The Role and Growth of *Bacillus thuringiensis* as a Biopesticide: Applications, Mechanisms and Adoption in India

Ragasruthi Malaravan[1*], Srinivasan G[2], Janani Mani[3] and Aswathi Narayanadas[1]

[1]Department of Agricultural Entomology, TNAU, Coimbatore, Tamil Nadu, India

[2] Department of Agronomy, TNAU, Coimbatore, Tamil Nadu, India

[3]Department of Nematology, TNAU, Coimbatore, Tamil Nadu, India

[*]Corresponding Author: ragasruthimalaravan@gmail.com

Bacillus thuringiensis, a naturally occurring gram positive bacterium which is soil dwelling and belongs to the family Bacillaceae. This was first discovered by Ishiwatari Shigetane, a Japanese sericulture engineer from Silkworm and named it as *Bacillus sotto*. Later, in 1911 Ernest Berliner reidentified it from the flour moth and changed the name as *B. thuringiensis* (McBride & Turnbull, 1998). *Bt* is a naturally occurring bacterium that has gained prominence as an eco-friendly pest control agent. Unlike chemical pesticides, *Bt* offers a targeted approach to managing agricultural pests, minimizing harm to non-target species and the environment. This overview explores the nature of *Bt*, its mechanism of action, benefits, and applications in sustainable agriculture (Kumar *et al.,* 2021). It is unique because it produces crystal (Cry) proteins also known as delta-endotoxins during its sporulation phase, which are toxic to specific insect pests. When susceptible insects ingest these proteins, the alkaline environment of their gut activates the toxins. The Cry proteins then bind to specific receptors in the gut lining, causing the cells to rupture. This leads to paralysis of the digestive system, resulting in the insect's death within a few days (de Maagd *et al.,* 1999). *Bt* is effective against a variety of insect pests, particularly those in the orders Lepidoptera (moths and butterflies), Coleoptera (beetles), and Diptera (flies and mosquitoes). Notably, *Bt* targets only specific insect larvae, making it safe for beneficial insects like bees, as well as mammals, birds, and humans (Mullaney & Gaalaas, 2024).

Applications of *Bt*

In agriculture, *Bt* is primarily used as a biopesticide, applied in various formulations such as sprays, dusts, and granules. These products target specific insect pests like caterpillars, beetles, and dipterans that harm crops. Additionally, *Bt* has been genetically engineered into crops such as cotton, corn, and soybeans, allowing these plants to produce their own insecticidal toxins. These *Bt* GM crops provide built-in resistance to major pests like the cotton bollworm and European corn borer, reducing the need for chemical pesticides and lowering production costs for farmers (Sanchis & Bourguet, 2008). *Bt* is a cornerstone of organic farming, offering an effective and natural solution for pest control that aligns with organic farming principles. Organic farmers rely on *Bt* to protect their crops while avoiding synthetic chemicals, helping maintain ecological balance. Home gardeners also benefit from *Bt*, using it to safely manage pests in vegetable gardens, ornamental plants, and small-scale agriculture (Metz, 2003).

Bt versatility extends to stored product pest control, where it is used to protect grains and other stored goods from insect infestations. By applying *Bt* formulations in storage areas or mixing them with stored products, pests like moths and beetles are controlled, preventing significant losses. Furthermore, *Bt* has become a valuable tool in scientific research and biotechnology, where its genes are studied for developing new pest control methods and transgenic crops. This wide range of applications underscores *Bt* importance as a natural and effective solution in pest management, contributing to sustainable agricultural practices and environmental conservation.

Bt biopesticide in India

In India, biopesticide currently account for 9% of the total biopesticide consumption. By the year 2050, it is expected that biopesticides will comprises up to 50% of the overall pesticide market with anticipated growth rate of 2.5% (Yadav, 2022). Additionally, data indicates that, India has escalated its utilization of biopesticides in recent decades. Specifically, the usage of *Bt* increased from 40 to 71 metric tons between the years 1994-95 and 1999-2000 (Anindita *et al.,* 2022). According to insecticide act 1968, 12 biopesticides were registered which includes three *Bt* biopesticides *viz., Bt israelensis; Bt kurstaki; Bt galleria* (Yadav *et al.,* 2022). In India, the Central Insecticides Board and Registration Committee (CIBRC), have approved a total of 970 biopesticides, with bacterial biopesticides contributing 29% of this total (Nayak and Solanki, 2021). In that *Bt* make up to 15% of the total bacterial biopesticide with an increasing rate of 10% annually (Chakraborty *et al.,*

2023). Totally 18 *Bt* based biopesticide formulations were registered, which is shown in the table 1.

