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Relative bio-efficacy of newer insecticide molecules against okra shoot and fruit borer and their dissipation: A review

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Abstract
Okra (*Abelmoschus esculentus*) is one of the most important vegetable crops grown worldwide because it is endowed with several unique characteristics with diversified uses for human needs and is an important crop in semiarid tropical and subtropical areas. Okra dry seed contains good edible oil (13-22%) and protein (20-24%). Many of the pests occurring on cotton are also found on okra crop. As high as, 72 species of insects have been recorded on okra of which, the sucking pests viz. Aphids, *Aphis gossypii* (Glover); leafhopper, *Amrasca biguttula biguttula* (Ishida); whitefly, *Bemisia tabaci* (Gennadius); shoot and fruit borer, *Earias vittella* and mite *Tetranychus cinnabarinus* (Boisduval) causes significant damage to the crop. Okra fruit and shoot borer *E. vittella* (Lepidoptera: Noctuidae) is a widely distributed insect pest. This pest has been reported to infest okra (*A. esculentus*), cotton, hollyhock, safflower .It is reported that 69 percent losses were observed in marketable yield due to attack of *E. vittella* on okra. The chemical control is generally practiced by farmer for higher gains, but its injudicious application has created many problems. Sole reliance on chemical control leads to the problem of pest resistance, resurgence of pests and creation of environmental pollution. Under such circumstances, the use of botanicals and bio- pesticides in pest management is considered as ecologically viable proportion to overcome these problems.

Keywords: *Leucinodes orbonalis* (Guen.), minerals, and insecticides

Introduction
Okra (*Abelmoschus esculentus*) is popularly known as bhindi, lady's finger etc. It is an annual vegetable crop grown in tropical and subtropical regions in an area of about 231 hectare with a total production of 6350 million tones. (Annonymus 2013) [10].
Agriculture is the backbone of the Indian economy because of 75% of Indian population depends on agriculture or agroindustries for livelihood. However, it is disheartening to know that India's economic growth is not keeping up with the expectations because its agricultural growth is lagging behind .The major crops of India are categorized into Cereals, Oilseeds, Pulses, Vegetables and Fruits (Dhaliwal, *et al.*, 2010) [21].
Radke and Undirwade (1981) [70] observed the appearance of *Earias* sp. with the initiation of fruiting. The infestation increased and reached its peak upto 100% after 12 weeks of sowing with an average larval population of 1.3 per fruit.
Vegetables are an indispensable part of our diet, supplying vitamins, carbohydrates and minerals needed for a balanced diet. Vegetables are important especially in developing countries like India, where malnutrition abounds (Randhawa, 1974 [73] and Masood Khan *et al.*, 2001) [43]. Amongst the various vegetables grown, okra *Abelmoschus esculentus* L. (Moench) belongs to family Malvaceae, is an annual vegetable crop grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afganistan, Pakistan, Burma, Japan, Malaysia, Brazil, Ghana, Ethiopia and the Southern United States. Okra dry seed contains good edible oil (13-22%) and protein (20-24%). The oil is used in soap, cosmetic industry and as vanaspati while protein is used for fortified feed preparations. High iodine content of fruits helps to control goitre while leaves are used in inflammation and dysentery. (Mishra 2001) [52].
In India, major okra producing states includes Uttar Pradesh, Bihar, West Bengal, Andhra Pradesh, Karnataka and Assam. Uttar Pradesh has a unique distinction of contributing about 20% production in the country followed by Bihar. (Anon., 2004) [7].
Adilakshmi *et al.* (2008) [2] reported that chemical control is generally practiced by farmer for higher gains, but its injudicious application has created many problems. Sole reliance on chemical control leads to the problem of pest resistance, resurgence of pests and creation of environmental pollution.

Under such circumstances, the use of botanicals and bio-pesticides in pest management is considered as ecologically viable proportion to overcome the above problems.

India ranks first in the world with an area of 4, 52,500 ha with a production of 48, 03,300 mt of okra fruits with a productivity of 10.6 mt. /ha. In Chhattisgarh, the crop is grown in an area of 25,233 ha with production of 2, 49048 mt. of okra fruits and productivity is 9.86 t /ha. (Anonymous, 2010) [8].

The Chhattisgarh state is contributing approximately 4 percent of the total production of okra in the country. It produces approximately 0.25 million mt. of okra from an area of 0.03 million ha with productivity of 9.9 mt./ha. The major okra producing belts in the state are Raipur, Durg and Rajnandgaon. (Anonymous, 2012) [9].

There are several constraints in the cultivation of okra. Many of the pests occurring on cotton are also found on okra crop. As high as, 72 species of insects have been recorded on okra (Srinivas Rao and Rajendran, 2002) [98], of which, the sucking pests viz. Aphids, *Aphis gossypii* (Glover); leafhopper, *Amrasca biguttula biguttula* (Ishida); whitefly, *Bemisia tabaci* (Gennadius); shoot and fruit borer, *Earias vittella* and mite *Tetranychus cinnabarinus* (Boisduval) causes significant damage to the crop.

Krishnaiah (1980) [46] reported about 40-56 percent losses in okra due to leafhopper. There is a reduction of 49.8 and 45.1 percent in height and number of okra leaves, respectively due to the incidence of leafhopper (Rawat and Sahu, 1973) [75]. Aphids and leafhoppers are important pests in the early stage of the crop which desap the plants, make them weak and reduce the yield. Incidence of these pests was very difficult to control in the initial stages cause a yield loss to the tune of 54.04 percent (Chaudhary and Dadeech, 1989) [18]. The spider mite, *Tetranychus cinnabarinus* has assumed the status of major pest and caused 17.46 percent yield loss in okra (Sarkar *et al.*, 1996) [79]. Okra fruit and shoot borer *E. vittella* (Lepidoptera: Noctuidae) is a widely distributed insect pest. This pest has been reported to infest okra (*A. esculentus*), cotton, hollyhock, safflower (Khan and Verma, 1946). It is reported that 69 percent losses were observed in marketable yield due to attack of *E. vittella* on okra (Rawat and Sahu, 1973) [75].

During summer 1996, “Parbhani Kranti” a variety of okra, at Raipur had 58.80 percent avoidable fruit losses by shoot and fruit borer *Earias vittella* (Fab.). In Chhattisgarh one of the major constraints identified in production is the increasing incidence of insect pests, sometimes resulting in substantial yield losses. Due to their tender and supple nature and their cultivation under high moisture and input regimes, okra is more prone to the pest attack and at a conservative estimate cause about 35-40% losses. Further, the excessive reliance on chemicals for the vegetable growers to apply 10-12 sprays in okra has led to the problem of resistance, resurgence, creation of environmental pollution and decimation of useful fauna and flora. (Dubey and Ganguli, 1998) [27].

To mitigate the losses due to these pests, a huge quantity of pesticides is used in okra and it is not unusual for the vegetable growers to give 10-12 sprays in okra in a season and thus the fruits harvested at short intervals are likely to retain unavoidable high level of pesticide residues which may be highly hazardous to consumers. Further, the excessive reliance on chemicals has led to the problem of resistance, resurgence, creation of environmental pollution and decimation of useful fauna & flora.

