Original Research Article

Effect of sowing timeon infestation of sucking pests in okra

Abstract

Okra is vulnerable to several insect pests, particularly sucking pests such as leafhoppers, whiteflies, and red spider mites, which can cause substantial yield losses. Farmers often rely on insecticidal applications for pest management due to their convenience, but the indiscriminate use of these chemicals can have adverse effects and should be minimized. To explore an alternative approach, a study was conducted at CCS Haryana Agricultural University, Hisar during *kharif* 2023 to assess the effect of sowing time oninfestation of sucking pests in okra. For this, okra was sown on different times *i.e.,* in the 3rd week of May, 1st and 3rd week of June, and 1st and 3rd week of July. The population of leafhopper,whitefly and red spider mite was recorded weekly, starting from the appearance of the pest. The study revealed that leafhopper population in crop sown in the 1st and 3rd week of July was *on a par*, however, significantly lower than that in other crops.Okra sown in the 1st week of July was resulted in significantly lower population of whitefly than rest of the sowing times population *on a par* with each other.Mite infestation was significantly lower in crop sown in the 3rd week of July compared to the others. Based on these findings, July appears to be the most suitable time for sowing okra to minimize sucking pests' infestation.

Keywords: Sowing time, leafhopper, whitefly,red spider mite, okra, sucking pest

Introduction

Vegetables are a vital component of the human diet, providing a wide range of essential vitamins and minerals necessary for maintaining good health. Among these, okra (*Abelmoschus esculentus* (L.) Moench) is one of the most popular crops, cultivated year-round across the country. The fruit of okra is a rich source of important nutrients, including β-carotene, thiamine, riboflavin, vitamin C, calcium, magnesium, oxalic acid, phosphorus, iron, sodium, potassium, copper, and sulfur (Anonymous, 2013-14). Additionally, okra is a significant source of both soluble and insoluble fibers, which promote intestinal health and reduce the risk of colon cancer, serum cholesterol, and heart disease (Bhutto et al., 2017). Though okra is native to South Africa, India holds the leading position in terms of both cultivated area and production. In India, okra is grown throughout the year over an area of 5.31 lakhs ha with annual production of 64.66 lakhs metric tons and productivity of 12.2 metric tons per ha. In Haryana, it occupied 0.12 lakh ha with a production of 1.19 lakh metric tons and productivity of 10.26 metric tons per ha. (Anonymous, 2022).

In spite of the respectable area and production of okra in India, there are several constraints in its cultivation, most importantlythe losses caused by pest infestation. Due to its vulnerability, about 72 species of insects have been reported to attack on okra (Srinivasa and Rajendran, 2003), predominantly by sucking pests such as leafhopper (*Amrascabiguttulabiguttula* Ishi.), whitefly (*Bemisiatabaci*Genn.) and red spider mite (*Tetranychusurticae* Koch.) which cause considerable losses to okra (Dadheech*etal*., 1977). Both nymphs and adults of leafhopper suck the cell sap from the underside of leaves and while feeding inject toxic saliva into plant tissues. Both the nymph and adult of whitefly also extract cell sap from the leaves which exhibit curling and drying. The affected plants demonstrate stunted growth and it resulted in about 4 per cent yield loss in the okra crop (Meenambigai*et al*., 2017). Besides this, these pests transmit certain viral diseases also causing huge losses to the crop (Atwal, 1994).Red spider mite appears as reddish or greenish spots on leaves and stems, and makes a fine web on as well as under the leaves and extracts cellular contents resulting in tiny pale spots or scars where the green epidermal cells have been damaged.

For managing these pests, farmers primarily rely on the use of insecticides due to their ease of application. However, various non-chemical practices, including cultural methods, biological control and the use of biorationals have also been recommended by the experts. Despite their potential benefits, many of these practices, especially cultural methods, are often overlooked in favour of the more effective and user-friendly pesticides. One of the key cultural practices that can affect the incidence of insect pests in okra, is the timing of sowing. The sowing time determines the developmental stages of the crop and its exposure to varying climatic conditions, which in turn affect pest population and their dynamics. In India, the sowing window for okra is quite extensive (March-July), as it is primarily cultivated during both the summer and *kharif* seasons. Moreover, staggered sowing favours the pest to complete 1-2 additional generations under such conditions, which can be mitigated by manipulating the sowing time. Additionally, growing concerns about the environmental and human health risks posed by pesticides have heightened interest in alternative pest management strategies. In light of this, the present study was conducted with the objective to study the effect of sowing time on the infestation of sucking pests in okra.

