https://doi.org/10.33307/entomon.v51i1.1609
ENTOMON 51(1): 19-26
Article No. ent. 51103

Consequences of environmental factors on the population distribution of *Acrida exaltata* (Walker), a pest in different ecosystems

Susanta Nath*

Department of Zoology, W.B.E.S., Government General Degree College, Singur 712 409, Hooghly, West Bengal, India.
Email: nathsus2017@gmail.com

ABSTRACT: The relations between environmental factors and population of *Acrida exaltata* (Walker) in three ecosystems were studied for two years. The biplot revealed that the total population was related to the temperature. The total population at fallow land was correlated with temperature ($r = 0.4578$, $p < 0.05$ for maximum temperature and $r = 0.6644$, $p < 0.05$ for minimum temperature). Biplot of total population, nymphal population, and male population of *A. exaltata* at the forest ecosystem showed a close relation to minimum temperature. But the female population was related to precipitation and temperature. The correlation matrix revealed a positive correlation of total population with relative humidity ($r = 0.4502$, $p < 0.05$) at agriculture land. The environmental factors regulated the vegetation as well as the soil consistence of the ecosystem. The eggs of acridids were capable of surviving in adverse conditions of weather and maintained the population throughout the year in the forest and fallow land due to the availability of the supporting vegetation. © 2026 Association for Advancement of Entomology

KEY WORDS: Acridid, fallow land, forest ecosystem, agriculture land, temperature, relative humidity, precipitation, vegetation

INTRODUCTION

The acridids, commonly called short-horned grasshoppers and locusts, belong to the order Orthoptera and family Acrididae, are almost cosmopolitan in distribution and very common in India. Different environmental factors, like temperature and humidity, had an immense role in the fecundity of grasshoppers (MacCarthy, 1956). Food plants also play an important role in maintaining the population of acridids (Pickford, 1960). The fertility and survival rates were related to the mortality and different ecological factors (Bhowmik, 1986). *Cyrtacanthacris tatarica*, a species of thicket and woodland, was a pest of crops in the plains of the Darjeeling district due to encroachments on its natural habitat (Bhowmik and Haldar, 1984). *Hieroglyphus banian* is a pest of paddy in India and other tropical countries. On the other hand, some grasshoppers, regarded as minor pests of paddy, also caused damage to cotton and sorghum in Asia (Kalaisekar *et al.,* 2017). *Acrida exaltata* (Walker) was considered a pest of rice and jute in West Bengal and Bangladesh (Bhowmik, 1986). Dwivadi and Chattaraj (1985) studied the population pattern in the grassland ecosystem of

* Author for correspondence

© 2026 Association for Advancement of Entomology

Madhya Pradesh. Haldar *et al.* (1995) have observed that the plants belonging to the family Poaceae were the most preferred food of *A. exaltata*. Nath and Haldar (1998) reported that monsoon and vegetation patterns had a profound impact on the population dynamics of the acridid in the arid zone of West Bengal. Effects of different heavy metals on *A. exaltata* in the highly polluted industrial belt were also reported (Nath, 2017; Nath *et al*., 2011). It is also a pest of sorghum in Asia (Gupta and Chandra, 2013; Kalaisekar *et al.,* 2017). Keeping these views in mind, a study was carried out on the population dynamics of this acridid in relation to different environmental factors in different ecosystems.

MATERIALS AND METHODS

Quantitative sampling of *A. exaltata* in three different ecosystems, namely, fallow land (FL), forest (FR) and agriculture land (AL) in Santiniketan (23.6776ºN; 87.6852ºE), West Bengal, India and its environs was carried out during a period of twenty-four months from March to February. The swiping technique of collection by an insect net was employed. Every ecosystem was divided into three quadrats, each $5m^2$ for the collection of the grasshoppers. The distance between the two quadrats was approximately ten feet. Thus, collection was made from nine quadrats, three quadrats of each ecosystem. Fortnight collections were done for 10 minutes in each of the quadrats. Therefore, the total collection time for each ecosystem was 30 minutes. Collections were made in the morning between 8 and 9 am. The collected insects from each plot were narcotised separately and transferred to the laboratory for further study. Data were used for the principal components analysis (PCA), correlation, by applying statistics Kingdom free software (https://www.statskingdom.com/pca-calculator.html).

