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Synergistic interaction of *Bacillus thuringiensis* Berliner with some Insecticides against the Tobacco Caterpillar, *Spodoptera litura* Fabricius on Cauliflower

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ABSTRACT

Pot culture studies on the interspecific economic synergism between *Bacillus thuringiensis* Berliner (*B.t.*) and endosulfan, phosalone and fenvalerate against the tobacco caterpillar, *Spodoptera litura* Fabricius showed that combination of fenvalerate (0.01%) with *B.t.* (4.40 x 10^8 viable spores/ml) was significantly superior to others in inflicting mortality/deformity in the insect pest. The combination of the bacterium with phosalone and endosulfan also proved effective against the insect pest. *B.t.* at 4.40 x 10^8 and 2.20 x 10^8 viable spores/ml produced a mortality of 58.37 and 38.22 per cent respectively, while the bacterium in combination with insecticides caused mortality/deformity in the pest to the extent of 53.99 to 96.27 per cent indicating potentiating synergism.

KEY WORDS : *Bacillus thuringiensis*, insecticides, economic synergism, *Spodoptera litura*

The adverse effects of broad spectrum and persistent insecticides on the agroecosystem are well documented. These insecticides are detrimental to the natural enemies like parasitoids and predators of the pests which otherwise regulate their abundance in the natural ecosystem. The bacterial pathogen, *Bacillus thuringiensis* Berliner (*B.t.*) can be used as an important component in integrated pest management either alone or in combination with reduced amounts of insecticides. Formulations containing viable spores of *B.t.* and sublethal doses of insecticides have been reported to be more effective (Lappa, 1964; Benz, 1971; Chalfant, 1971; Baskaran and Kumar, 1980). The resultant enhanced action in combination between pathogens and pesticides has been referred to as interspecific economic synergism (Benz, 1971). The present studies were carried out to determine the campatibility/interspecific economic synergism of *B.t.*- insecticide combinations in the management of tobacco caterpiller, *Spodoptera litura* Fabricius infesting cauliflower.

MATERIALS AND METHODS

A pot culture experiment was carried out to determine the compatibility vis-a-vis interspecific economic synergism of *B.t.* with endosulfan, phosalone and fenvalerate against tobacco caterpiller, *S.litura* infesting cauliflower (cv. Improved Japanese). The experiment was laid out in a completely randomized design with twenty seven treatments, including check (water spray) replicated thrice. Each plant transplanted in an earthen pot (10 litre soil capacity) served as a replicate.

The initial inoculum of the bacterium was obtained from the Biocontrol Laboratory of this department. This was previously isolated from an infected larva of *S. litura* collected from the field. Twenty four hour bacterial growth of *B.t.* cultured after three times purification on nutrient agar medium was harvested by adding 10 ml of sterile distilled water to each culture tube and transferred to a conical flask. The suspension was examined for viral contamination by "hanging drop" method. The

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bacterial suspension so obtained was used for making serial dilutions by adding distilled water.

The potency of bacterial suspension was tested by adding 10 ml of sterile distilled water to the stock inoculum of nutrient agar slant and considered to possess 100 per cent potency. From this suspension, 1ml was pipetted out and diluted seven times through a series of test tubes, each containing 9 ml of distilled water. From each grade 1 ml of suspension was pipetted out and mixed thoroughly with 15 ml of nutrient agar medium which was already maintained at 45^0C. It was then poured into Petri plates and incubated at 25 ± 2^0C.

After 24h, the appearance of bacterial colony was examined and the colonies were counted under colony counter. The potency in original stock of the bacterial isolate was determined as $22x10^8$ viable spores/ml.

Second instar larvae of *S.liture* were released on potted cauliflower plants (20 larvae/plant) 45 days after transplanting. Establishment of released larvae on the plants was ascertained the next day and the treatments applied. The treatments were of four categories. In the first category, the bacterium and chemical insecticides were applied in two concentrations *(i.e.,* one recommended and one reduced) as pure sprays. Thus the bacterium was sprayed at 4.40×10^8 and 2.20×10^8 viable spores/ml. Endosulfan was sprayed at 0.05 and 0.025% concentrations, fenvalerate at 0.01 and 0.005% and phosalone at 0.05% and 0.025% concentrations, as pure sprays. In the second category, the bacterium at 4.40×10^8 was mixed with the respective insecticides and applied. In the third category, the plants were first sprayed with insecticides followed by *B.t.* the next day. In the fourth category, the plants were first sprayed with *B.t.* followed by insecticidal sprays a day later.

In case of combination sprays, the solution was prepared by mixing equal volumes of insecticides and microbial suspensions, each having twice the desired concentration. Sticker (Triton X 100) @1 ml/l of spray solution was mixed with every treatment and sprayed with the help of a "hand compression sprayer". Soon after spraying, the potted plants were caged individually to prevent insect migration or bird picking.

Mortality of the larvae was recorded upto prepupal stage periodically. Surviving insects were transferred to (transparent plastic containers (7x7 cm dia) containing a 3 cm layer of sieeved moist soil at bottom, and maintained undisturbed for pupation. Observations on adult emergence were recorded. The deformed pupae and adults also were considered dead. Since some mortality was also observed in larvae serving as check, each replicate figure was subjected to Abbot's (1925) correction. The percentage mortality data were converted to arc sine percentages before analysis of variance (Fisher and Yates, 1983).

RESULTS AND DISCUSSION

All treatments/combinations proved significantly superior to the check (water spray) in causing mortality in *S.litura* at all durations, except that *B.t.* alone at lower concentration (i.e., 2.20×10^8 viable spores/ml) could not cause mortality in the larvae upto two days following applications (Table 1). All the *B.t.* insecticide combinations produced higher mortality of the pest than either of them used alone indicating potentiating synergism. Amongst the various treatments, fenvelerate (0.01%) + *B.t.* (4.40×10^8 viable spores/ml) was the most effective.