Materials and Methods

The present investigation was carried out during *kharif* 2023 at CCS Haryana Agricultural University, Hisar using randomized block design. Geographically this place is located between 29.15' N latitude and 75.69' E longitude at an elevation of 186 m above sea level. The field was prepared for sowing and divided into various plots of size 5.4 × 4.2 m. All agronomic practices were followed as per the package of practices (Anonymous, 2020).Okra was sown at five different times*i.e.*, in the 3^{rd}week of May (S1), 1^{st}week of June(S_2), 3^{rd}week of June(S_3), 1^{st}week of July(S_4) and 3^{rd}week of July(S_5).The population-sucking pests viz., leafhopper, whitefly and red spider mite was recorded weekly, starting from the appearance of the pest. The population counts for leafhopper (nymph) and whitefly (adult) were recorded from three leaves (one each from the top, middle, and bottom canopy) on each of the five randomly selected and tagged plants per plot and mean number of nymphs of leafhopper and adults of whitefly per leaf were calculated. Mite population (mite/cm^2) was also recorded on the same pattern as in the case of leafhopper and whitefly. However, the population count was recorded from 1 cm^2 leaf area.

Results

Effect of sowing time on infestation of sucking pests

Different sowing times had significant effect on the population of sucking pests in okra.

Leafhopper

In okra crops sown in the 3^{rd} week of May and 1^{st} week of June, leafhopper appeared 23 days after sowing (DAS). However, in crops sown during the 3rd week of June and the 1st and 3rd weeks of July, the initial appearance of leafhoppers was recorded at 17, 39, and 39 DAS, respectively (Table 1).Leafhopper population in crop sown in the 3^{rd} week of May increased gradually reaching its peak (15.22 nymphs/leaf) in the 2^{nd} week of July, followed by alternating periods of decline and increase, though remained above economic threshold level (ETL) of 2 nymphs per leafuntil the 3^{rd} week of August (Fig. 1). Afterwards, population remained below ETL, except in 3^{rd} week of September when it was 3.57 nymphs per leaf.

In the crop sown in the 1st week of June, the leafhopper population steadily increased, reaching its first peak of 15.03 nymphs per leaf in the 1^{st}week of August, followed by a gradual decline to 0.28 nymphs per leaf in the 1^{st}week of September. The population then surged again and reached its second peak (16.87 nymphs/leaf) in the 3^{rd}week of October, followed by sudden decline. Similarly, in the crop sown in the 3^{rd}week of June, the leafhopper population reached its first peak of

Table 1. Effect of sowing time on infestation of leafhopper in okra

Sowing time	Leafhopper population (nymph/leaf) in different months														
	June					July					August				
	1st week	2nd week	3rd week	4th week	Mean	1st week	2nd week	3rd week	4th week	Mean	1st week	2nd week	3rd week	4th week	Mean
S_1 (3rd week of May)	0.00 (1.00)	1.20 (1.48)	3.85 (2.19)	3.98 (2.23)	3.01 (2.00)	7.87 (2.98)	15.22 (4.03)	10.67 (3.41)	14.60 (3.94)	12.09 (3.62)	15.03 (3.99)	8.87 (3.09)	9.72 (3.24)	0.55 (1.23)	8.54 (3.09)
S_2 (1st week of June)	---	---	0.00 (1.00)	0.62 (1.27)	0.31 (1.14)	1.12 (1.45)	2.45 (1.85)	7.47 (2.89)	8.95 (3.15)	5.00 (2.45)	15.03 (4.00)	9.52 (3.24)	8.07 (3.00)	2.97 (1.98)	8.90 (3.14)
S_3 (3rd week of June)	---	---	---	0.00 (1.00)	0.00 (1.00)	0.82 (1.35)	1.35 (1.53)	3.58 (2.13)	4.72 (2.38)	2.62 (1.90)	16.90 (4.23)	7.30 (2.84)	5.67 (2.55)	1.70 (1.64)	7.89 (2.98)
S_4 (1st week of July)	---	---	---	---	---	---	---	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.08 (1.04)	0.25 (1.10)	0.50 (1.18)	0.21 (1.09)
S_5 (3rd week of July)	---	---	---	---	---	---	---	---	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.22 (1.10)	0.05 (1.03)
SE(m)±	---	---	**0.09**	**0.10**	**0.08**	**0.06**	**0.04**	**0.13**	**0.12**	**0.06**	**0.10**	**0.22**	**0.13**	**0.11**	**0.08**
CD (p=0.05)	---	---	**0.42**	**0.46**	**0.38**	**0.23**	**0.16**	**0.41**	**0.38**	**0.19**	**0.32**	**0.68**	**0.40**	**0.34**	**0.26**