RESULTS AND DISCUSSION

Fallow land ecosystem (Figs. 1 - 8): The population pattern of *A. exaltata* studied in relation to the environmental factors, revealed in the biplot, that the total population was related to the temperature (Fig.1). The total population was correlated with temperature ($r = 0.4578$, $p< 0.05$ for maximum temperature and $r = 0.6644$, $p< 0.05$ for minimum temperature). Whereas, the minimum temperature was correlated with the precipitation ($r = 0.4659$, $p< 0.05$). The eigenvalues from the scree plot revealed that principal components (PC-1) and PC-2 were 2.3373 and 1.4634, respectively, and the first two components explain more than 95 per cent of the variance in the data (Fig. 2).

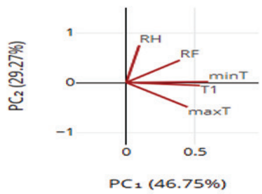
The biplot of nymphs of *A. exaltata* at fallow land revealed that the nymph population (N1) also related to the temperature (Fig. 3), like adult population (N1- Min temp, $r = 0.6213$, $p< 0.05$), and minimum temperature was correlated with precipitation ($r = 0.4659$, $p< 0.05$). The eigen values in the scree plot were 2.3055 and 1.4987, respectively (Fig. 4).

Male grasshopper population at fallow land was closely related to minimum temperature and rainfall (Fig. 5), and the population was directly correlated with minimum temperature ($r = 0.5135$, $p< 0.05$), and minimum temperature was correlated with rainfall ($r = 0.4659$, $p< 0.05$). The eigen values of PC- 1 and 2 were 2.253 and 1.4839, respectively, and the first two components explain more than 95 per cent of the variance in the data (Fig. 6). Female population was also correlated to minimum temperature ($r = 0.4956$, $p< 0.05$), and as presented in the biplot (Fig. 7). Eigen values for the PC-1 and PC-2 are presented in scree plot (Fig. 8).

Forest ecosystem: The biplot of total population (Fig. 9), nymphal population (Fig. 11), and male (Fig. 13) population of *A. exaltata* showed a close relation to minimum temperature. But the female population was related to precipitation and temperature (Fig. 15). There was correlation between the grasshopper total population ($r = 0.5037$, $p< 0.05$), nymphal population ($r = 0.4464$, $p< 0.05$), male population ($r = 0.4732$, $p< 0.05$) with minimum temperature and female population ($r = 0.4577$, $p< 0.05$) with precipitation. Moreover, eigen values also showed a similar trend as was observed in the fallow-land ecosystem (Figs. 10, 12, 14, 16).

Agricultural field: The biplot showed that the total population was closely related to the relative

Relation between *Acrida exaltata* population and environmental factors at Fallow land ecosystem (Figs. 1 – 8)



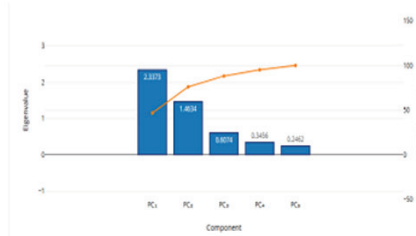
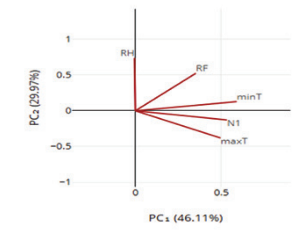


Fig. 1 Biplot - relations between total number and environmental factors; Fig. 2 Scree plot for total number and environmental factors



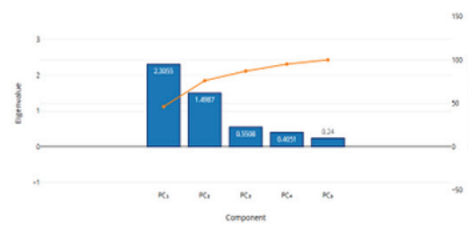
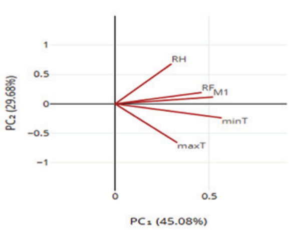


Fig. 3 Biplot - relations between nymph and environmental factors; Fig. 4. Scree plot for nymph and environmental factors



