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**CP Mallapur**
Department of Agricultural Entomology, College of Agriculture, Dharwad University of Agricultural Sciences, Dharwad, Karnataka, India

**Anjan Kumar Naik**
Department of Agricultural Entomology, College of Agriculture, Dharwad University of Agricultural Sciences, Dharwad, Karnataka, India

**GM Dharshini**
Department of Agricultural Entomology, College of Agriculture, Dharwad University of Agricultural Sciences, Dharwad, Karnataka, India

# Incidence of fall armyworm, *Spodoptera frugiperda* (J E Smith) and its natural enemies on maize in Northern Karnataka

## CP Mallapur, Anjan Kumar Naik and GM Dharshini

**Abstract**
It has been over two years since the first report of an outbreak of fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) in Karnataka, India. From the onset to the outbreak, there have been varied level of incidence at different locations. Its infestation in Northern Karnataka ranged from 0 to 59.59 per cent. During first year, highest average infestation (27.67%) was in Dharwad district succeeded by Uttara Kannada (24.80%), Belagavi (16.54%) and Haveri (16.07%) while no infestation was observed in Gadag district. During second year infestation was to the tune of 4.83 to 26.80 per cent. Highest infestation was at Belagavi district (26.80%) followed by Dharwad (22.50%), Haveri (9.75%), Gadag (8.34%) and least incidence was observed in Uttara Kannada district (4.83%). Among natural enemies, infection by *Metarhizium rileyi* was the major cause of death of Fall armyworm larvae compared to other predators and parasitoids. Due to its polyphagous nature and high migratory capacity, pest has a potential to spread to other important crops in near future and causing crop loss.

**Keywords:** Fall armyworm, *Spodoptera frugiperda,* per cent infestation

## Introduction
In 2018, the fall armyworm, *Spodoptera frugiperda* (J E Smith) (Lepidoptera: Noctuidae), a voracious agricultural pest native to North and South America invaded Asia and reported for the first time from India on maize and spread quickly across India (Sharanabasappa *et al.* 2018) [11]. The main reason for its fast spread might be its strong capacity to fly and disperse long distances annually during the summer months. It is a polyphagous pest that feeds on 353 plant species belonging to 76 families and causes significant loss in crop production (Montezano *et al*., 2018) [9]. Among the different host plants, maize and sorghum are most preferred by Fall armyworm. Maize is one of the important cereal crops grown in India. Among the major maize producing states, Karnataka stands first an area of 1.22 million ha and a production of 3.31 million tons (Anonymous 2017) [1]. The new invasive species has been occurring in serious proportions, causing significant damage to the maize crop, thus posing serious treat for maize production in the country. In this context, the present study was undertaken to generate information on incidence, distribution, extent of damage caused by fall armyworm and native natural enemies of the pest in major maize cultivating districts of North Karnataka.

## Material and Methods
A roving survey was carried out in maize growing areas of different taluks in Northern Karnataka covering Dharwad, Haveri, Belagavi, Gadag and Uttar Kannada districts during August – September 2019-20 and 2020-21. In each taluk, a minimum of three villages and in each village two farmer's fields were observed for the incidence of fall armyworm. In each field, twenty plants at 10 randomly selected spots were selected and observations on the number of plants damaged due to fall armyworm out of 200 plants, number of larvae per plant, number of predators, parasitoids and pathogen infected larvae were recorded. The per cent pest infestation was calculated by using the following formula.

**Corresponding Author**
**CP Mallapur**
Department of Agricultural Entomology, College of Agriculture, Dharwad University of Agricultural Sciences, Dharwad, Karnataka, India

$$\text{Per cent infestation} = \frac{\text{Number of plants damaged}}{\text{Total number of plants observed}} \times 100$$

## Results and Discussion

**Incidence of fall armyworm, *Spodoptera frugiperda* in different major maize growing districts of Northern Karnataka**

During the roving survey, 20 taluks from five districts of Northern Karnataka were studied for the incidence of fall armyworm *S. frugiperda* (Table 1) in Kharif 2019-20 and 2020-21. During first year (2019-20), among various districts surveyed, the infestation of fall armyworm ranged from 0 to 27.67 per cent (Table 1). Among these, maximum average infestation was observed in Dharwad district (27.67) followed by 24.80 per cent in Uttara Kannada, 16.54 per cent in Belagavi, 16.07 per cent in Haveri. However, no infestation

was observed in Gadag district. Within each district, the infestation varied among different taluks (Table 1). In Dharwad district, highest per cent infestation was observed in Kalghatagi taluk (34.80%) followed by 33.90 per cent in Dharwad taluk. The lowest incidence was observed in Navalgund (14.31%). Among eight taluks of Belagavi district surveyed, maximum incidence was noticed in Belagavi taluk (30.14%), followed by Gokak taluk (16.19%), Bailhongal taluk (14.84%), Saundatti taluk (5.00%) and no infestation was observed in Kittur, Khanapur, Chikkodi and Hukkeri taluk. In Haveri district, fall armyworm infestation ranged from 0 to 20.67 per cent.

