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# SPIROMESIFEN (LIPID BIOSYNTHESIS INHIBITOR) FOR MANAGEMENT OF WHITEFLY AND OTHER SUCKING PESTS ON POTATO IN AN INTEGRATED APPROACH

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**ABSTRACT: In the present scenario of climate change, management of *Bemisia tabaci* (Gennadius), a potential vector of apical leaf curl virus disease on potato to ensure production of disease free good quality potato seed is tough enough without an integrated approach of management. A combination of two different groups of chemical insecticides was tested to manage whitefly. Spiromesifen 240 SC, non-systemic chemical belongs to the class of spirocyclic tetronoic acid and thaimethoxam 25WG, systemic chemical belongs to neonicotinoids group were tested on potato crop as alternate foliar sprays under field conditions. The effect of these chemical was also recorded on other sucking insect pests like leafhopper and aphids which occurred simultaneously on potato crop. Results obtained indicated that whitefly could effectively be controlled with two foliar sprays-first of spiromesifen @ 96 g a.i./ha and second of thiamethoxam @ 100 g a.i./ha at 15 days interval and third if required again of spiromesifen @ 96 g a.i./ha. Therefore, the spray schedule developed in this study would be a very good strategy to suppress whitefly populations and other sucking pests significantly in potato to ensure better production of seed and ware potatoes.**

**KEY WORDS:** Aphids, *Bemisia tabaci,* potato, *spiromesifen, thiamethoxam*, whitefly.

## INTRODUCTION

Whitefly (*Bemisia tabaci*) is of considerable economic importance worldwide both as a pest as well as a vector (Navas-Castillo *et al.,* 2011). *B. tabaci* occurs in large numbers in western Uttar Pradesh (India) in October and November during main crop season of potato. *B. tabaci* transmits apical leaf curl disease in wide families of many crops including potatoes (Chandel *et al*., 2010) and more than 500 hosts have been reported worldwide (Dhawan *et al.,* 2007). It was reported that high apical leaf curl incidence coincided with the high build up of whitefly population (Garg *et al.*, 2001; Lakra, 2002 and 2003a).The primary infection of apical leaf curl disease in the field appears within 40–45 days after planting and infection results in significant decrease in size and number of tubers of potato (Lakra, 2003b). Losses in marketable yield were reported to be as high as 50 % in early planted susceptible cultivars (Lakra, 2002).

The management of whitefly *B. tabaci* (Gennadius) has been a problem in agricultural and horticultural crops since long (Brown *et al.,* 1995) because of its very high reproductive potential and capability to accommodate itself to changing adverse climatic conditions. Broad spectrum insecticides such as organophosphates, carbamates and pyrethroids had been used in past to control whiteflies (Palumbo *et al.*, 2001). Development of resistance in *B. tabaci* is another problem and had been reported by many workers against organophosphates, pyrethroids, some insect growth regulators and some neonicotinoid insecticides (Cahill *et al*., 1996, Prabhaker *et al.,* 1997; Palumbo *et al*., 2001). The significance of whitefly as

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a vector in potato seed production due to apical potato leaf curl virus disease cannot be ignored. Hence efforts were made to manage this insect at Central Potato Research Institute Modipuram (Meerut) Campus with chemicals of different modes of action. It became essential to look for chemicals with novel mode of action to combat the evolution of quick resistance in whiteflies.

A combination of two chemical insecticides, spiromesifen 240SC and thiamethoxam 25WG was tried to manage whitefly as well as the problem of insecticide resistance. Spiromesifen which belongs to new class of chemicals, spirocyclic phenyl substituted tetronic acids has a novel mode of action and non systemic in nature (Palumbo, 2017). It has long-lasting residual and IGR like activity against developmental stages of insects including eggs and provides excellent control of mites, psyllids and whiteflies. It was reported that spiromesifen is safe on beneficial organisms and has a favorable environmental profile (Nauen *et al*., 2002; Kavitha *et al*., 2006). Spiromesifen is also extremely effective against pyriproxyfen-resistant whiteflies and no cross resistance to any important insecticide and acaricide was found (Nauen *et al*., 2002).The action threshold for silverleaf whitefly in cantaloupe (Riley and Palumbo, 1995) and spray applications to initiate after populations exceeded a threshold of 2 adults per leaf or 0.5 large nymphs per 2 cm$^2$ leaf disc (Palumbo, 2009). Thiamethoxam is broad spectrum neonicotinoid insecticide can be applied as a foliar application, soil and as seed treatment. Thiamethoxam is approved in the United Kingdom for use on potatoes, apples, pears and ornamental house plants, effectively controls the sucking and chewing insects.