S_1 (22.05.2023); **S_2**(06.06.2023); **S_3** (21.06.2023); **S_4** (05.07.2023); **S_5** (20.07.2023); Figures in parentheses are √n+1 transformed value

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Sowing time	Leafhopper population (nymph/leaf) in different months										Overall Mean
	September					October					
	1st week	2nd week	3rd week	4th week	Mean	1st week	2nd week	3rd week	4th week	Mean	
S_1 (3rd week of May)	0.80 (1.33)	0.47 (1.19)	3.57 (2.12)	1.85 (1.67)	1.67 (1.63)	1.75 (1.63)	0.80 (1.34)	0.00 (1.00)	0.00 (1.00)	0.94 (1.38)	5.93 (2.63)
S_2 (1st week of June)	1.03 (1.38)	0.28 (1.12)	3.30 (2.07)	9.97 (3.31)	3.65 (2.16)	10.35 (3.37)	12.30 (3.64)	16.87 (4.22)	8.92 (3.15)	12.11 (3.62)	6.62 (2.76)
S_3 (3rd week of June)	0.77 (1.32)	0.50 (1.21)	3.85 (2.20)	9.30 (3.21)	3.60 (2.14)	11.75 (3.57)	11.50 (3.53)	8.27 (3.04)	5.05 (2.46)	9.14 (3.18)	5.47 (2.54)
S_4 (1st week of July)	0.95 (1.39)	1.73 (1.65)	3.65 (2.15)	9.50 (3.24)	3.96 (2.22)	10.18 (3.34)	9.58 (3.25)	11.37 (3.51)	5.95 (2.63)	9.27 (3.20)	3.58 (2.14)
S_5 (3rd week of July)	1.05 (1.43)	4.32 (2.30)	5.50 (2.53)	4.05 (2.23)	3.73 (2.17)	9.25 (3.20)	9.28 (3.20)	12.70 (3.70)	7.07 (2.84)	9.58 (3.25)	4.11 (2.26)
SE(m)±	**0.12**	**0.09**	**0.10**	**0.13**	**0.06**	**0.10**	**0.10**	**0.10**	**0.08**	**0.08**	**0.05**
CD (p=0.05)	**NS**	**0.28**	**0.31**	**0.41**	**0.17**	**0.32**	**0.30**	**0.34**	**0.27**	**0.26**	**0.15**

16.90 nymphs per leaf in the 1stweek of August, followed by a sharp decline to 0.50 nymphs per leaf in the 2ndweek of September. The population then increased again to a second peak of 11.75 nymphs per leaf in the 1stweek of October, after which a gradual decline was observed.In the crops sown in the 1stand 3rdweek of July, the leafhopper population continued to rise above the ETL after its appearance, reaching its maximum in the 3rdweek of October, with 11.37 and 12.70 nymphs per leaf, respectively.

When analyzing the month-wise mean population of leafhopper across different sowing times, the data for July showed a significantly higher population (12.09 nymphs per leaf) in the crop sown in the 3rdweek of May, followed by crops sown in the 1stand 3rdweek of June, with 5.00 and 2.62 nymphs per leaf, respectively. No leafhopper infestation was observed in the crops sown in the 1stand 3rdweek of July.In August, mean population of leafhopper in crop sown in the 3rd week of May, 1stweek of June and 3rdweek of June was *on a par* with each other (8.54, 8.90 and 7.89 nymph/leaf, respectively) and significantly higher than that in crop sown in 1st and 3rd week of July having 0.21 and 0.05 nymphs per leaf, respectively and *on a par* with each other. In the month of September,mean population in late sown crops (June and July) was*on a par* with each other (3.60 to 3.96 nymphs/leaf) but significantly higher than in crop sown in the 3rd week of May(1.67 nymphs/leaf). In October, leafhopper population was significantly higher (12.11 nymph/leaf) in crop sown in 1st week of June compared to others. Next to this, leafhopper population in crops sown in the 3rd week of June, 1st week of July and 3rd week of July was *on a par* with each other *i.e*., 9.14, 9.27 and 9.58 nymphs per leaf, respectively. However, crop sown in the 3rd week of May experienced significantly lower population of leafhopper (0.94 nymph/leaf).