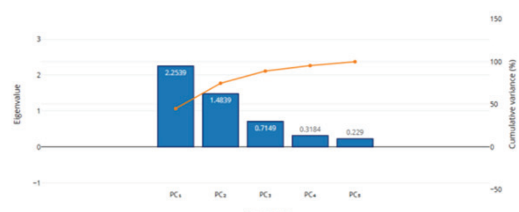
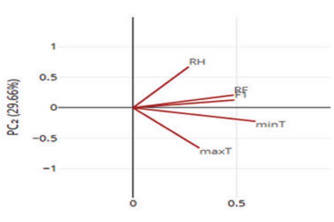


Fig. 5 Biplot - relations between male and environmental factors; Fig. 6. Scree plot for male and environmental factors



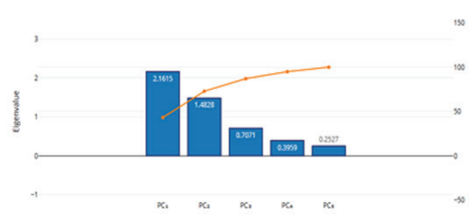
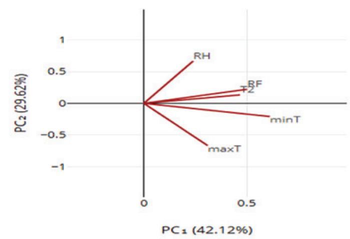


Fig. 7 Biplot - relations between female and environmental factors; Fig. 8 Scree plot for female and environmental factors

Relation between *Acrida exaltata* population and environmental factors at Forest ecosystem (Figs. 9 – 16)



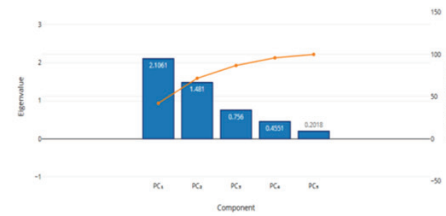
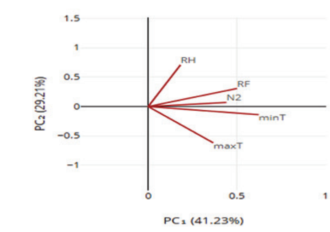


Fig. 9 Biplot - relations between total number and environmental factors; Fig. 10 Scree plot for total number and environmental factors



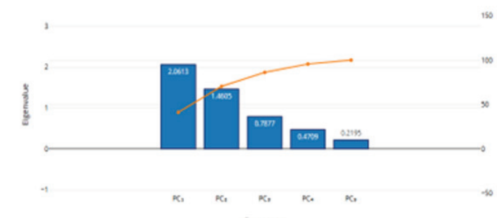
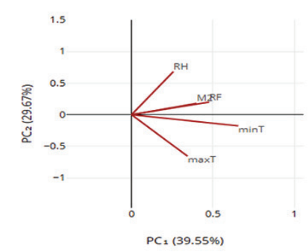


Fig.11 Biplot - relations between nymph and environmental factors; Fig. 12 Scree plot for nymph and environmental factors



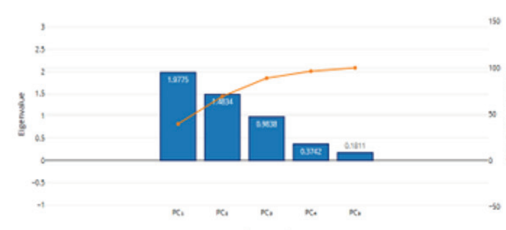


Fig. 13 Biplot - relations between male (M2) and environmental factors; Fig. 14 Scree plot for male and environmental factors

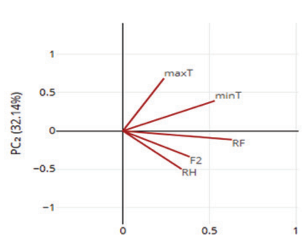


Fig.15 Biplot - relations between female (F2) and environmental factors; Fig. 16 Scree plot for female (F2) and environmental factors

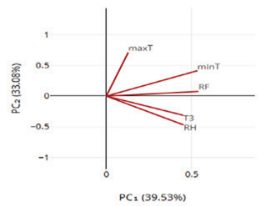
humidity and to the temperature, and precipitation (Fig. 17). The correlation matrix revealed a positive correlation of total population with relative humidity (RH) ($r = 0.4502$, $p < 0.05$). Minimum and maximum temperature also correlated ($r = 0.5563$, $p < 0.05$). Precipitation and minimum temperature had a significant correlation ($r = 0.4659$, $p < 0.05$). The eigenvalues observed from the scree plot (Fig. 18) indicate that PC-1 and PC-2 have 1.9763 and 1.654, respectively, and the first components explain more than 95 percent of the variance in the data. The nymph population also revealed almost similar pattern of relation between nymph population and environmental factors (Figs. 19, 20).

