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Field Efficacy of Biocontrol Agents and Microbial Insecticides for The Management of Fall Armyworm *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) on Maize in High Altitude Tribal Zone of Andhra Pradesh

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ABSTRACT

The invasive pest fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), was reported for the first time causing severe damage on maize in high altitude tribal zone of Andhra Pradesh, India, during May, 2019. It is causing extensive damage year after year on maize in the tribal mandals of Alluri Sita Ramaraju district. A field experiment was carried out at Regional Agricultural Research Station, Chintapalle during *kharif,* 2022-23 on the validation of bio control agents and microbial insecticides for the management of fall armyworm *Spodoptera frugiperda* (J E Smith) on maize. Among the treatments lowest mean larval population (0.45/plant, per cent plant infestation (8.57) and highest cob yield (67.95q/ha) was observed in T2(Seed treatment with Cyantraniliprole 19.8% + Thiomethoxam 19.8% @ 6ml/kg. + Release of egg parasitoid, *Trichogramma chilonis* @ 20,000 / ac / Release in 1 window (20 DAS)+spraying biopesticide, *Metarhizium anisopliae* (NBAIR Ma 35) @ 5g/lt) at 40DAS followed by T1(Release of *Trichogramma chilonis* @ 20,000 / ac / release,2 times at weekly interval from 7 days after sowing + spraying biopesticides *Metarhizium anisopliae* (NBAIR Ma 35) @ 5g/l at 10days interval from 20 days after sowing).

Keywords: *High altitude tribal zone, Maize, fall armyworm, Spodoptera frugiperda, Management, Seed treatment, biocontrol agents and Microbial Insecticides.*

Maize is a principal staple food particularly in tropical and subtropical countries. Due to its highest genetic yield potential, maize is familiar as "Queen of cereals" or "miracle crop". Maize grain contains about 70 per cent carbohydrates, albuminoids (10.4%), protein (10%), oil (4%), crude fiber (2.4%) and 1.4 per cent ash. Maize (*Zea mays* L.) is the most important cereal crop being cultivated in an area of 180.63 m ha in 165 countries across the world with a production of 1134 million tones growing at an average annual rate of 3.46%. It is widely valued for its extensive use as feed, fodder and as raw material for a large number of industrial applications. In India, it occupies an area of 9.38 m ha with a production of 28.75 m t and average productivity of 3065 kg ha-1 (Ramalakshmi *et al.,* 2022). Maize is the third most important cereal after rice and wheat, both in terms of area and production, registering maximum growth rate among food crops. Though maize is emerging as an important industrial crop in India, its productivity 3100 kg ha^{-1} is much lower than the world average 5620kg ha^{-1} (Suby *et al.,*2020). In Andhra Pradesh it is cultivated in an area of 3.01 lakh ha with a production of 21.21 lakh tones and average productivity of 7055 kg ha^{-1} (Directorate of Economics & Statistics, AP 2019-20).

Several known insect pests attack on corn and cause considerable yield loss, majorly two stem borers, spotted stem borer, *Chilo partellus* (Swinhoe) and pink stem borer, *Sesamia inferens* (Walker); two species of shoot fly, *Atherigona nuquii* (Steyskal) and *Atherigona soccata* (Rund); army worm, *Mythimna separata* (Walker); maize cob borer, *Helicoverpa armigera* and maize aphid, *Rhophalosiphum maidis* (Fitch) which causes accountable losses in various climatic regions of the country (Siddiqui *et al.,* 1994). The incursion of fall armyworm as an invasive pest into India was first