The growing adoption of *Bt* biopesticides, particularly in India, underscores its potential to play a major role in the future of pest control, as evidenced by increasing usage trends and expanding regulatory support. As the demand for sustainable agriculture intensifies, *Bt* role in reducing chemical pesticide reliance and promoting environmental conservation will become even more critical, paving the way for a safer and more sustainable agricultural landscape.

References

Anindita, P., Majumder, S., & Singh, S. (2022). Bio pesticide: A paradigm shifts of pesticide development in India. *Food Sci. Rep.* 3, 22–25.

Chakraborty, N., Mitra, R., Pal, S., Ganguly, R., Acharya, K., Minkina, T., Sarkar, A. & Keswani, C. (2023). Biopesticide Consumption in India: Insights into the Current Trends. *Agriculture*, *13*(3), 557.

de Maagd, R.A., Bakker, P., Staykov, N., Dukiandjiev, S., Stiekema, W., Bosch, D. (1999) Identification of *Bacillus thuringiensis* delta-endotoxin Cry1C domain III amino acid residues involved in insect specificity. *Appl Environ Microbiol*. 65(10):4369-74. doi: 10.1128/AEM.65.10.4369-4374.1999.

Kumar, P., Kamle, M., Borah, R. *et al. Bacillus thuringiensis* as microbial biopesticide: uses and application for sustainable agriculture. *Egypt J Biol Pest Control* **31**, 95 (2021). https://doi.org/10.1186/s41938-021-00440-3

McBride, B.W., & Turnbull, P.C.B (1998). *Bacillus*, Infection and Immunity. In: *Encyclopedia of Immunology*. pp: *311–315.*

Metz, M. (2003). *Bacillus thuringiensis: a cornerstone of modern agriculture*. CRC Press.

Mullaney, Emma Gaalaas. "*Bacillus thuringiensis*". *Encyclopedia Britannica*, 31 May. 2024, https://www.britannica.com/science/Bacillus-thuringiensis.

Nayak, P., & Solanki, H. (2021). Pesticides and Indian agriculture—A review. *Int J Res Granthaalayah*, *9*(5), 250-263.

Sanchis, V., Bourguet, D. *Bacillus thuringiensis*: applications in agriculture and insect resistance management. (2008). A review. *Agron. Sustain. Dev.* **28**, 11–20. https://doi.org/10.1051/agro:2007054

Yadav, R. (2022). Biopesticides: Current status and future prospects. *Proceedings of the International Academy of Ecology and Environmental Sciences*, *12*(3), 211.

Table 1: *Bt*-based biopesticide registered in India

S. No.	*Bt* subspeciaqueous suspensions	Strain /serotype	Formulations	Potency
1.	***Bt galleriae***	Strain 1593M, Serotype H 59 5b,	1.3% Flowable concentrate	1500IU/mg
2.	***Bt krustaki***	Strain Z-52, Serotype H-39, 3B,	Wettable powder	
3.		Serotype - 3a, 3b, 3c	0.5% wettable powder	55000 SU
4.		Strain DOR Bt-1, Serotype 3a, 3b, 3c,	0.5% wettable powder	9000 IU/mg min
5.		Strain DOR Bt-1 NAIMCC-B-01118, Serotype 3a, 3b, 3c,	0.5% wettable powder	13329 IU/mg min
6.		Strain DOR Bt-1, serotype 3a, 3b, 3c,	0.5% wettable powder	16000IU/mg min
7.			2.5 aqueous suspensions	
8.		Strain HD-1, Serotype 3a, 3b	3.5% aqueous suspensions	17600 IU/mg
9.		Serotype 3a, 3b,	Spot-on	53000 SU/mg,
			Wettable granules	32000 IU/mg

10.	***Bt israelensis***		Wettable powder	
11.		Serotype H-14	12% aqueous suspensions	1200 ITU / mg
12.		Strain VCRC-B-17, Serotype H14	5.0% aqueous suspensions	
13.		Serotype H-14	5.0% aqueous suspensions	
14.		Serotype H-14	5% wettable powder	2000 ITU/mg
15.		Strain Designation- ABIL, Accession No. NAMICC-B01318 (CFU Count- 4.8 x 108), Serotype H-14	5% wettable powder	7000 ITU/mg
16.			00.50% wettable powder	
17.			05.00% wettable powder	
18.	***Bt sphaericus***	Strain 1593 M, Serotype H 59 5b	1.3% flowable concentrate	1300 IU/ mg

Ref: https://ppqs.gov.in/divisions/cib-rc/registered-products

* * * * * * * *