The male population of *A. exaltata* at agricultural field revealed positive correlation with precipitation ($r = 0.4993$, $p < 0.05$) and at the same time minimum temperature was positively correlated with precipitation ($r = 0.4659$, $p < 0.05$). The biplot also revealed the same phenomenon (Fig. 21). Eigen values for PC-1 and PC-2 were 2.04 and 1.5423 respectively and scree plot revealed 95 percent of cumulative variance (Fig. 22). The biplot for female population revealed a close relation with precipitation and relative humidity (Fig. 23). But correlation matrix revealed no significant relation between adult female grasshoppers and environmental factors. Eigen values for PC-1 and PC-2 are 1.9464 and 1.5554 and scree plot also revealed a high per cent of cumulative variance (Fig. 24).

Studies on *A. exaltata*, a minor pest of paddy and sorghum in Asia (Gupta and Chandra, 2013), revealed that the occurrence was related to the environmental factors. This grasshopper was available almost throughout the year in the forest and the fallow land. Whereas, available in the cultivation field, when crop cultivation was done and availability of paddy plants as food during and after the monsoon. Moreover, the soil beside the cultivation fields became soft during and after the monsoon. The study also revealed that *A. exaltata* occurred in the agriculture land ecosystem during the period from June to September, when Kharif paddy was cultivated and in November during Boro paddy cultivation. The grass-feeding insects like grasshoppers were closely associated with the changes of weather (Jonas *et al.*, 2015). The present study revealed that the population pattern was highly correlated with the temperature, and the temperature was related to the precipitation. It appeared that the number of this insect increased gradually from April, when the temperature increased gradually, and nymphs hatched out due to the softening of the soil. After winter, the temperature rose which made the hatching easier for this insect. The minimum temperature was correlated with precipitation in all types of ecosystems.

Among the vegetation pattern of the forest, *Shorea robusta*, *Acacia auriculiformis*, *Cassia siamea*, *Anacardium occidentale*, *Eucalyptus citriodora*, *Azadirachta indica* and *Syzygium cumuni* were dominant. Among the shrubs, *Detura metel*, *Heliotropium indicum*, *Cassia occidentalis*, *Tribulus terrestris*, *Rumex dentatus*, *Polygonum plebeium,* etc. were dominant, whereas, *Chrysopogon aciculatus*, *Cynodon dactylon*, *Oplismenus compositus*, *Dactylotenium aegyptium,* etc., were the dominant species of the herbs in the forest ecosystem. No trees were present in the fallow land, where few herbs like *Chrysopogon aciculatus*, *Cynodon dactylon, Poa* sp, etc. and shrubs, such as *Leucas cephalotes, Ocimum canum, Xyris indica, Solanum surattense, Argemone mexicana,* etc, were found. *A. exaltata* mainly depends upon herbs for its food. In adverse situations, a few of these herbs acts as an additional food source in the forest and fallow land ecosystems; as a result, the population of *A. exaltata* was maintained throughout the year. Due to rain, the temperature of the weather reduced, and the soil became softer than dry season. These resulted in increased vegetation in the area. Which were suitable situations for reproduction, as well as increasing the population of the grasshoppers. The growth of paddy in agriculture land was rapid in comparison to other vegetation of the surrounding areas during its cultivation time. This attracted the acridid population to the paddy field during the cultivation period. The easy availability of paddy as food and the soft soil of the surroundings of the paddy field,

Relation between *Acrida exaltata* population and environmental factors at Agricultural ecosystem (Figs. 17 – 24)



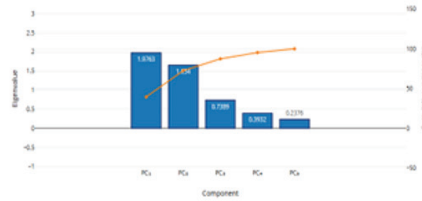
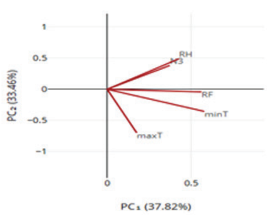


