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Influence of water quality on efficacy of *Bacillus thuringiensis* (Berliner) used as spray fluid*

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ABSTRACT: The influence of Electrical Conductivity (EC) - based quality of water, used as spray fluid, on the bioefficacy of commercial formulations of *Bacillus thuringiensis* (Berliner) (*B. t.*) was studied in laboratory bioassays against *Spodoptera litura* (Fabricius) and *Helicoverpa armigera* (Hübner). EC quality did not alter the efficacy of *B. t.* formulations significantly. However, larval mortality decreased with increase in EC.

KEY WORDS : *Bacillus thuringiensis*, bioefficacy, *Helicoverpa armigera*, *Spodoptera litura*, water quality

Biological control by microbial agents has gained great importance in recent years. *Bacillus thuringiensis* (Berliner) (*B. t.*) based bio-pesticides have been the most promising. *Bacillus thuringiensis* has been successfully exploited as a microbial pesticide against a wide range of insect pests including the diamondback moth *Plutella xylostella* Linnaeus (Makino and Hokikiri, 1985; Talekar *et al.*, 1985; Rushtapakornachari and Vattanatangam, 1986; Navon and Meir, 1990). Many formulations of *B. t.* are now available in the global market. Farmers need to choose the most effective product from the market and use it judiciously in the field. Often irrigation water is used by the farmers to prepare the spray fluid. It is, therefore, necessary to understand the influence of electrical conductivity on the field efficacy of *B. t.* products. A laboratory bioassay was conducted with larvae *of Spodoptera litura* (Fabricius) and *Helicoverpa armigera* (Hübner) to know the influence of quality of water on commercial brands *B. t.*

MATERIALS AND METHODS

In order to test the influence of quality of water upon the effectiveness of commercial *B. t.* products *viz.*, Delfin (*B. t.* var. *kurstaki* 53,000 SU/mg *S. exigua* units), Spicturin (*B. t.* var. *galleriae* 1 x 10^6/ml) and Agree (*B. t. k.* + *aizawai* 0.2%),

four different categories of irrigation water of variable EC having more or less similar pH (Table 1) were collected from different sources and studied in comparison with distilled water at Agricultural College and Research Institute, Killikulam during 1996.

Table 1. Quality of water used as spray fluid

Category	EC (m.mhos /cm)	pH
Well water	6.38	6.8
Well water	4.23	7.0
Well water	3.89	7.0
River water	0.17	7.1
Distilled water	0.08	6.9

Larvae of *S. litura* were mass reared on castor (*Ricinus communis* L.) leaves at 31±2° C. Disease-free culture was maintained by following proper sanitary conditions as outlined by Pawar and Ramakrishnan (1971). Laboratory population of *H. armigera* was established from field collected larvae and the culture was maintained according to Shorey and Hale (1965).

In the bioassay, leaf discs (6 cm diam.) of castor were used for *S. litura* and chickpea seeds for *H. armigera*. The food materials (leaf discs or seeds) were immersed in the *B. t.* suspension for 30 seconds and the excess fluid was removed after uniform jerking and shade drying. They were then placed separately inside petri dishes over moist blotting paper. To each disc, a single third instar larva was released after it was starved for 12 h. For each treatment ten larvae were used. The experiment was replicated ten times. Larvae were allowed to feed on the treated leaf disc or seeds for 24 h. Mortality counts were made at 24 h interval. Natural mortality was corrected (Abbott, 1925) before statistical analysis.

RESULTS AND DISCUSSION

Quality of water did not seem to have significant effect on the efficacy of *B. t.* in different formulations (Tables 2-4). However, the average larval mortality of *S. litura* and *H. armigera* varied 96 h after treatment with the use of different types of water. In all experiments, maximum number of larvae died when distilled water was mixed with *B. t.* and lowest when well water (with EC 6.38) was mixed with *B. t.* The mortality after 96 h in *S. litura* due to Delfin (Table 2), Spicturin (Table 3) and Agree (Table 4) was in the range of 51.55 - 71.22, 49.55 - 68.88 and 53.11 - 74.55 per cent, respectively. The mortality of *H. armigera* larvae after 96 h varied between 42.28 and 66.82 per cent due to Delfin (Table 2), between 36.75 and 62.17 per cent due to Spicturin (Table 3) and between 48.50 and 69.00 per cent due to Agree (Table 4). The results indicated that the quality of water did not alter the efficacy of *B. t.* significantly. However, the mortality in *S. litura* and *H. armigera* often decreased with increase in EC of the irrigation water. Thus, the mortality from *B. t.* added to five different types of water increased as : well water (6.38) < well water (4.23) < well water (3.89) < river water (0.17) < distilled water (0.08). Nevertheless, there was no statistically significant difference among the mortality levels from various spray fluids.