The overall mean population of leafhopper during the crop season revealed that okra sown in the 1st week of June registered significantly higher population (6.62 nymphs/leaf). It may be attributed to the longer duration of the crop than others, except crop sown in the 3rd week of May, which had matured by the time leafhopper population increased again in the month of October. The findings of the current studies are in close proximity of Agarwal *et al*. (1999) who reported that okra crop sown in the 1stweek of June harboured higher population of leafhopper which decreased with the delay in sowing time with lowest level in crops sown in the second fortnight of July. However, Brice *et. al.* (2017) reported that leafhopper population in okra sown on June 1st was lower than in crop sown on June 30th.Following to this, mean population in crop sown in the 3rd week of May as well as 3rd week of June was (5.93 and 5.47 nymphs/leaf, respectively) *on a par* with each other but significantly higher than in crop sown in the 1st and 3rd week of July which also had population *on a par* with each other *i.e.*, 3.58 and 4.11 nymphs per leaf, respectively. These findings are in agreement with Regmi *et al*. (2020) who reported that early sown crop has more leafhopper population than late sown crop, whereas, Mahmood *et al.* (1990) also reported that population of leaf hoppers peaked in early June, while lower numbers were observed in the third week of July. However, Bairwa *et al.* (2005) also mentioned that okra crop sown in 1stweek of July registered lower population of leafhopper population compared to that sown later. Similarly, the study conducted by Sinha *et al.* (2007) indicates that sowing okra in June resulted in a higher leafhopper population compared to the lower population observed in crops sown during the third week of July. However, Kumar (2013) reported that leafhopper populations were highest in June-sown okra and lowest in crops sown during the third week of July, indicating a seasonal influence on pest dynamics.

Whitefly

Okra crops sown in the 3rd week of May,1stweek of June, 3rd week of June,1stweek of July and 3rd week of July experienced the first attack of whitefly 30, 23, 17, 67 and 39 DAS, respectively (Table 2). Whitefly population gradually increased and in crop sown in the 3rd week of May, and 1st and 3rd week of June, it reached its peak (5.33, 5.93 and 6.60 adults/leaf, respectively) in 1st week of August, followed by decrease up to 2nd week of September (Fig. 2). Thereafter, whitefly population again increased but later on (2nd week of October), it started decreasing again. In crops sown in 1st week of July, whitefly population reached to its maximum (4.90 adults/leaf) in 3rd week of October while in crops sown in the 3rd week of July, maximum population (6.32 adults/leaf) was recorded in the 4th week of September. However, whitefly population remained below ETL (6-8 adults/leaf) during the entire cropping season in case of all the sowing times, except 3rd week of June and 3rd week of July, where it was recorded 6.60 adults per leaf in the 1st week of August and 6.32 adults per leaf in last week of September, respectively.

Table 2. Effect of sowing time on whitefly infestation in okra

Sowing time	Whitefly population (adult/leaf) in different months													
	June				July					August				
	2nd week	3rd week	4th week	Mean	1st week	2nd week	3rd week	4th week	Mean	1st week	2nd week	3rd week	4th week	Mean
S_1 (3rd week of May)	0.00 (1.00)	0.03 (1.02)	1.22 (1.48)	0.63 (1.27)	3.90 (2.21)	5.08 (2.46)	4.95 (2.44)	5.10 (2.46)	4.76 (2.40)	5.33 (2.51)	2.62 (1.88)	0.18 (1.09)	0.30 (1.14)	2.11 (1.76)
S_2 (1st week of June)		0.00 (1.00)	0.67 (1.28)	0.33 (1.15)	1.08 (1.44)	2.47 (1.85)	3.25 (2.05)	3.48 (2.12)	2.57 (1.89)	5.93 (2.61)	1.90 (1.70)	0.48 (1.22)	0.43 (1.19)	2.19 (1.78)
S_3 (3rd week of June)	---	---	---	---	0.25 (1.12)	0.52 (1.23)	1.50 (1.58)	2.80 (1.95)	1.27 (1.50)	6.60 (2.75)	2.50 (1.84)	0.75 (1.32)	0.00 (1.00)	2.46 (1.86)
S^4 (1st week of July)	---	---	---	---	---	---	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
S^5 (3rd week of July)	---	---	---	---	---	---	---	---	---	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.05 (1.02)	0.00 (1.00)
SE(m)±	---	---	**0.09**	**0.05**	**0.05**	**0.11**	**0.07**	**0.08**	**0.03**	**0.09**	**0.11**	**0.05**	**0.04**	**0.05**
CD (p=0.05)	---	---	**NS**	**NS**	**0.17**	**0.40**	**0.23**	**0.26**	**0.11**	**0.27**	**0.36**	**0.14**	**0.12**	**0.14**