Fig. 17 Biplot - relations between total number (T3) and environmental factors; Fig. 18 Scree plot for total number (T3) and environmental factors



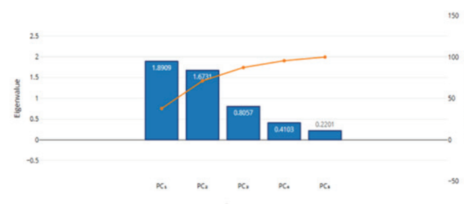
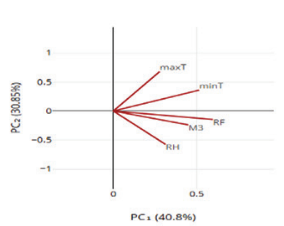


Fig. 19 Biplot - relations between nymph (N3) and environmental factors; Fig. 20 Scree plot for nymph (N3) and environmental factors



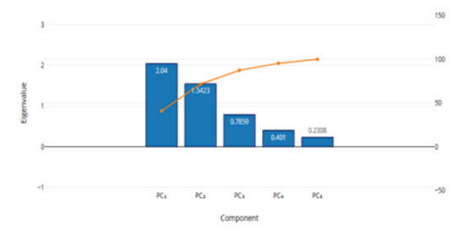
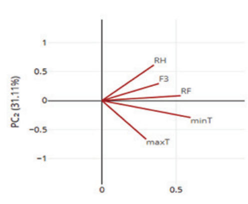


Fig. 21 Biplot - relations between male (M3) and environmental factors; Fig. 22 Scree plot for male (M3) and environmental factors



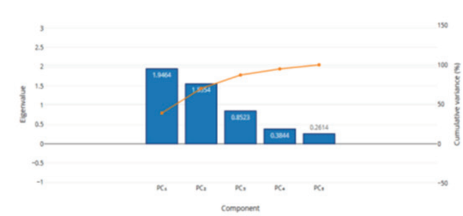


Fig. 23 Biplot - the relations between female (F 3) and environmental factors; Fig. 24 Scree plot for total number (F3) of *A. exaltata* and environmental factors

which in turn would assist in the oviposition by the female with ease. As a result, this acridid was available in maximum numbers in the crop field and surrounding areas during the monsoon. Moreover, due to rapid growth and an identical pattern of vegetation, like paddy, insects also migrated in large numbers from the surrounding areas. From the beginning of the winter month and onward, the crop land became dry, and, from the end of winter to the summer months, the supporting vegetation dried up, and the soil became hard. At the same time, a change in the suitable weather temperature also took place. Probably, that might be one of the reasons for the disappearance of the species from the crop land ecosystem under stressful situations. That conformed to the results reported by Dempster (1957). It appeared from the study that changes in the environmental factors affected the vegetation pattern of the study areas. Which affected the population pattern of *A. exaltata* in the study area (Anderson, 1964; Latchininsky, 1998). The eggs of acridids were capable of surviving in adverse conditions of weather, and maintained the population throughout the year in the forest and fallow land due to the availability of the supporting vegetation. When the conditions of agriculture land were suitable, this acridid was available in noticeable numbers, and the soft soil of the cultivation field assisted in the oviposition by the female with ease. Dempster (2008) reported that tropical grasshoppers generally laid eggs when conditions were suitable for growth, while eggs underwent diapause when both temperature and moisture were extreme. Meena *et al*. (2023) also revealed the significant role of climatic factors in limiting grasshopper populations in the summer and highest in the monsoon period. It was also reported that the mean annual precipitation was the main environmental factor that affected the distribution of grasshoppers in their habitat (Li *et al*., 2024). Development, abundance and diversity of grasshoppers influenced by the temperature of the environment (Wang and Hou, 2025). The present study also revealed that precipitation and minimum temperature were directly correlated in all the ecosystems studied, whereas precipitation, temperature, and relative humidity had direct correlation with the occurrence of the *A. exaltata* population.

ACKNOWLEDGEMENTS

Author is thankful to Professor Parimalendu Haldar, Visva Bharati University, for his guidance and support during this work.