Thiamethoxam is nicotinic acetylcholine receptor agonist/antagonist and rapidly taken up by the plant, with excellent translaminar movement, and is transported acropetally in the xylem. In potato crop imidacloprid and thiamethoxam were being used to manage whitefly adults and in turn managing the apical leaf curl disease to produce healthy seed of potato. In the present study we replaced imidacloprid with new chemical spiromesifen and combination of two classes of mode of action of 23 and 4A was used to manage whitefly (*B. tabaci*). The idea behind this study was that immature developmental stages will be killed by spiromesifen and persistently transmitted viruses which are acquired by the vector from phloem, the presence of systemic material thiamethoxam in the phloem can kill the vector prior to virus acquisition/inoculation. This may be useful in controlling disease resulting from vector/virus relationship.

## MATERIALS AND METHODS

Field experiments were conducted in the year 2013 and 2014 and potato crop was planted with variety Kufri Bahar in the month of October in second week (10$^{th}$ October) at ICAR-Central Potato Research Station, Modipuram (Meerut) with all standard agronomical practices without any application of insecticide in the field except test chemicals. The plot size was 3.6 x 2.0 m$^2$ with plant to plant and row to row distance of 20 x 60 cm respectively. There were six treatments including control and treatments were replicated thrice. Treatment T2 was positive control. Observations were recorded on the population of whitefly, leafhopper, *A. gossypii* and *M. Persicae* before and after the sprays on 5 plants/plot (calculated as number/100 compound leaf basis) as leaf turn samples in the field. This integrated schedule was mainly developed for white fly. Different treatments were applied as per details given in Table 1.

First spray was given in the treatments T2, T3, T4 and T5 in the last week of October,

**Table 1. Treatment details**

| | |
|---|---|
| T1 | Potato crop with two yellow sticky traps (15 x 20 cm) at canopy height |
| T2 | T1+ Seed treatment with imidacloprid (200 SL) @ 0.04% (4 ml/10 L) + foliar spray with imidacloprid @ 60 gm a.i./ ha at the emergence of crop + second spray with thiamethoxam (25 WG) @100 g a.i./ha after 15 days of first spray |
| T3 | Foliar spray of spiromesifen 240 SC after emergence of crop @ 96 g a.i./ha + second spray with thiamethoxam (25 WG) @ 100 g a.i./ha after 15 days of first spray |
| T4 | Foliar spray of spiromesifen 240 SC after emergence of crop @ 96 g a.i./ha (400 ml/ha) + second spray with thiamethoxam (25 WG) @ 100 g a.i./ha after 15 days of first spray + Third spray of spiromesifen 240 SC after emergence of crop@ 96 g a.i./ha after 30 days of first spray, |
| T5 | Foliar spray of spiromesifen 240 SC after emergence of crop @ 120 g a.i./ha + Second spray with spiromesifen 240 SC after emergence of crop @120 g a.i./ha after 30 days of first spray. |
| T0 | Control |

second spray in T2, T3 and T4 in second week of November and third spray was given in last week of November in T4 and second spray in T5 with the respective chemical insecticides mentioned above. After foliar sprays, observations were also recorded on the numbers of leafhopper (*Amrasca b. biguttula*) and both aphids, *Aphis gossypii* and *Myzus persicae* found on potato crop.

## RESULTS AND DISCUSSION

Adult whiteflies could be seen on undersides of the new leaves immediately after when the plant is still coming out of the soil. Whitefly remains very active in October and November months in western Uttar Pradesh. It was evident from the data obtained **(Table 2)** that even yellow traps were effective in removing some of the whiteflies from the crop as the time passed by.

Where seed treatment and first foliar spray of imidacloprid was given the number of whiteflies reduced to more than half after first spray. In next 15 days number of whiteflies increased as neonicotinoids are not effective killers of young stages. Second spray of thiamethoxam after 15 days in this spray schedule further reduced the numbers of adults as it is also effective against adult whiteflies. Thiamethoxam has shown promising activity against sucking pests when applied as a foliar spray (Liu, 2002). In spray schedule 3 and 4, after first spray of spiromesifen @96 g a.i./ha due to higher mortality of young stages, only few adults in (11.11 adults/100 compound leaves) were recorded. Second spray of thiamethoxam further reduced the adults of whitefly (13.22 and 2.22 adults/100 compound leaves, respectively). Although the