**Table 1:** Incidence of fall armyworm, *Spodoptera frugiperda* in different maize growing districts of Northern Karnataka

| District | Taluk | Pest infestation (%) | |
| --- | --- | --- | --- |
| | | 2019-20 | 2020-21 |
| Dharwad | Dharwad | 33.90 | 15.56 |
| | Navalgund | 14.31 | 47.22 |
| | Kalghatagi | 34.80 | 4.59 |
| | Average | 27.67 | 22.50 |
| Belagavi | Belagavi | 30.14 | 5.00 |
| | Saundatti | 5.00 | 23.81 |
| | Bailhongal | 14.84 | 20.28 |
| | Kittur | - | 50.42 |
| | Khanapur | - | 59.59 |
| | Chikkodi | - | 7.78 |
| | Hukkeri | - | 19.17 |
| | Gokak | 16.19 | 28.33 |
| | Average | 16.54 | 26.80 |
| Haveri | Shiggaon | 20.67 | 8.34 |
| | Hangal | - | 4.58 |
| | Byadgi | 11.67 | 6.25 |
| | Hirekeroor | - | 22.92 |
| | Haveri | 15.87 | 6.67 |
| | Average | 16.07 | 9.75 |
| Uttar Kannada | Haliyal | 14.34 | 3.83 |
| | Mundgod | 35.25 | 5.84 |
| | Average | 24.80 | 4.83 |
| Gadag | Gadag | - | 7.50 |
| | Naragund | - | 9.17 |
| | Average | - | 8.34 |

Highest per cent incidence was observed in Shiggaon (20.67%), followed by Haveri (15.87%) and Byadgi (11.67%), while no infestation was observed in Hangal and Hirekeroor taluks. In Uttar Kannada district, highest incidence was recorded in Mundgod taluk (35.25%) which is succeeded by Haliyal taluk (14.34%). In Gadag district, no infestation was observed in both Gadag and Naragund taluk. During second year (2020-21), across the five districts surveyed, the fall armyworm infestation ranged from 4.83 and 26.80 per cent. The maximum average infestation (26.80%) was observed in Belagavi district which was succeeded by Dharwad (22.50%), Haveri (9.75%) and Gadag district (8.34%), whereas Uttara Kannada district (4.83%) experienced the minimum infestation by the pest (Table 1). The infestation varied among different taluks in each district. In Dharwad district, highest incidence was recorded was observed in Navalgund taluk (47.22%) followed by 15.56 per cent in Dharwad taluk. The lowest incidence was observed in Kalghatagi (4.59%). In Belagavi district, highest incidence was recorded in Khanapur taluk (59.59%) followed by Kittur (50.42%), Gokak (28.33), Saundatti (23.81%), Bailhongal (20.28%), Hukkeri (19.17%), Chikkodi (7.78%). And the

least was observed in Belagavi taluk (5.00%)(Table 1). Among five taluks of Haveri district surveyed, maximum incidence (22.92%) was noticed in Hirekeroor taluk which was succeeded by Shiggaon (8.34%), Haveri (6.67%), Byadgi (6.25%) and Hangal (4.58%). In Uttar Kannada district, highest incidence was recorded in Mundgod taluk (5.84%) which is succeeded by Haliyal taluk (3.83%). In Gadag district, maximum incidence was observed in Naragund taluk (9.17%) followed by Gadag taluk (7.50%)(Table 1). Fall Armyworm infestation was observed in all the taluks surveyed during second year. Wherein, during first year few taluks of Belagavi district (Kittur, Khanapur, Chikkodi and Hukkeri), Haveri district (Hangal and Hirekeroor) and Gadag district (Gadag and Naragund) were found to have no infestation. The average pest infestation across the years and districts differs with varying levels. The present study depicts the incidence and spread of fall armyworm on maize in Northern Karnataka. The fall armyworm incidence on maize was observed in all the districts studied with varying degrees of infestation. It was observed that the pest feeds on the young plants most preferably rather than old and matured ones. Apart from leaves and central whorl, larvae feeds on young,