REFERENCES

Anderson N.L. (1964) Some relationship between grasshoppers and vegetation. *Annals of the Entomological Society of America* 57(6): 736–742. doi: 10.1093/aesa/57.6.736.

Bbowmick H.K. (1986) Grasshopper fauna of West Bengal, India (Orthoptera: Acrididae). Zoological Survey of India, Tech. Monograph 14: 1–180.

Bhowmik H.K. and Haldar P. (1984) Remarks of twelve species of newly recorded grasshoppers (Orth.) from West Bengal. Bulletin of the Zoological Survey of India 6 (1-3): 45–55.

Dempster J.P. (1957) The population dynamics of the Moroccan locust (*Dociostaurus maroccanus* Thunb.) in Cyprus. Anti-Locust Bulletin 27: 1–4.

Dempster J.P. (2008) Population dynamics of grasshoppers and locusts. Biological reviews of the Cambridge Philosophical Society 38(4): 490–529. doi: 10.1111/j.1469-185X.1963.tb00791.x.

Dwivedi K.P. and Chattoraj A.N. (1985) Energy budget of grasshopper *Acrida exaltata* (Walker) population in Mohanbhata grassland. Environment and Ecology 3(1): 1–5.

Gupta S.K. and Chandra K. (2013) Annotated list of Orthopteran insect pests in India. Bionotes 15(4): 117–122.

Haldar P., Bhandar K.P. and Nath S. (1995) Observation on food preferences of an Indian grasshopper, *Acrida exaltata* (Walker) (Orthoptera: Acrididae: Acridinae). Journal of Orthoptera Research 4: 57–59. doi: 10.2307/3503458.

Jonas L., Wolesensky W. and Joern A. (2015) Weather Affects Grasshopper Population Dynamics in Continental Grassland over Annual and Decadal Periods. Rangeland Ecology & Management 68(1): 29–39. doi: 10.1016/j.rama.2014.12.011.

Kalaisekar A., Padmaja P.G., Bhagwat V. and Patil J.V. (2017) Insect pests of millets: systematics, bionomics, and management. Elsevier, London. 10–240pp.

Latchininsky A.V. (1998) Moroccan locust *Dociostaurus maroccanus* (Thunberg, 1815): a faunistic rarity or an important economic pest? Journal of Insect

Conservation 2: 167–178. doi: 10.1023/A:1009639628627.

Li D., Gen H., Li, X., Zhou H., Zhang H., Liu Y., Dong R., Hua L. and Hu G. (2024) Changes in the Range of Four Advantageous Grasshopper Habitats in the Hexi Corridor under Future Climate Conditions. Insects 15(4): 243. doi: 10.3390/insects15040243.

MacCarthy H.R. (1956) A ten year study of the climatology of *Melanoplus maxicanus* (Sauss.) (Orthoptera: Acrididae) in Saskatchewan. Canadian Journal of Agricultural Science 36(6): 445–462.

Meena P., Prajapat R., Kumawat N. and Meena S. (2023) Grasshopper Species Composition and Severe Attack in the Semi-Arid Region of Rajasthan, India. Environment and Ecology 41 (4D): 3111—3119. doi: 10.60151/envec/RKAB4387.

Nath S. (2017) Mortality of a common Indian grasshopper exposed to dietary arsenic. ENTOMON 42(2): 173–176.

Nath S., Anand H. and Haldar P. (2011) Study of short horned grasshoppers in relation to heavy metals accumulation. Journal of Entomological Research 35(3): 291–293.

Nath S. and Haldar P. (1998) Population dynamics of the grasshopper *Acrida exaltata* (Walker) in the arid zone of West Bengal. Journal Interacad 2(1&2): 51–53.

Pickford R. (1960) Survival fecundity and population growth of *Melanoplus bilituratus* (Wlk.) (Orthoptera: Acrididae) in relation to date of hatching. The Canadian Entomologist 92(1): 1–10. doi: 10.4039/Ent921-1.

Wang W. and Hou F. (2025) Population dynamics and diversity of typical steppe grasshoppers in response to long-term grazing. Journal of Environmental Management 395: Article 127793. doi: 10.1016/j.jenvman.2025.127793.

https://www.statskingdom.com/pca-calculator.html

(Received June 17, 2025; revised ms accepted August 21, 2025; published March 31, 2026)