**Table 2. Population of adult whitefly (*Bemisia tabaci*) (Number/100 compound leaves) under different treatments after sprays (2013 and 2014).**

| Treatments | First spray | | Second spray | | Third spray in T4 only | |
|---|---|---|---|---|---|---|
| | Before | after | before | after | before | after |
| T1 | 353.33 (18.64) | 380.67 (19.51) | 428.88 (20.84) | 282.22 (17.34) | 17.77 (4.33) | 17.77 (4.33) |
| T2 | 388.88 (19.68) | 75.55 (8.62) | 133.11 (11.59) | 20.02 (4.58) | 2.22 (1.79) | 2.22 (1.79) |
| T3 | 314.44 (17.52) | 11.11 (3.78) | 82.22 (8.62) | 13.33 (4.58) | 2.22 (1.79) | 2.22 (1.79) |
| T4 | 224.22 (15.06) | 11.11 (2.78) | 68.88 (7.83) | 2.22 (1.09) | 17.77 (4.33) | 2.22 (1.79) |
| T5 | 300.09 (17.34) | 4.44 (1.00) | 140.02 (12.15) | 4.44 (2.76) | 2.22 (1.79) | 2.22 (1.79) |
| T0 | 393.33 (20.02) | 446.66 (21.15) | 493.33 (21.93) | 384.44 (19.68) | 235.55 (15.38) | 213.33 (14.64) |
| LSD (p= 0.05) | (1.69)** | (0.78)** | (1.00)** | (1.30)** | (1.49)** | (0.90)** |

**Table 3. Population of sucking pests (Number/100 compound leaves) under different treatments after final spray (2013 and 2014).**

| Treatments | *Myzus persicae* | | *Aphis gossypii* | | Leafhopper *Amrasca b. biguttula* | |
|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After |
| T1 | 144.44 (12.06) | 213.55 (4.20) | 360.66 (19.01) | 91.11 (9.59) | 702.20 (26.51) | 33.33 (5.85) |
| T2 | 2.22 (1.79) | 2.22 (2.76) | 9.77 (3.28) | 4.44 (2.33) | 93.33 (9.71) | 13.33 (3.78) |
| T3 | 48.22 (7.01) | 2.22 (1.02) | 46.88 (6.92) | 17.77 (4.33) | 386.66 (19.68) | 53.38 (7.37) |
| T4 | 2.22 (1.79) | 15.11 (3.51) | 96.22 (9.86) | 46.88 (6.92) | 548.88 (23.44) | 31.11 (5.66) |
| T5 | 88.88 (9.48) | 38.88 (6.19) | 434.66 (20.87) | 47.33 (6.95) | 495.55 (22.28) | 46.66 (6.90) |
| T0 | 92.66 (9.67) | 231.11 (14.64) | 268.22 (16.40) | 89.33 (9.50) | 628.88 (25.09) | 17.77 (4.33) |
| LSD (0.05) | NS | 0.40** | 1.30** | 0.84 NS | 1.64 NS | 0.29** |

control was achieved with 2 sprays, further one more of spiromesifen can be given if number of whiteflies is still higher. In last spray schedule, higher dose of spiromesifen @ 120 g a.i./ha, has resulted in lesser number of adult whiteflies (4.44 and 2.22 adults/100 compound leaves) after first spray and second foliar spray after 30 days in last week of November. The higher dose of spiromesifen in this treatment was meant for larger fields of seed crop of potato to save the cost of one extra spray and man power to manage whitefly. It was also recorded that adults of whitefly keep moving from other crops in the vicinity to healthy crop as it is knownfact that adults of whitefly prefer healthy and young foliage to feed on. Treatment of spiromesifen @ 96 g a.i./ha (11.11 adults/100 compound leaves) was quite effective in controlling whitefly comparable to standard practice (T2) when two chemicals of same class were used, imidacloprid and thiamethoxam have similar mode of action. Thiamethoxam has been reported to have very low toxicity to fish, Daphnia, mollusks and earthworms (Maienfisch *et al.*, 2001) and much shorter half-life compared to imidacloprid (Liu *et al.*, 2011) ranges from 9 days in the fields (Karmakar and Kulshrestha, 2009) to 75 days in laboratory soils (Maienfisch *et al.*, 2001).

The results obtained with spiromesifen were in accordance with the results obtained to show the susceptibility of field populations of *B. tabaci* to spiromesifen on melons and tomato (Liu, 2004; Mann *et al.*, 2008; Palumbo, 2009 and 2017). Efficacy of spiromesifen against glasshouse whitefly was studied on strawberry crop (Bi and Toscano, 2007). Imidacloprid and thiamethoxam did not let the population of aphid, *A. gossypii* and leafhopper build up **(Table 3)**. Observations recorded on leafhopper and aphids indicated that the spiromesifen could reduce the numbers of these pests too although not as effectively as neonicotinoids- imidacloprid and thiamethoxam (Sujayanand *et al.*, 2013) which result in quick knock down of these sucking pests.

## CONCLUSIONS

This study demonstrated that spiromesifen combined with neonicotinoid like thiamethoxam have good potential and can be used as effective tool to manage vector whitefly and in turn apical leaf curl disease, and other sucking pests. Yellow sticky traps can be integratedfor additional advantage in the field. Furthermore, this combination would also reduce the development of resistance in whitefly as they belong to two different groups.

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