reported in mid-May of the year, 2018 in the maize fields of college farm, University of Agricultural and Horticultural Sciences (UAHS), Shivamogga, Karnataka (Sharanabasappa *et al.,* 2018). The larvae of *Spodoptera frugiperda* (J. E. Smith) feed on leaves, stems and reproductive parts of more than 100 plant species, causing major damage to economically important crops *viz.,* maize, rice, sorghum, sugarcane, cabbage, soybean, tomato, *etc.,* (Georgen *et al.,* 2016., Burtet *et al.,* 2017, Sisodiya *et al.,* 2018, Lamsal *et al.,* 2020 and Gouthamibai *et al.,* 2021). The invasive pest fall armyworm, *S. frugiperda* was reported for the first time causing severe damage on maize in high altitude tribal zone of Andhra Pradesh, India, during August,2018 (Rameshnaik *et al*.,2020). Even though the novel insecticides are very effective in controlling the pest but the Agency area is default organic zone hence, there is need to evaluate the cost effective management strategies by using bio control agents and bio pesticides is an effective tactic for the proficient management of *S. frugiperda* on corn in high altitude tribal zone of Andhra Pradesh.

MATERIAL AND METHODS

The observation field experiment was conducted at Regional Agricultural Research Station, Chintapalle during *kharif,* 2022-23 to validate the efficacy of seed treatment, biocontrol agents and microbial insecticides against fall armyworm in maize. The experiment was laid out in a bulk plot of each treatment in an area of 600m^2 with the private hybrid (Sravani M20) and spacing of 60 x 25 cm^2. The treatments were imposed as per the schedule (table.1). The biocontrol agents and microbial insecticides were received from the biocontrol laboratories of Regional Agricultural Research Stations of Anakapalle and Tirupathi. The crop management practices were adopted as per the ANGRAU recommendations. The microbial insecticides were applied based on type of formulation i.e., as a foliar spray at 40 DAS. Pretreatment counts of larva was made one day prior to the spray and post treatment counts made at 10 days after spray from 20 randomly selected plants per each treatment in a 'W' pattern subsequently, per cent plant infestation and cob damage were recorded as per the standard procedures (Davis and Williams, 1992) and cob yield of each plot was recorded at the time of harvest. The data on larval counts/ plant, cob damage per cent and weight of fresh green cobs per plot were subjected to ANOVA. The per cent reduction in incidence was calculated by using modified Abbot's formula (Flemming and Ratnakaran, 1985).

Table :1 : Treatment details

T1	T2	T3
Release of *Trichogramma chilonis* @ 20,000 / ac / release,2 times at weekly interval from 7 days after sowing + spraying biopesticides *Metarhizium anisopliae* (NBAIR Ma 35) @ 5g/lt, at 10day interval from 20 days after sowing.	Seed treatment with Cyantraniliprole 19.8% + Thiomethoxam 19.8% @ 6ml/kg. + Release of egg parasitoid, *Trichogramma chilonis* @ 20,000 / ac / Release in 1 window (20 DAS)+spraying biopesticide, *Metarhizium anisopliae* (NBAIR Ma 35) @ 5g/lt at II, III & IV windows (30, 40, 50 DAS).	Seed treatment (cyantraniliprole + thiomethaxam) @ 6ml/lt. *Bacillus thuringiensis* strain **TPTC 33@ 2g / lt**., 2 sprays at 30 & 40 DAS

RESULTS AND DISCUSSION

On scrutiny of the results of the experiment conducted during *Kharif*, 2022-23 on the validation of seed treatment, biocontrol agents and microbial insecticides for the management of fall armyworm at 40DAS revealed that all the treatments were significantly superior over each other in managing the incidence of fall armyworm (table .2). Among the treatments T2 (Seed treatment with Cyantraniliprole 19.8% + Thiomethoxam 19.8% @ 6ml/kg. + Release of egg parasitoid, *Trichogramma chilonis* @ 20,000 / ac / release in 1 window (20 DAS)+spraying biopesticide, *Metarhizium anisopliae* (NBAIR Ma 35) @ 5g/l at II, III & IV windows (30, 40, 50 DAS) have recorded lowest mean larval population (0.45), mean plant infestation (8.57%) and mean cob