Table 2. Influence of water quality on toxicity of Delfin to *S. litura* and *H. armigera*

Water source	EC (m.mhos/cm)	Cumulative larval mortality (%)			
		S. litura		*H. armigera*	
		72 h	96 h	72 h	96 h
Well	6.38	31.56 (34.05)^{b}	51.55 (45.92)^{c}	28.00 (31.82)^{c}	42.28 (40.40)^{c}
Well	4.23	33.56 (35.22)^{b}	53.44 (47.04)^{bc}	33.00 (33.02)^{c}	57.49 (49.4)^{ab}
Well	3.89	38.88 (38.48)^{b}	63.65 (53.88)^{ab}	30.00 (30.02)^{c}	47.28 (43.39)^{c}
River	0.17	39.95 (38.95)^{b}	64.10 (53.08)^{ab}	37.00 (37.40)^{ab}	60.22 (51.34)^{ab}
Distilled water	0.08	49.88 (44.94)^{a}	71.22 (57.73)^{a}	41.00 (39.75)^{a}	66.82 (55.06)^{a}
Untreated check	-	2.00 (3.69)^{c}	3.00 (5.53)^{d}	0.00 (0.00)^{d}	3.00 (5.53)^{d}

Figures in parentheses are angular transformed values. In a column, means followed by a common letter are not significantly different at P=0.0 5 level by DMRT

Table 3. Influence of water quality on toxicity of Spicturin to *S. litura* and *H. armigera*

Water source	EC (m.mhos/cm)	Cumulative larval mortality (%)			
		S. litura		*H. armigera*	
		72 h	96 h	72 h	96 h
Well	6.38	24.56 (29.43)^{c}	52.55 (46.49)^{bc}	23.00 (28.42)^{d}	36.75 (37.25)^{b}
Well	4.23	34.99 (36.21)^{b}	58.55 (49.75)^{bc}	28.00 (31.72)^{cd}	38.69 (40.15)^{b}
Well	3.89	29.77 (33.09)^{bc}	49.55 (44.77)^{c}	31.00 (33.75)^{bc}	54.05 (47.34)^{a}
River	0.17	37.18 (37.58)^{ab}	61.89 (51.88)^{ab}	34.00 (35.58)^{ab}	60.00 (51.17)^{a}
Distilled water	0.08	44.55 (41.90)^{a}	68.88 (56.10)^{a}	39.00 (38.61)^{a}	62.17 (51.57)^{a}
Untreated check	-	3.00 (9.97)^{d}	3.00 (9.97)^{d}	0.00 (0.00)^{e}	2.00 (4.43)^{c}

Figures in parentheses are angular transformed values. In a column, means followed by a common letter are not significantly different at P=0.05 level by DMRT

Table 4. Influence of water quality on toxicity of Agree to *S. litura* and *H. armigera*

Water source	EC (m.mhos/cm)	Cumulative larval mortality (%)			
		S. litura		*H. armigera*	
		72 h	96 h	72 h	96 h
Well	6.38	28.66 (32.17)^{c}	57.11 (49.14)^{bc}	26.00 (30.44)^{d}	48.50 (44.14)^{d}
Well	4.23	38.77 (38.44)^{b}	58.22 (49.8)^{bc}	30.00 (33.10)^{cd}	51.69 (45.58)^{cd}
Well	3.89	29.44 (33.36)^{c}	53.11 (49.53)^{c}	38.00 (36.73)^{bc}	57.00 (49.07)^{bc}
River	0.17	40.77 (39.65)^{b}	63.33 (52.82)^{b}	41.00 (39.78)^{b}	63.00 (52.67)^{b}
Distilled water	0.08	46.88 (45.22)^{a}	74.55 (59.86)^{a}	49.00 (44.41)^{a}	69.00 (56.88)^{a}
Untreated check	-	2.00 (3.69)^{d}	1.25 (6.55)^{b}	0.00 (0.00)^{e}	0.00 (0.00)^{e}

Figures in parentheses are angular transformed values. In a column, means followed by a common letter are not significantly different at P=0.05 level by DMRT

Eventhough, the quality of water did not alter the efficacy of *B. t.* in commercial formulations, it is better to use good quality water to get better results. Falcon (1971) reported that the persistence of NPV was affected by various chemicals like carbonates, bi-carbonates, sodium, potassium and calcium, which are normally expressed as EC. These products in the irrigation water could well influence the infectivity and persistence of *B. t.*

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