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# Evaluation of insecticides against whitefly on tomato and their effect on natural enemies

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### Abstract
The study was conducted during tomato growing season of 2011 and 2012 in Jama block of Dumka district of Jharkhand to evaluate the effectiveness of imidacloprid as seed/root treatment and spraying of same insecticide or followed by Dimethoate as foliar application against the whitefly (*Bemisia tabaci*) after analysis of technological gap of package of practice of tomato cultivation. The experimental result revealed that the root treatment done with Imidaclorprid70 WS solution @ 3 g/L of water for 30 minutes followed by one spray with Imidaclorprid 17.8 SL@ 0.3 ml/L and second spray with Dimethoate 30 EC @1.5ml/L water was more effective in reduction of whitefly population to obtain higher fruit yield of tomato than by seed treatment done with Imidaclorprid 70 WS @ 3g/kg of seed and 2 sprays done with Dimethoate 30 EC @1.5ml/L water. Both the insecticides showed no or minimum suppression of coccinellid & spider population. Hence, neonicotinoids can suitably be included in Integrated Pest Management of sucking insect pests like whitefly in tomato because of their less toxicity to predators.

**Keywords:** *Bemisia tabaci*, Imidacloprid, Dimethoate, Coccinellid, Spider

### Introduction
Tomato (*Lycopersicon esculentum* Mill.) belonging to the family Solanaceae, is one of the most popular and widely grown vegetable crops of both tropics and subtropics of the world (Govindappa *et al.*, 2013). The cultivated tomato originates from wild plants found in the Andean regions of Chile and Peru. It is grown in practically every country in the world in outdoor fields, greenhouses and net houses. The tomato plant is very versatile and the crop can be divided into two categories: fresh market tomatoes and processing tomatoes. The latter are grown only outdoors and are mechanically harvested for the canning industry. According to the Food and Agriculture Organization (FAO) of the United Nations, global tomato production (processing and fresh) reached 110 million metric tons in 2003, while global trade increased to $4.3 billion. However, due to its continuous large-scale production throughout the year, it has become susceptible to a number of pathogens, limiting its production. Apart from a number of bacterial and fungal pathogens which cause severe infections on tomato, it is infested by a number of sucking pests in vegetative stage and borers at fruiting stage. Among the sucking insects, whitefly *(Bemisia tabaci*) is one of the most damaging as it also acts as vector of tomato leaf curl virus (Dempsey *et al*., 2017). Whitefly is an important pest under the order hemiptera and carries piercing and sucking type of mouthpart (David *et al*., 2006) They cause direct and indirect damage to the tomato especially in the early growth stage. Both nymphs and adults suck the cell sap from the lower leaf surfaces. In addition, they disrupt transportation in conducting vessels and apparently introduce a toxin that impairs photosynthesis in proportion to the amount of feeding (Sharma *et al*., 1998). When several insects suck the sap from the same leaf, yellow spots appear on the leaves, followed by crinkling, curling, bronzing, and finally drying of leaves. This phenomenon is known as "hopper burn" (Das *et al*., 2014). In case of severe damage all leaves of the plants become crinkled or twisted with drastic reduction in photosynthesis which ultimately causes severe yield reduction. On the other hand, this insect is a potential vector of various viruses including tomato leaf curl and their honeydew attracts black sooty mould which inhibits photosynthesis thus reducing the yield (Sharma *et al*., 1998). Although insecticidal control is one of the common means against white fly, tomato being a vegetable crop, use of broad-spectrum insecticides will leave considerable toxic residues on the fruits and may cause considerable health hazards (Schuster *et al*.,2010) Neonicotinoid insecticides represent the fastest growing class of insecticides introduced to the market since the launch of pyrethroids (Nauen *et al*.,2002) The current market share of this group of insecticides is well above 600 million Euros per year, including imidacloprid as the biggest selling insecticide worldwide (Jemec *et al*., 2007) Neonicotinoid insecticides are compounds acting agonistically on insect nicotinic

acetylcholine receptors (nAChR). They are especially active on hemipteran pest species such as aphids, whiteflies, and plant hoppers, but also commercialized to control many coleopterans and some lepidopteran pest species (Nauen *et al*., 2003) The benefits of using systemic insecticides over contact insecticides is that in most cases they provide continuous plant protection through most of the growing season without the need for repeated applications. In addition, systemic insecticides are not susceptible to ultraviolet light degradation or ''wash off'' during watering, and the risk of overexposure to applicators is minimized (Herbert *et al*., 2008) Keeping in view the importance of sucking insect pests on tomato, based on technological gap analysis, on farm trial was conducted.