immature cobs and grains. High incidence of fall armyworm was observed in northern transitional belt of Karnataka (Haveri, Dharwad and Belagavi districts) except for Kittur, Khanapur, Chikkodi, Hukkeri, Hangal, Hirekeroor taluks during first year wherein, during second year high incidence was observed in all the taluks of northern transitional belt where the crop was sown early. Extensive cultivation of maize, staggered sowing and prevailing congenial environmental conditions (temperature and rainfall) favoured higher incidence of fall armyworm in northern transitional belt. No incidence (First year) and Lower incidence (Second year) of fall armyworm in Gadag district may be probably due to harsh environmental conditions and the delay in migration of the pest and its further build up. The infestation ranged from 0 to 59.59 Per cent by fall armyworm on maize from different districts surveyed. Similarly, pest infestation in Northern Karnataka was observed to the tune of 6.00 to 100 per cent (Mallapur *et al.*, 2018) [6]. The present study corroborated the observations of Shylesha *et al.* (2018) [13] who reported that the infestation ranged from 9.0 to 62.5 per cent at various locations in the Karnataka. The present results are in line with the observations of Mitchell (1978) [7], who reported that early planting of sweet corn results in escape from cob damage made both earworm and fall Armyworm. This study strengthens the recommendation of avoiding delayed planting in Integrated Pest Management practices (IPM) of fall armyworm *S. frugiperda* suggested by Beseh PK (2018) [3]. Murua *et al.,* (2006) [10] recorded a range of 0.1% to 71.30% infestation from two agrological regions over a period of four years.

**Incidence of natural enemies on *Spodoptera frugiperda* in different major maize growing districts of Northern Karnataka**
Natural enemies of fall armyworm observed includes predators (Ear wigs, Spiders and Coccinellids), parasitoids (*Campoletes chloridae* and *Chelonus formosanus*) and fungal pathogen (*Metarhizium rileyi*). Among these, *Metarhizium rileyi* infection observed was 8-43%. Wherein among insect natural enemies, pupae of *Campoletes chloridae* (2-11 pupae / 20pls) were more in numbers followed by Ear wigs (1-8 / 20pls), Spiders (1-7 / 20pls), Coccinellids (1-5 grugs/ 20pls) and *Chelonus formosanus* (0-2 adults/ 20pls)(Table 2). A wide range of parasitoids has been recorded on fall armyworm worldwide as shown by the inventory of parasitoids and parasites of fall armyworm in the Americas and the Caribbean basin that included approximately 150 species of parasitoids and parasites from 14 families (Molina-Ochoa *et al.*, 2003) [8].

**Table 2:** Incidence of natural enemies on *Spodoptera frugiperda* in different maize growing districts of Northern Karnataka

| S.N. | Natural enemies | Incidence level |
|------|-----------------|-----------------|
| 1 | *Metarhizium rileyi* | 8-43% |
| 2 | *Campoletes chloridae* | 2-11 pupae / 20 plants |
| 3 | *Chelonus formosanus* | 0-2 adults/ 20 plants |
| 4 | Ear wigs | 1-8 / 20 plants |
| 5 | Spiders | 1-7 / 20 plants |
| 6 | Coccinellids | 1-5 grugs/ 20 plants |

Ashley (1986) [2] reported eight native parasitoids on FAW in south Florida. These included *Apanteles marginiventris, Campoletis grioti, Chelonus insularis, Meteorus autographae, Ophion spp*., *Rogus laphygmae, Ternelucha spp*. and

*Eiphosoma vitticole* (imported) and 63 per cent of the first four larval instars were parasitized by these species. In Ghana, one of the most abundant parasitoid was *Chelonus bifoveolatus* with a relative abundance of 29.0% and it was the most dispersed parasitoid, found in 6.6% of the inspected sites (Koffi *et al.,* 2020) [5]. Sharanabasappa *et al.* (2019) [12] reported 5 larval parasitoids, 3 predators, and 1 entomopathogenic fungus from different maize growing areas of Karnataka and Tamil Nadu. They recorded 2–4% parasitism by *Campoletis chlorideae, Coccinella transversalis* (0.5–1.00 per plant) and *Nomuraea riley* (10–15% infection). Firake and Behere (2020) reported that the entomopathogenic fungus, *Metarhizium rileyi* (Farlow) Samson was observed to be the dominant mortality factors throughout the season and responsible for >50% mortality of FAW larvae in Meghalaya state.

**Conclusion**
Based on the present studies, it can be concluded that the fall armyworm has spread all over the Northern Karnataka and is able to cause potential damage to the maize crop. In a tropical country like India where wide range of crops are cultivated, due to continuous supply of food pest may stretch to other important crops. The geographical extension of this pest into India and across states in India is a matter of great concern to the farmers and to the overall food production. Although populations were recovered only from maize, it is possible that it may spread to other crops also. In this context, it is important to conduct swift survey of the pest and to contain it at the earliest. Further studies should be directed towards mitigating this notorious pest and its dispersal. For eco-friendly management of pest population, further information on the occurrence and rates of parasitism of indigenous natural enemies is of great importance in designing a biological control program for fall armyworm, either through conservation of native natural enemies or the introduction of new species for augmentative release. In this regard, there is an urgent need to understand, promote and maximize the effectiveness of indigenous populations of natural enemies against the fall armyworm and it would be worthwhile to evaluate indigenous parasitoids that are known to be effective in India against *S. frugiperda*. Among natural enemies of pest, fungal infection by *Metarhizium rileyi* was found cause maximum death of larvae and the same can be used to mitigate the pest.

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