Keeping in view of above points, the present study had been undertaken to overcome the problems observed by the okra shoot and fruit borer and the experiment were conducted at the department of Entomology, college of Agriculture, Raipur with the following objectives: -

1. To study the succession of insect-pests and their natural enemies on okra.
2. To find out the bio-efficacy of newer insecticide molecules against major insect pests on okra.
3. To find out the residual toxicity of newer insecticide molecules against shoot and fruit borer on okra.
4. To find out the dissipation of newer insecticide molecules residues in/on okra fruits.

Review Literature

1. To study the succession of insect-pests and their natural enemies on okra.

Radke and Undirwade [70] (1981) noticed the appearance of *Earias* spp. on okra in 3rd week (51 SMW) of December at Akola (Maharashtra) and reported 100 percent infestation in fruits with an average larval population per fruit to be 1.33 when the average weekly maximum and minimum temperature were 28.1˚C and 10.2˚C, correspondingly and relative humidity was 56.50 percent. An increase of 83.33 percent was recorded in 1st week of January (1 SMW) and beyond 2nd week (3 SMW) of January, 100 percent fruits were found infested. During this week, average weekly maximum and minimum temperature were 30.8˚C and 12.1˚C, respectively with 49-50 percent relative humidity. Dhamdhere *et al.* (1984) [22] observed the arthropod pests of okra during the kharif season of 1980 and summer 1981 at Gwalior, M.P. The Cicadellid. *Amrasca biguttula biguttula* remained active in both the seasons. Low humidity in 1980 appeared to be responsible for population build-up of shoot and fruit infestation by *Earias vittella* which was 5.5 to 23.9 and 25.93 to 40.91 percent during kharif and summer season, respectively whereas, the population was observed as 4.65 to 17.15 and 16.62 to 17.5 percent in 1981. Temperature and humidity had no apparent effect in the activity of the pest in 1980, but in 1981, the activity increased with increased humidity. Infestation by *Melanagromyza hibisci* in 1980 and 1981 was 2.56 to 22.91 and 1.27 to 16.31 percent, respectively. Other pests on okra crop were *Aphis gossypii. Bemisia (abaci, Negara viridula, Tetranychus telarius* auct. *(T.urticae), Dysdercus koenigii, Mylabris pastulata Anomis /lava, Myllocerm undercimpiistulalus* var. *maculosus* and *Sylepta derogata.* Dhawan and Sidhu (1984) [23] observed the incidence of *Earias* spp. on okra in Punjab, India, during 1974 - 77. The maximum damage to shoots (1.7%) and flowers (1.5%) was in mid August. In India the spring crop, showed maximum damage to fruits (33.04%) and larval population (1.4/plants) was observed in late July. The population of *Earias* spp. increased slowly up to mid September and rapidly thereafter. Heavy rainfall adversely affected population build up of *E .vitella* being most abundant, while *E. cupreoviridis* was a new record for this part of the country. Kakar and Dogra (1988) [42] reported the insect pest complex of okra in H.P., India in July 1985. The most important pest were the Cicadellid, *Amrasca bigutlula bigiitlula* and the Meloid *Mylabris pastnlata.* Kumar and Urs (1988) [47] recorded the seasonal incidence of *Earias vittella* on okra in Karnataka, India, in 1983-85. They observed the infestation on shoot and fruits started in the 2nd and 6th weeks after germination, respectively. Oops sown in any month had infested shoots from the 3rd to 5th weeks in both year of the study. The infestation level on fruits varied from 8.4 to 33.8 and 9.2 to 73.2 percent in different weeks during 1983-84 and 1984-85, respectively. The crop suffered heavily in the 10th week after sowing in 1984-85. Infestation was more severe in crop sown in warmer months than in those sown in rainy or cooler months. There was significant positive correlation between the incidence of the pest and prevailing temperature. Relative humidity was found to be negatively correlated with pest incidence, whereas rainfall did not show any correlation. Uthamasamy (1988) [105] reported that the incidence of leafhopper (*A. biguttula biguttula)* on okra crop was highest on 25th and lowest on 35th day after sowing at Coimbatore (Tamil Nadu). Further, percent hopper burn damage showed a negative correlation (r= -0.57) with the yield whereas leafhopper infestation and the hopper burn damage on the leaves had a significant positive correlation (r=+0.43). Chaudhary and Dadheech (1989) [18] observed the occurrence and economic importance of insect pests on okra in Rajasthan, India. The summer crop was attacked by *Aphis gossypii* (with a peak of 2.89 individuals / leaf), the Cicadellid, *Amrasca biguttula biguttula* (4.78 / leaf), the aleyrodid, *Bemisia tabaci* (0.78 / leaf) and the Noctuid, *Earias fabia (E. vittella)* (57.5% infested fruits). Singh and Bichoo (1989) [96] observed the injuriousness *of Earias fabia (E. vittella)* on okra in the laboratory and field in Madhya Pradesh, India. The first symptoms of attack were visible when the crop was 3 week old and the larvae bore into the shoots. Under severe attack, the top leaves wilted and the whole apex of the plant drooped down. As soon as fruiting began, the larvae migrated to the flower buds, small fruits and even mature pods causing reduction in yield. Jamwal and Kandoria (1990) [39] observed that the pest *A. gossypii* was active on okra crop during September-October and the population declined from mid-May to the end of June due to high temperature i.e. 40-45 ˚C Jamwal and Kandoria (1990) [39] noticed that *A. gossypii* remained active from 4th week of July (29 SMW) to 3rd week (41 SMW) of October on okra with a peak population of 450 aphids per 30 plants observed in 1st week (35 SMW) of September. Borad *et al*. (1993) [16] observed the population and the incidence of yellow vein mosaic virus (YVMV) of *Bemisia tabaci* in okra field of Maharashtra, India It was low in both years i.e. August-October during 1988 and 1989. The population reached to maximum during the first week of October while symptoms of yellow vein mosaic virus (YVMV) infestation appeared with *B. tabacci.* Both nymphs and adults of *B. tabacci* were observed at 16 and 20 days after seed sowing. Srinivasan (1993) [99] reported shoot and fruit borer, *(E. vittella* Fab. and *E. insulana* Boisd), leaf hopper *(Amrasca biguttula biguttula* Ishrda), okra stem fly. *(Melonagromyza hibisci* .S'pencer), mites *(Telranychus neocaledonicus* Andre) and *(T. cinnabarinces* Boisd). Ants *(Monomorium* sp.) white fly *(Bemisia tabaci* Genn). Aphid *(Aphis gossypii* Glower), Blister beetles *(Mylabris pastulata]* and few species of ash weevils *(Myllocerus maculosus* Deb, *M. variegates* Boheman and *M. viridanus)* as pest on okra. Ratanpara *et al*. (1994) [74] stated that minimum temperature, average temperature and vapour pressure were negatively associated with population build up of *Amrasca biguttula biguttula*. Sunshine hours had a positive association with increasing number of the pests. Kadam and Khaire (1995) [41] observed that during summer season infestation of *E. vittella* was highest (50.63%) from 7th to 20th meteorological week. It was low to moderate from 21st to 40th meteorological week (24.23% in rainy season). Thereafter, it increased rapidly and reached its peak, becoming severe (54.56%) in 45th to 52nd meteorological week (November-December). There were significant and negative correlations between pest infestation, relative humidity and rainfall. Bhagat (1996) [11] observed twelve insects infestation on okra, *i.e.* cotton leaf miner *(Acrocercops bifasciata Wlsm),* onion thrips *(Thrips tabaci* Lind) jassid *(Amrasca biguttula bigultula),* shoot and fruits borer *(Earias vittella* Fab.), aphid *(Aphis gossypii* Glover), flea beetle *(Podagrica* sp.). white fly *(Bemisia tabaci* Genn.), semilooper *(Anomis flava),* leaf folder *(Sylepta derogeta).* Prasad and Logiswaran (1997) [68] stated a significant positive correlation of maximum temperature, relative humidity and a negative of minimum temperature during winter on the population of insect pests during winter 1991 and summer, 1992 on brinjal cv. MUT-1. The population of *Amrasca biguttula biguttula* showed a significant positive correlation with maximum temperature and negative correlation with rainfall. During winter, the population of *Bemisia tabaci* showed a significant positive correlation with maximum temperature, relative humidity and wind velocity whereas, during summer a significant negative correlation was observed with rainfall. Prasad and Logiswaran (1997) [68] observed that the peak activity of *Aphis gossypii* and *Amrasca biguttula biguttula* occurred during winter (September-October) and summer (March-April). Sriramula and Ravi (1997) [101] reported that jassid population reached to maximum in the okra sown crop during June- July and December- January Negative correlation was observed with temperature, whereas positive correlation was observed with relative humidity. Shukla *et al.* (1997) [90] studied seasonal incidence of *E. vittella* in summer okra crop at Jabalpur (Madhya Pradesh) and reported the peak shoot damage before fruiting (8.5 %) and peak fruit infestation (41.25 %) before harvesting in 1st fortnight of June. An experiment conducted at Samastipur (Bihar) to forecast the okra shoot and fruit borer damage (weight basis) in relation to weather factors revealed that the minimum incidence (3.2%) was recorded in last week of May (22 SMW) and the maximum (32.1%) in 4th week (29 SMW) of July. Significant positive relationship with the minimum temperature (r=0.8245), total rainfall (r=0.3387) as well as significant negative correlation with maximum temperature (r=-0.6194) were observed. Srinivasan *et al.* (1988) [100] studied the seasonal occurrence of the cicadellid, *Amrasca biguttula biguttula* on okra in Karnataka, India from 1981-83. Low incidence of *Amrasca biguttula biguttula* was recorded from January to mid April. Among the different weather parameters analyzed, minimum temperature only had a significant positive correlation with the insect population. Dubey *et al.* (1999) [28] reported that the summer crop of okra (cv. Parbhani Kranti) was infested by different insect-pests viz. *A. biguttula biguttula, E. vittella, B. tabaci, H. armigera*, *A. gossypii, and D. koenigii* and based on their occurrence and infestation *A. biguttula biguttula*, *E. vittella,* and *B. tabaci* were rated as the major pests. Al Eryan *et al.* (2001) [6] reported that *A. gossypii* activity started in July on okra and reached to its peak in late August (1343.38 aphids/plant). Mahmood *et al.* (2002) [49] reported that incidence of leafhopper, *A. biguttula biguttula* showed positive and significant correlation with maximum and minimum temperatures. Relative humidity and rainfall was negatively and non-significantly correlated with population fluctuation. Sunshine hours were also positive but non-significant. Ghosh and Senapati (2003) [33] found that life cycle duration of jassid was lowest (25.11 days) in June-July and highest (36.36 days) in October-November. The highest jassid population (4.63/leaf) was in April-May and lowest (0.50/leaf) in mid-