S_1 (22.05.2023); **S_2**(06.06.2023); **S_3** (21.06.2023); **S_4** (05.07.2023); **S_5** (20.07.2023); Figures in parentheses are √n+1 transformed value **Continued below…..**

Sowing time	Whitefly population (adult/leaf) in different months										Overall Mean
	September					October					
	1st week	2nd week	3rd week	4th week	Mean	1st week	2nd week	3rd week	4th week	Mean	
S_1 (3rd week of May)	0.08 (1.04)	0.07 (1.03)	0.63 (1.27)	3.45 (2.11)	1.06 (1.43)	3.45 (2.11)	1.43 (1.56)	0.00 (1.00)	0.00 (1.00)	1.56 (1.60)	2.10 (1.76)
S_2 (1st week of June)	0.00 (1.00)	0.00 (1.00)	0.67 (1.29)	4.23 (2.29)	1.23 (1.49)	4.52 (2.35)	4.38 (2.32)	3.72 (2.17)	1.92 (1.71)	3.63 (2.15)	2.17 (1.78)
S_3 (3rd week of June)	0.17 (1.07)	0.00 (1.00)	0.67 (1.28)	4.48 (2.34)	1.33 (1.53)	3.82 (2.17)	3.77 (2.18)	4.62 (2.37)	2.32 (1.82)	3.63 (2.15)	2.17 (1.78)
S_4 (1st week of July)	0.00 (1.00)	0.28 (1.13)	0.37 (1.16)	4.75 (2.39)	1.35 (1.53)	3.75 (2.17)	4.43 (2.33)	4.90 (2.43)	2.52 (1.88)	3.90 (2.21)	1.50 (1.58)
S_5 (3rd week of July)	0.38 (1.17)	2.07 (1.75)	1.83 (1.68)	6.32 (2.70)	2.65 (1.91)	3.33 (2.08)	2.85 (1.96)	3.47 (2.11)	2.42 (1.85)	3.02 (2.00)	1.89 (1.70)
SE(m)±	**0.06**	**0.03**	**0.07**	**0.06**	**0.04**	**0.10**	**0.07**	**0.04**	**0.03**	**0.05**	**0.02**
CD (p=0.05)	**NS**	**0.10**	**0.20**	**0.19**	**0.11**	**NS**	**0.21**	**0.13**	**0.09**	**0.14**	**0.06**

Considering month wise population of whitefly across different sowing times, notable variations were observed. In July, okra sown in the 3rd week of May registered significantly higher population of whitefly (4.76 adults/leaf), followed by that sown in 1st and 3rd week of June (2.57 and 1.27 adults/leaf, respectively). No infestation of whitefly was observed in crop sown in the 1st week of July. Moving to the month of August, mean population of whitefly in crops sown in 3rd week of May, 1st and 3rd week of June did not differ significantly, however, no infestation was observed in crops sown in the 1st and 3rd week of July. During the month of September, mean infestation of whitefly was significantly higher (2.65 adults/leaf) in crop sown in the 3rd week of July, however, no significant difference was observed among the other sowing times with respect to whitefly population. In October, whitefly population in crop sown in the 1st and 3rd week June was equal (3.63 adults/leaf) and *on a par* with that in crop sown in the 1st week of July (3.90 adults/leaf). Population in crops sown in 3rd week of July was significantly lower (3.02 adults/leaf) than that in former sowing times but significantly higher than in crop sown in the 3rd week of May (1.56 adults/leaf). Notably, okra sown in the 3rd week of May consistently showed significantly lower population of whitefly across the month, possibly due to crop maturity.