## Materials and Methods

Field experiments were conducted in tomato growing season during 2011 and 2012 taking tomato (hybrid) as a test crop. The experiment was laid out in Randomized Block Design with 5m x 5m plot size using ten replicates of three treatments viz., TO1: Farmers practice; TO2: Seed treatment with Imidaclorprid 70 WS @ 3g/kg of seed+2 spray with Dimethoate 30 EC @1.5ml/L water.; TO3: Root treatment with Imidaclorprid 70 WS solution @ 3 g/L of water for 30 minutes + one spray with Imidaclorprid 17.8 SL@ 0.3 ml/L of water & second spray with Dimethoate 30 EC @ 1ml/L of water. The experimental plots were prepared by ploughing and cross-ploughing followed by laddering. Healthy disease free 25-day-old seedlings of tomato were planted at a spacing of 0.8 m × 0.8m. Spraying of insecticides was given in two schedules with an interval of twenty days from first occurrence of the pest i.e. 30 days after planting. For all the treatments, the crop was grown with same dose of NPK as per State recommendation i.e. 100:50:50 kg N, P2O5 and K2O ha-1, respectively. Half of N along with the full amounts of P and K of inorganic fertilization were applied during final land preparation and the rest half of N was given at the time of earthing up. All intercultural operations were performed following standard package of practices.

Observations on count of whitefly both nymphs and adults were recorded on five randomly selected plants per treated plot. Three leaves were randomly selected from each plant. Then the count of white fly populations were taken carefully (since the adults are highly mobile) from the lower side of each leaf and the nymph by using 20X lens. Finally, the results were expressed as mean populations/3 leaves/plant. First count was taken one day before first spray and post treatment counts were taken 5, 10 and 15 days after each spray. The count of natural enemies was also taken in similar manner as that of whitefly.

## Results and Discussion

The frequency distribution of knowledge level, categorized into 6 categories and found that plant protection measures is one of the major concerns for technological gap.Most of the small category farmers have high technological gap. Whitefly incidence was observed at early stage i.e. 30 days after planting (DAP) of tomato seedlings. So, the first spray of insecticide was given at 30 DAP. The insecticidal activity of in different doses on whitefly population in tomato is presented in Table 3. There were significant reductions of pest population in tomato after 5, 10 and 15 days of application of insecticides compared to the untreated check (FP). Reduced whitefly population was recorded at 5 days after first spray of imidacloprid 17.8% SL and Dimethoate 30 EC after seed / root treatment. Similar trend was also observed in second spray. It was also observed that irrespective of spray schedule, the minimum populations or maximum reduction in pest populations was observed with root treated with Imidaclorprid70 WS solution @ 3 g/L of water for 30 minutes followed by one spray with Imidaclorprid 17.8 SL@ 0.3 ml/L of water and 2nd spray with Dimethoate 30 EC @1.5ml/L water compared to other treatments. It was followed by the seed treated with Imidaclorprid 70 WS @ 3g/kg of seed and 2 spray with Dimethoate 30 EC @1.5ml/L water. It is essential to mention that the efficacy of both the insecticides tested against the immature stages of whitefly (nymphs) was more than the adults. It may be due to high mobility of adults that they could hide themselves in the surrounding field having alternate host. Thus, the adults are in contact with the treated surface for a very short time while immature stages were found to be almost in continuous contact with the treated surface for a long time and consequently suck more toxicants (El-Dewy, 2006). It has also been reported that imidacloprid had a better efficacy against sucking pests than Dimethoate because it is highly systemic (Anonymous *et al.*, 1992). It was also reported (Dhandapani *et al*., 2002) that imidacloprid controlled those sucking pests attacking cotton for upto 8 weeks after seed treatment with imidacloprid while El-Dewy, 2006 found that imidacloprid had relatively faster initial effects with long residual action against thrips and immature stages of whitefly while it had a moderate effect on jassids and adults of whitefly. The natural enemies observed in the experimental field include coccinellids and spiders. The insecticides showed no effect on the population of spider. On the other hand maximum reduction of coccinellid population was recorded when root treatment done with Imidaclorprid70 WS solution @ 3 g/L of water for 30 minutes followed by one spray with Imidaclorprid 17.8 SL@ 0.3 ml/L of water followed by seed treatment done with Imidaclorprid 70 WS @ 3g/kg of seed alond 2 sprays done with Dimethoate 30 EC @1.5ml/L water at 5 days after spray (Table 3). However, the natural enemy population was increased from 10 days after spray. The similar result was observed after second round of spray (Table 3). The side effects of neonicotinoids against non-target insects especially predators under laboratory condition were reported in the literature (Awasthi *et al.*, 2013). However, results of a field study have also reported less toxicity of these insecticides for a variety of predators (Mensah *et al*., 2002). The toxicity of neonicotinoids varied with not only method of application, but also feeding behaviour of the predators. The nonselective organophosphate and pyrethroids insecticides can bring serious problems of reduction in the population of beneficial insects on the crops all over the world. Hence, in order to preserve natural enemies, selective insecticides compatible with biocontrol agents should be used to include in the programs of integrated pest management (IPM) (Fernandes *et al*., 2010).