July. Muthukumar and Kalyanasundaram (2003) [54] reported that the peak activity of shoot and fruit borer was observed during May to July. Maximum and minimum temperatures, evaporation, sunshine hours had positive association with shoot and fruit damage, while relative humidity had negative influence. *Henosepilachna vigintioctopunctata* incidence peaked during March-April. It was positively associated with maximum temperature. *A. biguttula biguttula* had a negative association with minimum temperature and rainfall. *Bemisia tabaci* had a positive association with relative humidity and negative association with minimum temperature, evaporation and wind velocity. Ghosh *et al*. (2004) [34] reported that aphid, *Aphis gossypii* in terai region of West Bengal was active throughout the year and reached to its highest population (94.08/leaf) in early August. Population of aphid showed significant positive correlation with average temperature, relative humidity and weekly rainfall. Singh *et al*. (2005c) [94] revealed that the jassid (*Amrasca biguttula biguttula)* incidence was recorded from the 3rd week (33 SMW) of August till the last week of December (52 SMW). The jassid population gradually increased from the last week of October (44 SMW) until the 3rd week (47 SMW) of November (82.20-100.0% incidence, and 1.11-1.84 jassids /leaf). The highest jassid density was recorded in the 1st week of November (45 SMW), coincided with average temperature (22.57^{0}C) and relative humidity (69.0%). The jassid population was significantly affected by temperature (21-25^{0}C), relative humidity (62-75%) in dry season. Aphids were noticed from the 3rd week (33 SMW) of August, and were at its peak in the 3rd week (47 SMW) of November (4.28 aphids/ leaf, 92.20% incidence). Temperature, relative humidity and total rainfall were negatively correlated with aphid infestation. Aphid infestation was highly favourable with temperature (21-28^{0}C) and relative humidity (61-75%), respectively. Mandal *et al.* (2006b) [50] reported that the activity of *E. vittella* on summer okra crop was observed from the age of 35 days. The infestation on shoots ranged from 0.3 to 3.46 percent in 2000 and 1.45 to 4.86 percent in 2001. Maximum temperature had negative effect while minimum temperature, relative humidity (morning and evening) and rainfall had positive effect on larval population and fruit damage. Sardana (2006) [78] reported that significantly higher populations of coccinellids, predatory spiders and *Chrysopa* were observed in IPM fields compared to fields adopting farmers practice (FP) during both years. Coccinellids and predatory spiders were present throughout the crop season starting from September until mid-March; however, *Chrysopa* appeared from September to mid-December. Netam *et al.* (2007) [56] reported the insect pest succession in okra on 24 and 20 cultivars were evaluated in Raipur, Chhatisgarh, India during the kharif and rabi seasons of 2002 and 2003, respectively. Nine insect pests were recorded during kharif 2002: *Amrasca biguttula biguttula* (jassid), *Bemisia tabaci* (whitefly), *Earias vittella* (shoot and fruit borer), *Aphis gossypii* (aphid), *Anomis flava* (semilooper), *Dysdercus koenigii* (red cotton bug), *Amsacta moorei* (red hairy caterpillar), *Heliothis armigera* [*Helicoverpa armigera*] (gram pod borer) and *Nezara viridula* (green stink bug). During rabi 2003, five insects were observed: jassid, whitefly, shoot and fruit borer, semilooper and leaf miner (*Acrocercops bifasciata*). Appearance of jassid, and shoot and fruit borer were noticed during the entire cropping season; while during the vegetative stages with low intensity of infestation of white fly, aphid and leaf miner were observed. Naik *et al*. (2008) [55] reported that the incidence of shoot and fruit borer, in terms of shoot infestation was observed during the third week of February (8 SMW) 2006 and the incidence had no significant relationship with temperature, relative humidity and rainfall but had a significant relationship with coccinellids and spiders. Selvaraj *et al.* (2010) [80] reported that the incidence of aphid had significant positive correlation (r = 0.494) with maximum temperature (30^{0}C) and wind speed (6.2 kmph) while negative correlation (r = -0.335) with morning and evening relative humidity and dewfall. Leafhopper showed significant positive correlation (r = 0.297) with maximum and minimum temperatures, while none of the weather parameters had significant influence on thrips population. Both the maximum and minimum temperatures showed significant positive influence on the whitefly population *Earias vittella* whereas, *H. armigera* population showed significant positive correlation (r = 0.606) with maximum temperature and dewfall. Sharma *et al.* (2010) [83] revealed that shoot and fruit borer borer *Earias vittella* (Fab.) incidence commenced in the 29th standard week. The peak infestation (91.6%) was observed in 45th standard week (1st week of November). The maximum numbers of larvae (7.5 larvae/10 plants) were recorded in the 42nd standard week (3rd week of October). The maximum quantum of damaged fruits was 54.3% and 54.7% on number and weight basis. Boopathi *et al.* (2011) [14] showed that okra was invaded by eleven insect pests, one mite and four natural enemies. Among all insect pests *Mylabris pustulata* and *Dysdercus cingulatus* were the major ones. The incidence of these pests were noticed during the reproductive stage and attained peak levels of infestation on 1st week of July (26 SMW) and first week of August (35 SMW). The second most important and dominant insect pest was *Basilepta* sp., observed throughout the cropping period and attaining peak levels of infestation on the last week of July (30 SMW). The incidence of *Aphis gossypii* commenced during the 2nd week of June (23 SMW) and attained peak infestation levels on the last week of June (26 SMW). *Dysdercus koenigii* was observed during the 2nd week of July (27 SMW) with peak infestations occurring during the 1st week of August (31 SMW). *Amrasca biguttula biguttula* recorded during the 2nd week of June (23 SMW), with peak infestation during the 2nd week of July (27 SMW). *Bemisia tabaci* was noticed during the 3rd week of May (20 SMW), with peak infestation during the 3rd week of June (24 SMW). Lady bird beetles, syrphid flies and spiders were the natural enemies observed during the cropping season. *Alcidodes affaber* (cotton shoot weevil) was recorded during the later stages of crop growth, while *Myllocerus* spp. were found throughout the cropping season. Varma *et al*. (2011) [106] reported that the peak activity of leafhopper *A. biguttula biguttula* on brinjal crop was observed during 1st week of February to 1st week of March. The leafhopper incidence showed positive correlation with maximum temperature, relative humidity, rainfall, wind speed and sunshine hours. Patel *et al.* (2012) [63] studied on insect-pests succession in okra during *kharif* 2007 at Navsari Agricultural Univesity, Navsari. Observations on five important insect pests, aphid (*Aphis gossypii)*, jassid (*Amrasca biguttula biguttula)*, whitefly (*Bemisia tabaci)*, shoot and fruit borer (*Earias vittella)*, mite (*Tetranychus macfarlanei)* and predators like green lacewing (*Chrysoperla scelestes)* and lady bird beetle (*Coccinella septempunctata)* were recorded. The incidence of sucking pest like jassid, whitefly and borer like shoot and fruit borer started simultaneously in 4th weeks after sowing *i.e.* the last week of July (30 SMW). Out of these, two sucking pests occurred throughout the season. Among them, whitefly multiplied at comparatively faster rate reaching the peak level 8th weeks after sowing. It was followed by jassid which attained the peak level 11th weeks after sowing conforming positive correlation with whitefly. The third sucking pest *i.e.* aphid multiplied relatively slowly and as such reached to the peak level 13th weeks after sowing *i.e.* 1st week of October (40 SMW) disclosing positive correlation with jassid. The population of these sucking pests declined at the end of crop season. Mite population started in 9th weeks after sowing, which multiplied relatively at slower rate and as such reached to the peak level in 12th weeks after sowing *i.e.* last week of September (39 SMW), conforming significant positive correlation with aphid (r= 0.966). Shoot and fruit borer population started to see in 4th weeks after sowing, which also multiplied relatively slowly and reached to the peak level in 10th weeks after sowing *i.e.* second week of September (37 SMW), conforming significant positive correlation with jassid (r= 0.940) and whitefly (r= 0.579). The population of these pests gradually declined at the end of crop season. The chrysopid appeared in the early stage of crop suppressing jassid and whitefly population. The incidence of coccinellids predator started during later part of crop stage and prevailing throughout the remaining crop season. Konar *et al.* (2013) [45] studied the population dynamics of aphid, *Aphis gossypii* (Glover) and efficacy of some insecticides on okra against it. The incidence of aphid was initiated during 2nd week of July (27 SMW) in both the years. Population of aphid was increased gradually to reach its peak during 1st week of September (36 SMW) (39.28 aphids/3 leaves) with the prevalence of minimum (26.10°C) and maximum temperature (33.50°C) and minimum (72.57%) and maximum R.H. (97.57%), respectively with 1.6 mm rainfall and persisted throughout the crop period with low incidence. Nisha shukla (2014) [88] studied the periodic incidence of different sucking pests on okra during the crop season was significant at different period of crop growth. The period mean revealed that the aphid population was reached to its peak level (27.17 aphids / 3 leaves) during 14th weeks after sowing (1st week of July). The aphids were considered as sucking insect pests. The population of aphids was more abundant on the crop during June and July 2011. Results revealed that maximum activity was recorded during July and the correlation studies were made between the incidence of major sucking insect pests and selected weather parameters. Aphids showed positive correlation with rainfall (r = 0.261) and negative correlation with both maximum and minimum temperatures. Aphids showed positive correlation with relative humidity.