The *B.t.* - fenvalerate (0.01%) or fenvalerate *B.t.* sequential treatments were as effective as fenvalerate *B.t* combination. Since no significant difference was recorded in the efficacy of combined sprays or when fenvalerate (0.01%) application preceded bacterial sprays by one day. Hence the two materials can be applied in a mixed spray, which could reduce the application costs.

Table 1. Efficacy of *B.thuringiensis* (*B.t.*) either alone or in combination with insecticides against II instar larvae of *S.litura* on cauliflower plants in pots

Treatment	Cumulative larval mortality (%) on day			
	2	4	6	Final
Check (water spray)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
B.t. (4.40 x 10^8 spores/ml)	0.60 (4.44)	33.35 (35.27)	51.00 (45.57)	58.37 (49.82)
B.t. (2.20 x 10^8 spores/ml)	0.00 (0.00)	22.86 (28.56)	34.57 (36.01)	38.22 (38.18)
Endosulfan (0.05%)	24.54 (29.68)	46.27 (42.86)	61.93 (51.90)	61.93 (51.90)
Endosulfan (0.025%)	17.50 (24.73)	37.37 (37.68)	45.28 (42.29)	45.28 (42.29)
Phosalone (0.05%)	33.32 (35.25)	48.13 (43.73)	69.08 (56.22)	69.08 (56.22)
Phosalone (0.025%)	22.80 (28.52)	39.27 (38.80)	48.98 (44.42)	48.98 (44.42)
Fenvalerate (0.01%)	64.97 (53.71)	69.65 (56.57)	74.56 (59.71)	74.60 (59.74)
Fenvalerate (0.005%)	47.37 (43.49)	55.45 (48.13)	56.46 (48.71)	56.46 (48.71)
B.t. + Endosulfan (0.05%)	33.32 (35.25)	71.47 (57.71)	81.87 (64.80)	91.11 (72.65)
B.t. + Endosulfan (0.025%)	24.52 (29.68)	53.43 (49.97)	61.90 (51.88)	69.13 (56.25)
B.t. + Phosalone (0.05%)	38.50 (38.35)	73.29 (58.88)	83.93 (66.36)	91.11 (72.65)
B.t. + Phosalone (0.025%)	28.03 (31.97)	57.13 (49.12)	65.51 (54.04)	72.93 (58.68)
B.t. + Fenvalerate (0.01%)	72.04 (58.08)	85.79 (67.85)	89.55 (71.14)	96.27 (78.86)
B.t. + Fenvalerate (0.005%)	54.38 (47.51)	62.50 (52.24)	69.13 (56.25)	75.50 (60.33)
Endosulfan (0.05%)-B.t.	33.32 (35.25)	66.12 (54.40)	76.36 (60.91)	86.52 (68.46)
Endosulfan (0.025%)-B.t.	21.10 (27.35)	48.13 (43.93)	59.98 (59.76)	69.13 (56.25)
Phosalone (0.05%)-B.t.	35.05 (36.30)	71.65 (57.83)	78.40 (62.31)	85.56 (67.67)
Phosalone (0.025%)-B.t.	24.52 (29.68)	53.62 (47.07)	65.43 (53.99)	70.98 (57.40)
Fenvalerate (0.01%)-B.t.	68.52 (55.87)	80.39 (63.71)	87.34 (69.17)	94.50 (76.44)
Fenvalerate (0.005%)-B.t.	50.90 (45.52)	53.50 (47.01)	63.82 (53.02)	70.96 (57.39)
B.t. - Endosulfan (0.05%)	28.03 (31.97)	64.55 (53.46)	74.60 (59.74)	83.60 (66.11)
B.t. - Endosulfan (0.025%)	20.92 (27.21)	50.00 (45.00)	58.20 (49.72)	65.43 (53.99)
B.t. - Phosalone (0.05%)	35.05 (36.30)	66.27 (54.49)	76.47 (60.98)	83.90 (66.34)
B.t. - Phosalone (0.025%)	24.44 (29.63)	50.14 (45.08)	64.15 (53.22)	70.33 (57.00)
B.t. - Fenvalerate (0.01%)	64.97 (53.71)	770.07 (61.39)	85.78 (67.84)	92.86 (74.51)
B.t. - Fenvalerate (0.005%)	50.87 (45.50)	55.37 (48.08)	65.55 (54.06)	70.96 (57.39)
S.Em	(1.7071)	(2.0466)	(1.9800)	(1.4712)
C.D. (P=0.05)	(4.8400)	(5.8000)	(5.6100)	(4.1700)

* *Bt.* : 4.40 x 8^{10} viable spores/ml.

Phosalone (0.05%) + *B.t.* (4.40 x 10^8 viable spore/ml) was as effective as fenvalerate +*B.t.* and fenvalerate (0.01%) - *B.t.* sequential treatments. Phosalone (0.05%) - *B.t.* combinations also resulted in potentiating synergism like that of fenvalerate - *B.t.* combinations, but to a lesser extent. Edosulfan (0.05%)- *B.t.* combinations produced significantly higher mortalities than either of them used alone. Creighton *et al.* (1972) also found enhanced action of *B.t.* + endosulfan against *S.littoralis* infesting cabbage. A good compatibility of *B.t.* with phosalone and endosulfan was reported by Baskaran and Kumar (1979) against *S.litura* on cauliflower. Kushwaha (1982) also observed additive effect of *B.t.* - endosulfan combinations on *s.litura* infesting cauliflower. All the insecticides in combination with the bacterium even at the reduced dosages indicated potentiating synergism against *S.litura* on cauliflower.

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