.84
7	**Annagiri**	0.55	1.75	2.54	1.61	4.48	26.68
8	**RVG-202**	0.22	0.56	0.02	0.29	5.32	28.66
SEm		**0.02**	**0.03**	**0.05**	**0.03**	**1.12**	**1.98**
CD (5%)		**0.07**	**0.10**	**0.14**	**0.08**	**3.26**	**5.56**

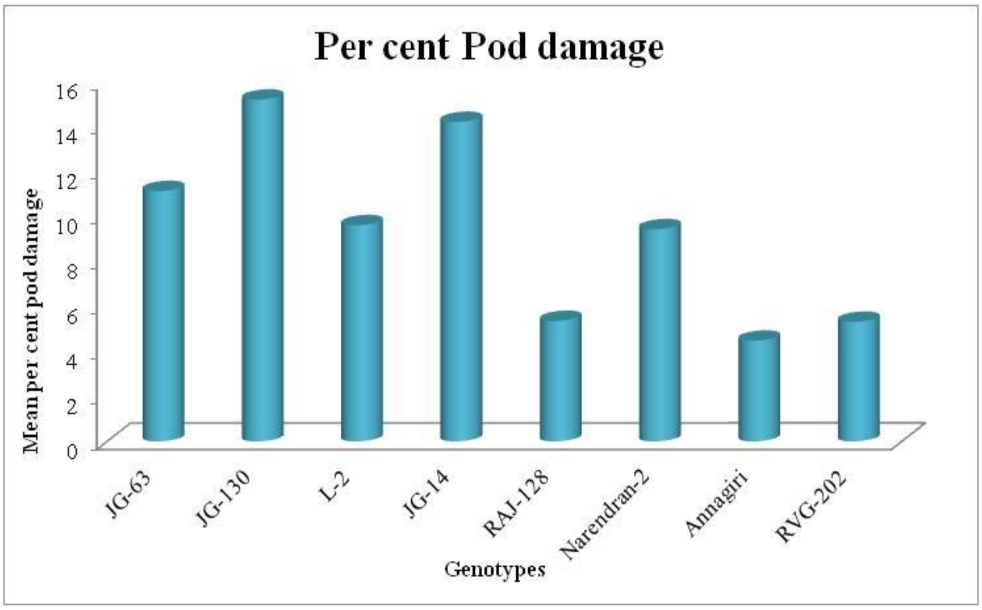

Fig. 6. Mean per cent pod damage of *H. armigera* on chickpea genotypes

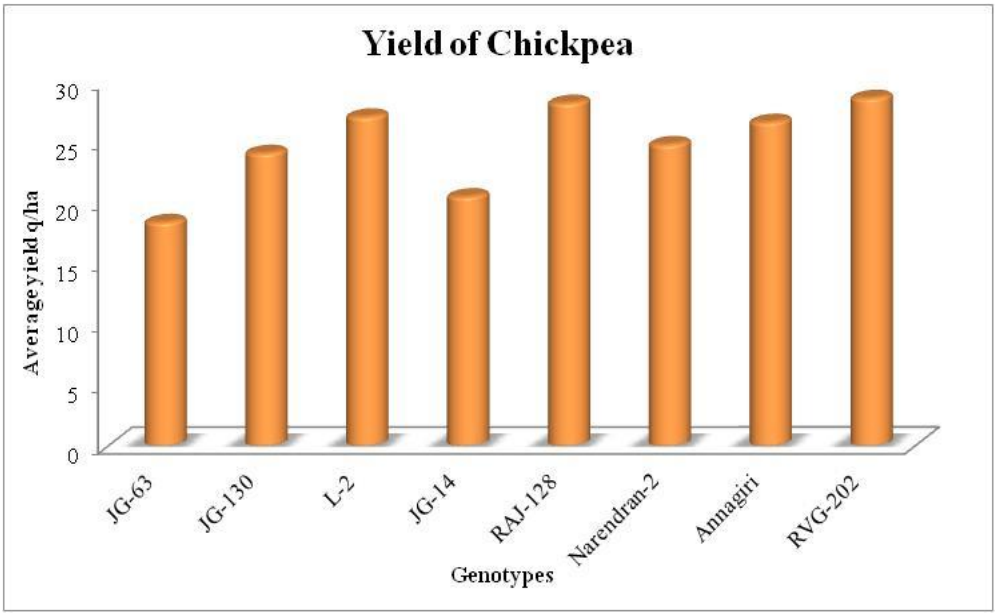

Fig. 7. Mean seed yield (q/ha) of chickpea genotypes

Maurya et al.[3]identified genotypes ICC 1964, ICC 14, ICC 729, and ICC 515 as the least susceptible to *H. armigera*. Kumar et al.[14] and Cheema et al.[15] noted genotype C 235 as tolerant to *H. armigera*, with the lowest pod damage of 5.5%. However, in the present study, pod damage percentage was not considered as a criterion for comparing genotype performance against *H. armigera* incidence, due to variations in the inherent pod bearing capacity of different genotypes.

Ruttoh et al. [16] observed significant variation in larval densities among genotypes and found genotypes EC 58318, ICC 10, ICC 14831, EC 583260, EC 583264, and EC 583250 to exhibit high resistance against *H. armigera*. Dialoke et al.[17]reported that the cultivar ICCV 16903 displayed resistance to *H. armigera*, while Patange et al.[4]and Brar [1] identified the variety Virat as resistant against *H. armigera*. In the present experiment, genotypes RAJ-128 and RVG-202 recorded the lowest seasonal mean larval population of *H. armigera* and proved to be the least preferred genotypes under protected conditions.

4. CONCLUSIONS

Based on the findings of the current study, it can be inferred that genotypes RAJ-128, RVG-202, and Narendran-2 exhibited the lowest seasonal mean population density of *Helicoverpa armigera*. Additionally, genotypes Annagiri, RVG-202, and RAJ-128 showed the lowest pod damage in protected condition. This underscores the significant role of host plant resistance, exemplified by marigold, pea, and chickpea, in managing pests effectively.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that no generative AI technologies such as Large Language Models and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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