2. To find out the bio-efficacy of some newer molecules against major insect pests on okra.

Prasad *et al.* (1993) [69] evaluated the efficacy of acephate, triazophos, cypermethrin, alphamethrin and bifenthrin against *A. gossypii*, *Amrasca biguttula biguttula* and *E. vitella* on okra. Acephate (0.1 and 0.15 %) and triazophos (0.1 %) were effective against A *gossypii* and *Amrasca biguttula biguttula* while alphamethrin (0.006 %), bifenthrin (0.005 %) and cypermethrin (0.006 %) were effective against *E. vitella.* The, residues of acephate, trizophos and cypermethrin in/on okra fruits were reduced below detectable levels by 20, 15 and 10 days after spraying, respectively. Dhawan and Simwat, (1994) [24] reported that Polytrin-C (mixture of 40 g cypermetherin + 400 g profenofos) @ 140 g *a.i.*/ha was as effective as cypermethrin alone @ 50 g *a.i.*/ha for bollworm control. It was more effective against jassid than cypermethrin alone. Borach (1995) [15] tested several insecticides against *E. vitella* on okra. Malathion 0.05 percent applied 15 days after germination in combination with dimethoate 0.03 percent at 25 and 30 days after germination was the most effective treatment against the pest. Shukla *et al.* (1996) [91] reported, fenvalerate 20 EC 0.05 percent giving the highest level of control followed by cypermethrin 10 EC 0.005 percent, malathion 50 EC 0.05 percent sprays against okra fruits and shoot borer. Tomar (1998a) [103] conducted the field experiment to evaluate the efficacy of some insecticides viz. endosulfan, fenvalerate, Multineem carbaryl, acephate, and Dipel (Bacillus thuringiensis subsp. Kurstaki) for the control of *Melangromyza hibisci* on okra, endosulfan gave the largest percentage of reduction in leaf infestation and number of larvae, pupae and larvae+ pupae, followed by carbaryl and fenvelrate, whereas Dipel and Multineem were less effective. Tomar (1998b) [104] reported that dipel+ endosulfan and dipel+fenvalerate were effective for reducing the percentage shoot and fruit infestation on okra. The maximum yield of healthy fruits was obtained in dipel+fenvalerate. They gave highest profit and cost benefit followed by dipel+acephate+endosulfan. Biswas and Senapati (1998) [12] tested the compatibility of synthetic pyrethroids with organophosphate insecticide to control the pest on bhindi in West Bengal. They found fenvalerate and cypermethrin as most effective in controlling the *Amrasca biguttula biguttula*. Tomar (1998a) [103] conducted the field experiment to evaluate the efficacy of some insecticides viz. endosulfan, fenvalerate, carbaryl, acephate, dipel (13.7) for the control of *Melangromyza hibisci* on okra. He observed that endosulfan gave the largest percentage of reduction in leaf infestation and number of larvae, wherein the acephate was least effective. Tomar (1998b) [104] reported that dipel+ endosulfan and dipel+fenvalerate were effective for reducing the percentage shoot and fruit infestation on okra. The maximum yield of healthy fruits was obtained in dipel+fenvalerate with the highest profit and cost benefit followed by dipel+acephate+endosulfan. Shaw *et al.* (1999) [84] studied the efficacy of some insecticides mixtures against bollworm complex of cotton under rainfed conditions. The three years study revealed that spraying of four rounds of polytrin-C 44 EC @ 1.0 1/ha at fortnightly interval starting from 35 days after germination was found to be optimum and effective with higher yield in keeping the low bollworm complex incidence under rainfed conditions. Dikshit *et al.* (2001) [26] studied that beta-cyfluthrin @ 18.75 g *a.i.*/ha, deltamethrin @ 20 g *a.i.*/ha, endosulfan @ 700 g *a.i.*/ha and neem Azal (azadirachtin 50 000 ppm) @ 500 ml/ha were sprayed on sponge gourd (*Luffa cylindrica* [*L. aegyptiaca*]) at the flowering stage and the treatments were repeated after 15 days. Deltamethrin @ 20 g *a.i.*/ha was sprayed on okra at the fruiting stage. The residue studies were carried out only for beta-cyfluthrin and deltamethrin. Bioefficacy studies for all the insecticides were conducted only for sponge gourd against blister beetle, *Mylabris pustulata*. Residues of beta-cyfluthrin and deltamethrin were undetectable after 7 days in okra and sponge gourd fruits. Washing of non-contaminated and 3-day-contaminated okra fruits dislodged 42 and 38% of the residues of beta-cyfluthrin and deltamethrin, respectively. Washing followed by steaming or cooking decreased the beta-cyfluthrin and deltamethrin residues by 62.3 and 61.8%, respectively. Unwashed or washed samples of sponge gourd, when peeled and steamed, showed maximum mitigation of residues of beta-cyfluthrin and deltamethrin *i.e.* 72.0-73.4%. The highest concentration of insecticide residues were found on the peel of sponge gourd fruits. Beta-cyfluthrin and deltamethrin treatments effectively controlled blister beetles in sponge gourd compared to endosulfan and neem Azal. The treatments did not exhibit any phytotoxicity. Patra *et.al.* (2007) [66] studied the efficacy of five insecticides, viz., emamectin benzoate (Proclaim 5SG) (15 g *a.i.*/ha), lufenuron (Match 10EC @ 50 g *a.i.*/ha), spinosad (Success 2.5SC @ 50 g *a.i.*/ha), indoxacarb (Avaunt 14.5SC @50 g *a.i.*/ha) and methoxyfenozide (Runner 24 SC @ 200 g *a.i.