damage (9.21%) with highest cob yield (67.95q ha^{-1}) and also highest C:B ratio (2.17); followed by T1 (Release of *T. chilonis* @ 20,000 / ac / release 2 times at weekly interval from 7 days after sowing + spraying biopesticides *M. anisopliae* (NBAIR Ma - 35) @ 5g/l at 10day interval from 20 days after sowing) with a mean plant infestation (10.085) and mean cob damage (12.50%) with a cob yield of (53.10 q ha^{-1}) and C:B ratio (1.87). The results in the present study on the efficacy of biocontrol agents *T. chilonis* it breaks off from the egg shell after attaining adult stage, which led to death and control of the population of fall armyworm and *M. anisopliae* have been proven effective against the second third instar larvae of fall armyworm are in corroboration with the findings of (Komivi *et al.* 2019, Bhusal *et al*., 2020, Suby *et al.,*2020 and Visalakshi *et al.,* 2020). Natural epizootics of *M. rileyi* were reported to cause significant larval mortality ranging from 1.87% to 18.30% in Karnataka (Mallapur *et al.,* 2018). Mooventahn *et al*(2019) who reported that augmentative release of egg parasitoid *T. pretiosum or Telenomus remus* @ 50,000 per acre at weekly intervals or based on trap catch of 3 moths/trap use following entomopathogenic fungi and bacteria: *M. anisopliae* (1 × 10 cfu/g) @ 5g/l whorl application were effective against FAW on maize. The native strain of *N. rileyi*, Akp-Nr-1, had a great potential in reducing the population and damage caused by FAW and hence might be utilized as one of the components of integrated pest management module in maize (Visalakshi *et al.,* 2020).The main critical factor in corn protection from fall armyworm larva damage was excellent microbial insecticide coverage of the whorl of the plant and two applications only provided enough protection for fall armyworm, and subsequently resulted in higher yields compared with the untreated field.

The sustainable approach in containing the fall armyworm with the integration of seed treatment with Cyantraniliprole 19.8% + Thiomethoxam 19.8% @ 6ml/kg seed followed by release of biocontrol agents of *T. chilonis* @ 20,000 per acre at 20 DAS and foliar spray with *M. anisopliae* (1 × 10 cfu/g) @ 5g/l at appropriate time and in appropriate manner would be an effective, environmentally feasible and economically viable tactic for the management of FAW in maize ecosystem in the agency area.

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Table 2: Field efficacy of different treatments against fall army worm in maize at 40DAS during *Kharif*-2022-23at RARS, Chintapalle

Treatments	Pre treatment		Post treatment at 10DAS		Cob damage (%)	cob yield (Q/ha)	C:B ratio
	Mean No. of Larvae per plant	Mean Per cent Plant infestation	Mean No. of Larvae per plant	Mean Per cent Plant infestation			
T1: Release of *Trichograma chilonis* @ 20,000 / ac / release,2 times at weekly interval from 7 days after sowing + spraying biopesticides *Metarhizium anisopliae* (NBAIR Ma 35) @ 5g/l, at 10day interval from 20 days after sowing.	0.58	12.75	0.50	10.08	12.50	53.10	1:1.87
T_2: Seed treatment with Cyantraniliprole 19.8% + Thiomethoxam 19.8% @ 6ml/kg. + Release of egg parasitoid, *Trichograma chilonis* @ 20,000 / ac / Release in 1 window (20 DAS)+spraying biopesticide, *Metarhizium anisopliae* (NBAIR Ma 35) @ 5g/l at II, III & IV windows (30, 40, 50 DAS).	0.61	13.11	0.45	8.57	9.21	67.95	1:2.17
T3: Seed treatment (cyantraniliprole + thiomethaxam) @ 6ml/lt. *Bacillus thuringensis* strain **TPTC 33@ 2g / l**., 2 sprays at 30 & 40 DAS	0.69	12.56	0.57	11.81	14.62	46.82	1:1.28

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