The overall mean population of whitefly during the crop season in okra sown in the 1st as well as 3rd week of June was equal (2.17 adults/leaf) and*on a par* with that in crop sown in 3rd week of May (2.10 adults/leaf)but significantly higher than that in other crops. In crop sown in 3rd week July, the mean population of whitefly was significantly higher (1.89 adults/leaf) than in crop sown in 1st week of July (1.50 adults/leaf).Likewise, higher population of whitefly in crop sown in the month of June might be due to long exposure of the crop to the pest. Conversely, total crop period for the crops sown in July was shorter and thus avoided the whitefly attack. The current findings align with Kumaranag (2015) who also reported higher population of whitefly in okra sown in the month of June compared to that in sown in the month of July and August. However, other studies (Kalita and Dhawan, 2006; Arian *et al.,* 2020) have noted an increase in whitefly populations with delayed sowing. Whereas, Bairwa *et al*., (2005) reported that whitefly infestation was minimum in early sown (July 7th) crop of okra increasing gradually with the delayed sowing time. These discrepancies could be attributed to variations in environmental conditions and the specific okra varieties used in each study.

Red spider mite

Mite infestation in okra sown in the 3rd week of May, 1st week of June, 3rd week of June and 1st week of July initiated in the first week of August *i.e.*, 74, 60, 45 and 30 days after sowing,respectively, however, in crop sown in 3rd week of July, it first appeared in 3rd week of August (30 DAS) and continued until the end of September (Table. 3). Mite population in crop sown in the 3rd week of May reached its peak (11.88 mites/cm^2) in second week of August, followed by a gradual decline (Fig. 1). However, infestation remained above ETL (2 mites/cm^2) up to the 1st week of September. In case of crop sown in the 1st week of June, mite population reached its peak (14.03 mites/cm^2) in the 3rd week of August, followed by gradual decline and dropping below ETL (1.23 mites/cm^2) in 3rd week of September. In the crop sown in the 3rd week of June, the mite population recorded was maximum (9.55 mites/cm^2) in the last week of August, decreasing thereafter and dropped below ETL by the 3rdweek of September. In case of crop sown in 1st and 3rd week of July, mite population continued increasing after appearance and reached their respective peaks (9.85 and 6.08 mites/cm^2) in the 1st week of September.

When the month wise mean population of mite across different sowing times is taken into account, in the month of August, population in the 3rd week of May (8.65 mites/cm^2), 1st week of June (8.71 mites/cm^2) and 3rd week of June (7.55 mites/cm^2)was on a par with each other but significantly higher than in other crops. Mean population of mite in crop sown in the 1st week of July was significantly higher (3.03 mites/cm^2) than in crop sown in the 3rd week of July (1.21 mites/cm^2). In the month of September, however, reverse trend was observed with respect to mean population of mite. Okra sown in the 3rd week of May registeredsignificantly lower population of mite (1.30 mites/cm^2) than other crops. Next to this, mean population of mite in the 1stand 3rdweek of June,and 3rd week of July was *on a par* with each other (2.59, 2.73 and 3.15 mites/cm^2, respectively) but significantly lower than in crop sown in the 1st week of July.

Overall mean population of mite in crop sown in the 3rd week of May (4.98 mite/cm^2), 1st week of June (5.65 mite/cm^2) and 3rd week of June (5.14 mite/cm^2) was *on a par* with each other but significantly higher than in other crops. Crop sown in the 3rd week of July registered significantly lower population (2.18 mite/cm^2) than sown in the 1st week of July (3.31 mite/cm^2).The higher population in early sown crops might be due to favorable crop stages and environmental conditions that encourage