*/ha) was evaluated against the shoot and fruit borer, *Earias vittella* (F.) on okra in field trial conducted at BCKV, Mohanpur, West Bengal during *kharif* season of 2006. It was found that all the insecticides resulted the reduction of shoot as well as fruit infestation and gave significantly higher yield than control. Among the insecticides, emamectin benzoate spray resulted in maximum reduction of borer infestation and thereby the highest fruit yield of 97.25 q/ha which was on par with spinosad (96.1 q/ha) but significantly more than indoxacarb (92.8 q/ha), methoxyfenozide (84.2 q/ha) and lufenuron (83.4 q/ha) while in the control, yield was 49.3 q/ha. Hasan, Wajid (2010) [109] reported that the efficacy of eight insecticides *viz*., dimethoate, profenofos, lambda-cyhalothrin, monocrotophos, indoxacarb, endosulfan, chlorpyriphos and multineem against the spotted bollworm, *Earias vittella* (Fabricius) on okra cultivars *viz*., Arka Anamica, Parbhani Kranti, Selection-9, Seed Tech-71, NBR-1, Hari Rani, Deepti, Green Gold, Ajeet-121, Ajeet-311 (Hybrid) during summer season of 2005-06. The highest suppression of fruit borer infestation was with lambda-cyhalothrin 14.60% and 27.07% while the lowest with multineem was 26.91 and 32.64 % as compared to untreated control with 40.41 and 36.09% infestation during 2005 and 2006. The highest seed yield was observed with application of dimethoate (234.9g) and lambda-cyhalothrin (244.9g) and the lowest was with multineem (226.1g) and endusulfan (241.3g/10 plants) during 2005 and 2006. All the insecticides were significantly effective in controlling *E. vittella* infestation and the seed yield differed significantly among treatments in all cultivars of okra during both the years. Pardeshi *et al.* (2011) [60] reported that among tested of eleven insecticides on okra against *Earias vitella* (fab.), profenophos+cypermethrin (0.044%), chlorpyriphos+cypermethrin (0.055%), cypermethrin 0.006% and profenophos 0.05%, were found to be the most effective in reducing the fruit infestation from 6.47 to 10.52% against 43.5% in the control. The highest yield of healthy fruits was recorded in the treatment of profenophos+cypermethrin, 0.044% (2366.3 kg/ha) followed by chlorpyriphos+cypermethrin, 0.055% (2155.4 kg/ha), cypermethrin, 0.006% (2127.1 kg/ha) and profenophos, 0.05% (2103.9 kg/ha). The highest cost benefit ratio (1:20.3) was obtained in the treatment of cypermethrin, 0.006%, followed by profenophos+cypermethrin (1:11.9), chlorpyriphos (1:10.4), chlorpyriphos+cypermethrin (1:10.2), profenophos (1:8.7), acephate (1:5.1) and methomyl (1:4.1). Mandal and Jena (2013) [51] studied to evaluate the bio-efficacy of a new product emamectin benzoate 5 SG at three doses viz., 5.00, 6.75 and 8.50 g *a.i.*/ha for controlling the fruit and shoot borer in okra. The new product @ 8.5 g *a.i.*/ha was the most effective treatment which reduced the larval population to the tune of 74.18-88.01%, shoot damage by 93.72%, fruit damage by 92.82% and increased the fruit yield to 72.13% over untreated check. However, this treatment was at par with its lower dose @ 6.75 g *a.i.*/ha and the check insecticide Proclaim (emamectin benzoate 5 SG @ 6.75 g *a.i.*/ha) on the basis of larval population, shoot and fruit damage and yield. Nigade *et al.* (2013) [57] revealed that emamectin benzoate @ 10 g *a.i.*/ha was highly effective against *Earias vittelia* (Fabricius). The next in the order of effectiveness were thiodicarb (468.5 g *a.i.*/ha), indoxacarb (72.5 g *a.i.*/ha) and profenophos (250 g *a.i.*/ha). Maximum fruit yield (1408 kg/ha) was recorded from the plots treated with emamectin benzoate @ 10 g *a.i.*/ha which registered maximum net profit of Rs. 17,700/ha. The maximum incremental cost benefit ratio was obtained from the plots treated with cypermethrin @ 62.5 g *a.i.*/ha (1:4.61) followed by thiodicarb @ 468.75 g *a.i.*/ha (1:4.26). Patil *et al.*, (2014) [65] studied the efficacy of some new insecticides against sucking insect pests viz., leafhopper, aphid and whitefly in okra. Three sprays of different insecticides viz., Thiamethoxam 25 WG, Lambda cyhalothrin 5 EC and Triazophos 40 EC, at three different concentrations of Thiamethoxam 25 WG, Lambda cyhalothrin 5 EC and Triazophos 40 ECwere made at 15 days interval. This study revealed that, amongst the treatments tested, the cumulative effect of foliar spray of Thiamethoxam 25 WG @ 0.006% was the most effective against aphids, followed by Lambda cyhalothrin 5 EC @ 0.004%. While, Thiamethoxam 25 WG @ 0.006% was effective against leafhoppers population followed by Thiamethoxam 25 WG @ 0.008%. Also, in case of whitefly the effective treatment recorded was Thiamethoxam 25 WG @ 0.006%. The recommended doses of insecticides were more effective than other doses. Shimoge and Vemuri (2014) [85] evaluated the efficacy of six insecticides *viz.*, bifenthrin 10 EC @ 80 g *a.i.*/ha, fipronil 5 SC @ 500 g *a.i./* ha, flubendiamide 480 SC @ 60 g *a.i.*/ha, quinalphos 25 EC @ 350 g *a.i.*/ha, profenofos 50 EC @ 400 g *a.i.* /ha and beta-cyfluthrin 25 SC @ 18.75 g *a.i.*/ha against shoot and fruit borer (*Earias vittella* Fabricius) and white fly *Bemisia tabaci* (Gennadius) on okra of which flubendiamide @ 60 g *a.i.*/ha, profenofos @ 400 g *a.i.*/ha and beta-cyfluthrin @ 18 g *a.i.*/ha, applied twice as foliar sprays were found to be most effective in controlling the okra pests.

3. To find out the residual toxicity of some newer molecules against shoot and fruit borer on okra.

Nimbalkar and Ajari (1981) [58] Studied to determine the residual toxicities of permethrin, cypermethrin, fenvalerate and deltamethrin (Decis) okra on by bioassay using first-instar larvae of the okra pest *Earias vittella* (F.). It was found that cypermethrin (Cymbush) had the maximum residual toxicity, its LT50 (Lethal toxicity) being 20.58 days, as compared with 20.05 days for deltamethrin, 17.18 days for fenvalerate (Sumicidin) and 13.75 days for permethrin (Ambush). On the basis of these LT50s, cypermethrin was 1.5 times, deltamethrin 1.46 times and fenvalerate 1.25 times was persistent to permethrin. Patil and Pokharkar (1981) [64] evaluated spray residues of 7 commonly used insecticides on potted okra (bhendi) plants to adults of *Earias vittella* (F.) caged on them 1, 5 and 10 days after application was determined in laboratory tests in India. Mortality of *E.vittella* after 48 h of caging showed that endrin at 0.04% was the most toxic compound after 1 day (giving 86.66% mortality) and endrin at 0.04% and Heliotox (a mixture of DDT and toxaphene) at 0.20% were the most toxic compounds after 5 days (both giving 28.51% mortality). No mortality was recorded when adults were exposed to 10-day old residues of the compounds. Chaudhaury (1991) [17] conducted laboratory experiments and reported the order of toxicity to Dysdercus cingulatus on okra of various insecticides was: monocrotophos (0.04%) > decamethrin [deltamethrin]