Table 3. Effect of sowing time on red spider mite infestation in okra

Sowing time	Mite population (mite/cm^2) in different months											Overall Mean
	July	August					September					
	4th week	1st week	2nd week	3rd week	4th week	Mean	1st week	2nd week	3rd week	4th week	Mean	
S_1 (3rd week of May)	0.00 (1.00)	5.85 (2.60)	11.88 (3.56)	11.15 (3.48)	5.72 (2.56)	8.65 (3.09)	2.03 (1.74)	1.15 (1.46)	1.48 (1.57)	0.53 (1.24)	1.30 (1.52)	4.98 (2.44)
S_2 (1st week of June)	0.00 (1.00)	4.08 (2.25)	7.65 (2.94)	14.03 (3.88)	9.07 (3.17)	8.71 (3.12)	6.00 (2.64)	2.45 (1.83)	1.23 (1.49)	0.63 (1.27)	2.59 (1.89)	5.65 (2.58)
S_3 (3rd week of June)	0.00 (1.00)	4.03 (2.24)	8.02 (2.99)	8.60 (3.04)	9.55 (3.22)	7.55 (2.92)	7.97 (2.99)	2.18 (1.73)	0.48 (1.22)	0.28 (1.13)	2.73 (1.93)	5.14 (2.48)
S_4 (1st week of July)	0.00 (1.00)	0.60 (1.27)	1.60 (1.61)	3.92 (2.21)	6.02 (2.63)	3.03 (2.00)	9.85 (3.29)	1.17 (1.46)	2.45 (1.85)	0.88 (1.37)	3.59 (2.14)	3.31 (2.07)
S_5 (3rd week of July)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	1.27 (1.50)	3.02 (2.00)	1.21 (1.49)	6.08 (2.65)	4.87 (2.42)	1.03 (1.42)	0.62 (1.27)	3.15 (2.03)	2.18 (1.78)
SE(m)±	**---**	**0.11**	**0.17**	**0.19**	**0.19**	**0.11**	**0.10**	**0.16**	**0.10**	**0.05**	**0.06**	**0.07**
CD (p=0.05)	**---**	**0.34**	**0.53**	**0.58**	**0.60**	**0.35**	**0.32**	**0.49**	**0.30**	**NS**	**0.20**	**0.23**

S_1 (22.05.2023); **S_2**(06.06.2023); **S_3** (21.06.2023); **S_4** (05.07.2023); **S_5** (20.07.2023); Figures in parentheses are √n+1 transformed value