(0.005%) = permethrin (0.01%) = cypermethrin (0.005%) > quinalphos (0.07%) > phosalone (0.035%) = endosulfan (0.07%). Bodhade (1992) [13] The residual toxicity of 11 insecticides to *Aphis gossypii* was determined by confining aphids to sprayed bhindi [okra] plants. Monocrotophos was the most toxic and persistent insecticide, followed by phosphamidon and dimethoate. Among the pyrethroid insecticides studied, fenvalerate, cypermethrin and deltamethrin were quite effective and moderately persistent, whereas the insecticides bromophos, permethrin, carbaryl and cyfloxylate [cyfluthrin] were less persistent. Samanta *et al.* (1998) [77] studied on okra cv. Pusa Parbhani Kranti were treated with 500 or 1000 g quinalphos 20 AF a.i./ha, 400 or 800 g methomyl @ 12.5 L a.i/ha or alpha-cypermethrin @ 10EC @ 30 or 60 g a.i./ha. were applied at once or twice recommended doses. Maximum residue limit values were reached after 3.16-4.12 days for quinalphos, 2.83-4.12 days for methomyl and 0.52-1.48 days for alpha-cypermethrin. Decontamination processes like washing and cooking of fruits dislodged 33.33-85.01% residues depending on the insecticides and application rates whereas, 23.17-67.03% dissipated by washing alone. In another experiment, the residual toxicity of the three insecticides, applied at the recommended rates, on *Trichogramma chilonis* and *Bracon hebetor* was estimated. Okra leaves were sampled 1-10 days after the second spray of these insecticides. Alpha-cypermethrin was the safest for both parasitoids. It was found that both the parasitoids could be safely released on 3, 4 and 5 days after crop has been sprayed with alpha-cypermethrin, methomyl and quinalphos, respectively. Sharma *et al.* (1999) [82] studied the residual toxicity of carbaryl, endosulfan, malathion and monocrotophos were applied to determine the second instar nymphs of *Amrasca biguttula biguttula* infesting okra leaves @ 0.10, 0.07, 0.08 and 0.05%, respectively. The PT (Persistence toxicity) values (derived from the product of average residual toxicity and the period for which the toxicity persisted) for carbaryl, endosulfan, malathion and monocrotophos were 503.12 days, 406.08 days, 219.84 days and 1034.08 days, whereas LT50 (Lethal time) values were 4.10 days, 1.64 days, 1.24 days and 7.72 days, respectively. The order of relative toxicity on the basis of PT (Persistence toxicity) and LT50 (Lethal time) values remained the same. Monocrotophos was the most effective insecticide followed by carbaryl, endosulfan and malathion. Sharma and Mohapatra (2005) [81] evaluated the persistence of indoxacarb residues in tomato grown during January-March, 2003 and thiamethoxam residues in okra grown during August-September, 2003 through foliar application of the insecticides. Indoxacarb (Avaunt 25 SC) was sprayed on tomato cv. Arka Shreshtha at the colour break stage (colour of fruits changing from green to red) 0.5 and 1.0 ml/litre (700 litres/ha). Thiamethoxam (Actara 25 WG) was sprayed on okra cv. Arka Anamika at 35 and 45 days after germination 0.2 and 0.4 g/litre (700 litres/ha). Both insecticides dissipated at a very fast rate and their residues were below detectable limits within 7-10 days after their last application. The residues dissipated with half lives of 1.1 to 1.5 days and the preharvest intervals calculated on the basis of MRL [maximum residue limit] values were 1 day only for both insecticides. Shinde *et al.* (2010) [87] reported that on the basis of PT (Persistence toxicity) values spinosad 0.005% (1026.2) and on LT50 Lethal toxicity) values cypermethrin 0.01% (10.41 days) were found effective against first instar larvae. However, PT (Persistence toxicity) and LT50 (Lethal time) values against first instar larvae on okra fruits were 1.59 and 14.74 days, respectively to spinosad 0.005%. The highest PT value was obtained for spinosad 0.005% (764.9 days) while the highest LT50 value was recorded from profenofos 0.08% (6.07 days) against third instar larvae on okra fruits. Shinde and Shetgar (2011) [86] reported the persistence and residual toxicity against first and third instar larvae of *E. vittella* on okra shoot and fruits. The descending order of residual efficacy against first instar larvae on okra shoots based on PT (Persistence toxicity) values of spinosad 0.005 percent was 1026.2 days, indoxacarb 0.01 percent (1003.1 days), endosulfan 0.06 percent (1002.7 days), profenofos 0.08 percent (979.6 days), cypermethrin 0.01 percent (793.1 days) and imidacloprid 0.004 percent (435.1 days), respectively. However, on the basis of LT50 (Lethal time) values the order of residual efficacy was cypermethrin 0.01 percent (10.41 days), spinosad 0.005 percent (9.50 days), endosulfan 0.06 percent (9.39 days), indoxacarb 0.01 percent (9.13 days), profenofos 0.08 percent (6.67 days) and imidacloprid 0.004 percent (3.52 days), respectively. The order of residual efficacy against first instar larvae on fruits of spinosad 0.005 percent (1.59), indoxacarb 0.01 percent (1.52), profenofos 0.08 percent (1.52), imidacloprid 0.004 percent (1.12), cypermethrin 0.01 percent (1.08) and endosulfan 0.06 percent (1.00) on the basis of PT (Persistence toxicity) values, respectively. However, the highest LT50 (Lethal time) values to the extent of 14.74 days was observed due to spinosad 0.005 percent when applied against first instar larvae on okra fruits, followed by indoxacarb 0.01 percent (13.79 days), profenofos 0.08 percent (13.49 days), imidacloprid 0.004 percent (11.94 days), cypermethrin 0.01 percent (11.24 days) and endosulfan 0.06 percent (9.75 days), respectively. The highest PT value was obtained due to spinosad 0.005 percent (764.9) followed by indoxacarb 0.01 percent (718.2), while the highest LT50 value was recorded by profenofos 0.08 percent (6.07 days), followed by spinosad 0.005 percent (5.16 days) against third instar larvae of *E. vittella* on okra fruits. Gagan *et al*. (2014) [31] studied on emamectin benzoate, a synthetic derivative of abamectin, was effective against fruit borer and jassid in okra crops. The present studies were carried out to study the dissipation pattern of emamectin benzoate on okra and to suggest a suitable waiting period for the safety of consumers. Following three applications of emamectin benzoate (Proclaim 5 SG) at 68.1 and 136.2 g *a.i.*/ha, the average initial deposits of emamectin benzoate were observed to be 0.22 and 0.42 mg/kg, respectively. These residues dissipated below the limit of quantification (LOQ) of 0.05 mg/kg after 5 days at both the dosages. Soil samples collected after 15 days did not reveal the presence of emamectin benzoate at LOQ of 0.05 mg/kg. Acceptable daily intake (ADI) of emamectin benzoate is 0.0005 mg/kg body weight day-1, which means an adult of 55 kg weight can safely tolerate an intake of 27.50 micro g emamectin benzoate. Assuming an average consumption of 80 g okra fruit and multiplying it by average and maximum residues observed on 0 day at recommended dosage, the intake of emamectin benzoate comes out to be about 20 micro g and these values are quite safe in comparison to its ADI. He, suggested that the use of emamectin benzoate at the minimum effective dosages do not seem to pose any hazards to the consumers if a waiting period of 1 day is observed.