Image 1-Red spider mite **Image 2-Leafhopper** **Image 3 -Whitefly**

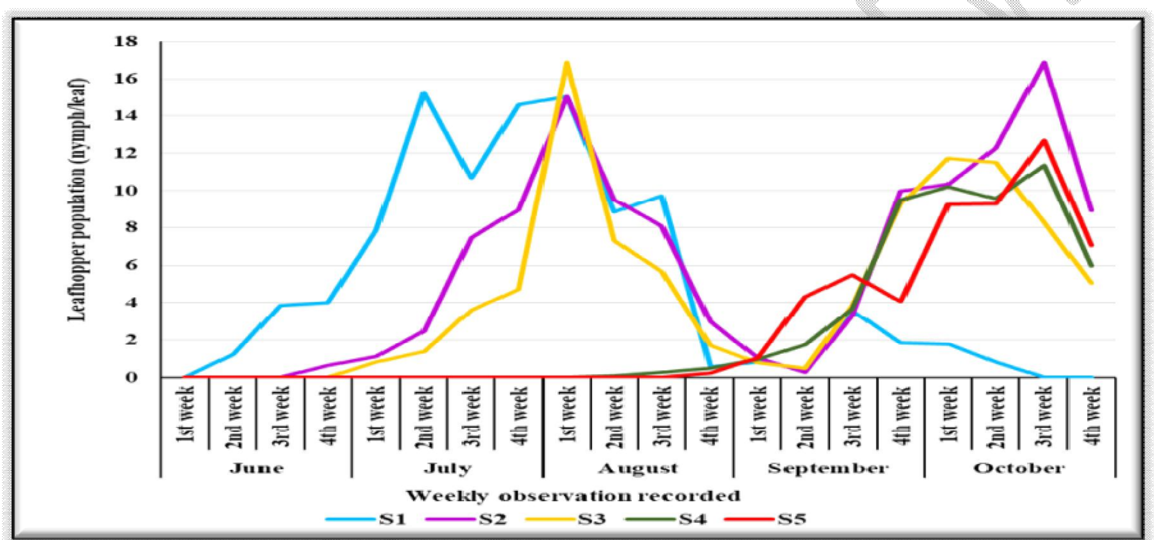

Fig. 1. Effect of sowing time on leafhopper population

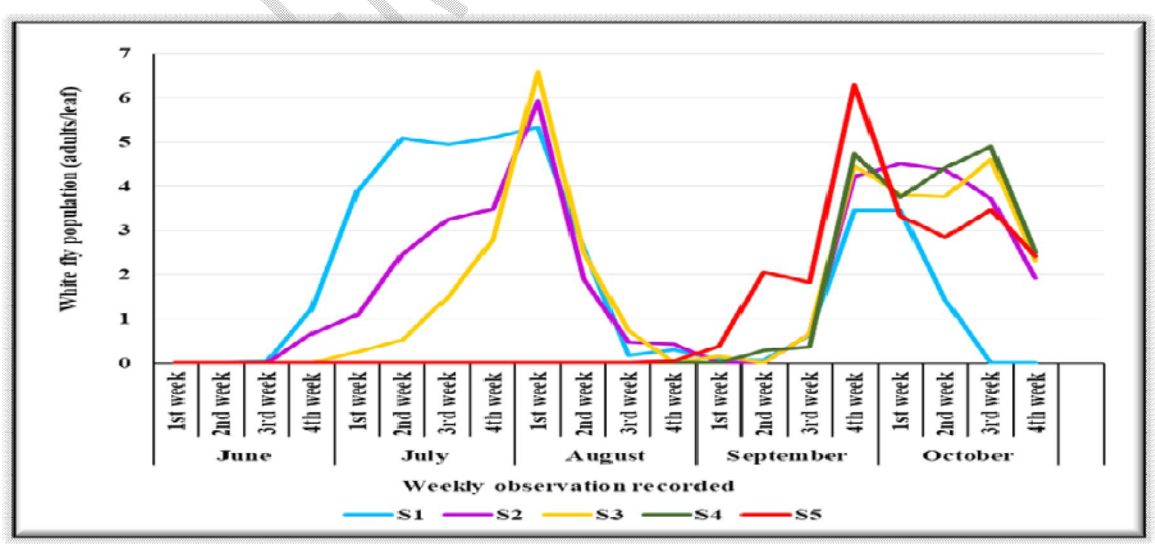

Fig. 2. Effect of sowing time on whitefly population

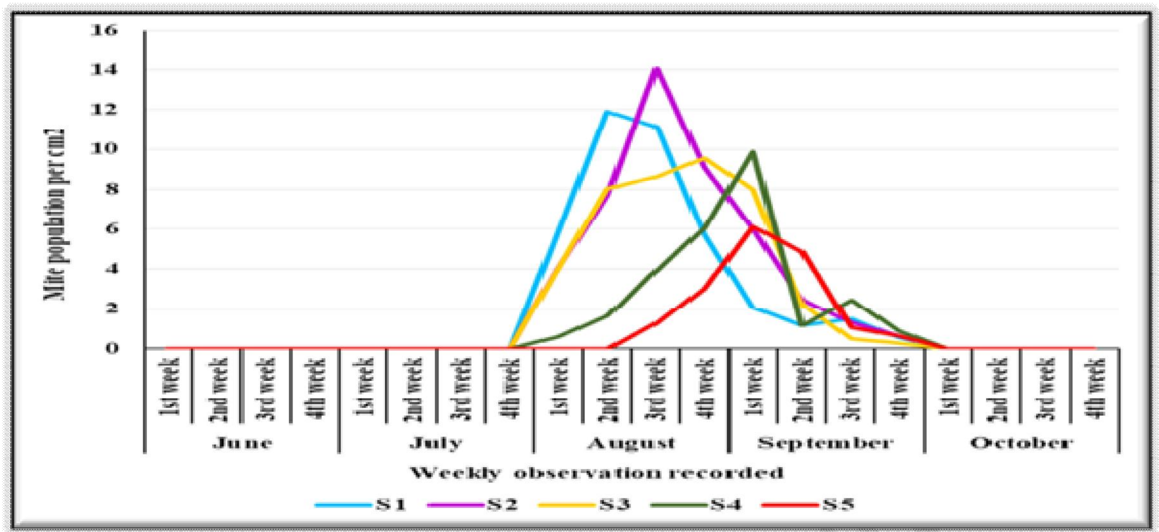

Fig. 3. Effect of sowing time on red spider mite population

mite infestations. Conversely, at the onset of mites, late sown crops had less canopy development, resulting in lower populations compared to early sown crops. These findings are consistent with Naga *et al.* (2017), who also reported that okra sown in the last week of July harboured lower population of mite than sown in 1st week of July. However, these are at variance with those of Kumaranag (2015) who reported that okra crop sown in the month of June harboured lower population of mite than sown in the month of July and August. These discrepancies could be attributed to variations in environmental conditions prevailed at places of study during the study period.

Conclusion

The timing of sowing is a crucial factor in okra cultivation, significantly influencing the population of insect and mite pests. Proper sowing time can optimize the plant's growth environment, reducing pest populations and helping farmers achieve higher marketable yield with lower production costs.It was observed that okra crop sown in the month of July had lower infestation of sucking pests (leafhopper, whitefly and mite) compared to that sown in the month of May and June.

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