4. To find out the dissipation of newer molecules residues in/on okra fruits.

Pokharkar and Dethe (1982) [67] carried out the micro-bio-assay for endosulfan residues on chillies and okra. The waiting period of five and seven days for chillies was worked out after application of four sprays with 0.03 and 0.08 percent endosulfan, respectively. Similarly, the waiting period in case of okra was five and six days after four sprays with 0.05 and 0.1 percent endosulfan, respectively. Agnihotri *et al.* (1983) [3] conducted experiments to study the dissipation of residues of permethrin, cypermethrin and fenvalerate on okra and chillies fruits. The residues of permethrin and cypermethrin reached the maximum residue limit (0.5 ppm) in 7 days in okra and 15 days on chillies. In case of onion, residues were estimated to be below the maximum residue limit within one hour of application. Murugsen and Kareem (1986) [53] studied the effect of ultra low volume, low volume and high volume sprays of endosulfan at 1.5 1/ha on the residues deposited on the fruits and leaves of okra 24, 48 and 96 hours after treatment. The initial deposit of endosulfan on the fruits and leaves were highest in the plots treated with ULV sprays, followed by those treated with low and high volume sprays. For each of the techniques, residues on fruits were well below the FAO/WHO tolerance limit of 2.0 ppm 96 hours after spraying. Singh *et al.* (1987) [93] studied the persistence of fenvalerate, permethrin at 0.05 percent in okra leaves. It was found that synthetic pyrethroids proved more persistent than endosulfan. The most persistent were fenvalerate (LT_{50} 13.7 days), permethrin (13.3 days) and cypermethrin (13.2 days). Rajakanna *et al.* (1998) [71] determined the residues of HCH, carbaryl and endosulfan from bhindi fruits by following application at 0.1, 0.1 and 0.07 percent, respectively. The half life values were highest in the case of HCH and lowest in the case of carbaryl on the basis of the results, waiting period of 2.0, 4.0 and 6.5 days were recommended for carbaryl, endosulfan and HCH, respectively. Jhala and Sham (1991) [40] determined the residues of monocrotophos on okra fruits. Average residue of monocrotophos 0.04 percent as a foliar application during the fruiting period on okra fruits at three and six days after spraying were 0.76 and 0.28 ppm. Based on the residue data a minimum waiting period of 8-10 days is recommended before consumption of treated fruits. Singh, *et al.* (1992) [92] studied that maximum initial deposits of cypermethrin, fenvalerate and deltamethrin at 50, 50 and 12 g a.i./ha were 0.34, 0.096 and 0.25 mg/kg, respectively on cabbage heads and 1.34, 0.08 and 0.30 mg/kg, on cabbage leaves, respectively. All these values were within maximum residue limits. Ahmed and Rizvi (1993) [5] reported that residues of deltamethrin 12 g *a.i.*/ha, cypermethrin 60 g *a.i.*/ha, permethrin 120 g *a.i.*/ha, fenvalerate 120 g *a.i.*/ha and monocrotophos 320 g *a.i.*/ha on green fruits of okra were 0.02-0.41 ppm on two days for deltamethrin, cypermethrin and permethrin and of 5 days for fenvalerate and monocrotophos were observed. Dethe *et al.* (1995) [20] surveyed the market bhindi samples and found endosulfan.,cypermethrin, dimethoate, monocrotophos and mancozeb most frequently than other pesticides and percentage detectable residues were 33.3 in tomato, 73.3 in brinjal and 14.3 in okra samples. Jain (1996) studied on safe waiting period of okra after spraying of sumicidin 20EC @ 300 ml/ha, 375 ml/ha and 500 ml/ha. He observed that initial deposits were 1.4ppm, 2.8 ppm and 4.5 ppm in C1, *C*2 and C3 respectively. After seven days the initial deposition was drastically reduced to 0.03, 0.05 and 0.67 ppm in C1, *C*2 and C3, respectively. The residues of fenvalerate was below the tolerance limit (0.2 ppm) in all treatments except C3 and after ten days all treatments showed below the tolerance limit. Parihar *et al.* (1997) [61] collected 37 samples of brinjal to determine the residue level of monocrotophos, dimethoate, phosphamidan, endosulfan and BHC. Only 13 samples were showed residues of above insecticides and which were above the maximum residual limit. Rajakanna *et al.* (1998) [71] studied the residues of HCH, carbaryl and endosulfan from bhindi fruits by the application at 0.1, 0.1 and 0.07 percent, respectively. The half life values were highest in the case of HCH and lowest in the case of carbaryl on the basis of the results, waiting period of 2.0, 4.0 and 6.5 days were recommended for carbaryl, endosulfan and HCH, respectively. Dikshit *et al.* (2005) [25] studied on persistence and dissipation which were conducted on okra cv. A4 and tomato cv. Pusa Ruby after foliar treatments of 20 g *a.i.* deltamethrin/ha, at flowering to fruiting and a repeat application after 15 days. The initial residues of 0.58 mg deltamethrin/kg in okra fruits were non-detectable until the seventh day, while in the case of tomato fruits, residues were not detected until the tenth day. The insecticidal schedules appeared to be safe with regard to the consumption of okra and tomato fruits after 5 and 7 days of treatment, respectively. Paras Nath *et al.* (2005) [59] studied dissipation behaviour of ready mix polytrin C 44EC (profenophos 40%+cypermethrin 4%) and spark 36EC (triazophos 35%+deltamethrin 1%) applied at 1 l/ha in okra crop during Kharif, 2000 was studied at 0, 1, 3, 5 and 7 days after treatment. Dissipation on 7th day was found to be maximum (98.4%) for profenophos followed by triazophos (86.2%), cypermethrin (73.5%) and deltamethrin (55.7%). Half life ($t_{1/2}$) values for the above insecticides were 1.35, 2.55, 4.11 and 7.60 days, respectively. All the insecticides followed a first order kinetics. Profenophos and triazophos followed a biphasic dissipation pattern with faster dissipation in phase I (0-1 days) and manifesting slower rate of dissipation in phase II (1-7 days). Sharma and Mohapatra (2005) [81] studied persistence of indoxacarb residues in tomato and of thiamethoxam residues in okra was studied on foliar application of indoxacarb @ 0.5 and 1.0 ml/l and thiamethoxam @ 0.2 and 0.4 g/l. The residues of the insecticides dissipated fast to be below detectable limits within 7-10 days after their last application. The residues dissipated with half lives of 1.1 to 1.5 days and the pre harvest intervals calculated 1 day only on the basis of respective MRL values for both the insecticides. Gupta *et.al.* (2009) [35] reported that the initial deposits varied from 0.259–0.382 lg g-1 at low and 0.461 - 0.688 lg g-1 at high rate of application. The residues persisted upto 10 days with half-life of 1.32–1.58 days for bifenthrin, 0.65–1.12 days for fipronil and 0.58–1.02 days for indoxacarb. On the basis of ADI, waiting period was suggested 1 day for bifenthrin and indoxacarb and 3 days for fipronil. All the insecticides were effective against leafhopper and shoot and fruit borer. Waghulde *et al*. (2011) [108] studied the dissipation of chlorpyrifos, dimethoate and malathion residues in/on okra (*Abelmoschus esculentus* L) fruits at North Maharashtra region, India. The samples were procured up to 21 days after application of pesticides by Knapsack sprayer. A typical multi-residue extraction procedure using ethyl acetate and sodium sulphate has been applied and concentrated extracts were estimated on GC-ECD system. The dissipation of all residues was noticed to be initially fast. As time advances, the dissipation rate of extractable residue decreases. The half life of residues in okra ranged between 3.68 to 6.92 days and waiting period from 14.54 to 20.93 days. Highest recovery of chlorpyrifos (91.4%) from okra was observed. Das *et al.* (2012) [19] studied the residue persistence of flubendiamide in /on okra fruits following foliar application of Belt 39.35% SC formulation at 24 (standard dose) and 48 (double dose) g *a.i.*/ha. After HPLC analysis study revealed that residues of flubendiamide in/on okra persisted till 5th and 7th day after the last spray at standard and double dose, respectively. The residues of flubendiamide were reported as parent compound and des-iodo flubendiamide, a metabolite (photo product) of flubendiamide, was not detected in/on okra at any time during the study period. The initial deposits of 0.28 and 0.53 micro g/g in/on okra fruits reached below determination level of 0.01 micro g /g on the 7th and 10th day at standard and double dose, respectively. The half life of flubendiamide in/on okra fruits ranged from 4.7 to 5.1 days at standard and double dose, respectively. Raj *et al.* (2012) [72] studied the dissipation of spiromesifen in/on okra. The foliar application of the insecticide was carried out twice at 10 days interval @ 120 and 240 g *a.i* /ha at fruiting stage of the crop. Samples of okra fruits were drawn at 0, 1, 3, 5, 7, 10, 15 and 20 days after second spray. Soil samples were also collected on 20th day after second application. The initial deposits of spiromesifen on okra fruits were 0.964 and 1.819 mg/g at standard and double the standard dose of application, respectively. The residues gradually declined and persisted upto 3rd and 5th day at lower and higher dose, respectively. The residues reached below quantitation limit of 0.01 micro g/g on the 5th and 7th day at standard and double the standard dose, respectively. Half life of the insecticide on okra fruits was 1.68 and 1.65 day for standard and higher dose, respectively. Reddy *et al*. (2013) [76] Evaluation of efficacy of six insecticides *viz.*, bifenthrin 10 EC @ 80 g *a.i.*/ ha, fipronil 5 SC @ 500 g *a.i.*/ ha, flubendiamide 480 SC @ 60 g *a.i.*/ ha, quinalphos 25 EC @350 g *a.i.* /ha, profenofos 50 EC @ 400 g *a.i.* /ha and beta-cyfluthrin 25 SC @ 18.75 g *a.i.* /ha against shoot and fruit borer (*Earias vittella* Fabricius) and white fly *Bemisia tabaci* (Gennadius) on okra revealed that flubendiamide @ 60 g *a.i.*/ha, applied twice as foliar spray, was the most effective. Its dissipation pattern, revealed initial deposit of 1.49 mg/kg which dissipated by 98.88% by 7th day and reached below detectable level (BDL) by 10th day with half life of 1.83 days. Vemuri *et al.* (2014) [107] studied on dissipation pattern by collecting okra fruits at 0, 1, 3, 5, 7, 10 and 15 days after last spray and analyzed at AINP on Pesticide Residues, Rajendranagar, Hyderabad The initial deposits of flubendiamide at 60 g *a.i.*/ha sprayed at 50 % flowering and repeated ten days after first spray recorded 1.49, mg /kg which dissipated to below detectable level (BDL) on 10th day. The initial deposit of profenofos (400 g *a.i.*/ha) in okra fruits was 1.52 mg/kg which degraded to 0.09 by 7th day after last spraying. The initial deposit of beta-cyfluthrin (18.75 g *a.i.*/ha) in okra fruits was 0.11 mg/kg and by one day after treatment dissipated by 45.04 percent.

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