**Table 1:** Extent of technological gap of package of practices of tomato (percentage)

| Sl.No. | Improved practices | Categories of respondents | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Big (20) | | | Medium (50) | | | Small(80) | | | Total (N=150) | | |
| | | f | % | Rank | f | % | Rank | f | % | Rank | f | % | Rank |
| 1 | Suitable varieties | 10 | 50.00 | III | 24 | 48.00 | VI | 39 | 48.75 | IV | 73 | 48.67 | VI |
| 2 | Sowing operation | 12 | 60.00 | I | 25 | 50.00 | V | 38 | 47.50 | V | 75 | 50.00 | V |
| 3 | Fertilizer management | 8 | 40.00 | V | 30 | 60.00 | I | 39 | 48.75 | IV | 77 | 51.33 | IV |
| 4 | Irrigation management | 7 | 35.00 | VI | 26 | 52.00 | IV | 47 | 58.75 | I | 80 | 53.33 | III |
| 5 | Plant protection | 11 | 55.00 | II | 28 | 56.00 | III | 44 | 55.00 | II | 83 | 55.33 | I |
| 6 | Harvesting & marketing | 9 | 45.00 | IV | 29 | 58.00 | II | 43 | 53.75 | III | 81 | 54.00 | II |
| Total | | 57 | 47.50 | - | 162 | 54.00 | - | 350 | 52.08 | - | 469 | 52.11 | _ |

F= Frequency, %= Percentage

**Table 2:** Field efficacy of insecticides against white fly (*Bemisia tabaci*) in tomato after 1st and 2nd round of spray (Pooled of two years)

| Technological options | Pre spray white fly/3leaf/plot | Mean no. of white fly/3 leaves/plant (1st spray) | | | Mean | Reduction (%) | Pre spray white fly/3leaf/plot | Mean no. of white fly/3 leaves/plant (2nd spray) | | | Mean | Reduction (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5 DAS | 10 DAS | 15 DAS | | | | 5 DAS | 10 DAS | 15 DAS | | |
| **TO1:** Farmers practice | 7.26 (15.43) | 3.03 (9.97) | 3.73 (11.06) | 3.83 (11.21) | 3.53 | - | 4.75 (12.48) | 3.89 (11.30) | 4.33 (11.92) | 4.42 (12.04) | 4.21 | - |
| **TO2:** Seed treatment with Imidaclorprid 70 WS @ 3g/kg of seed+2 spray with Dimethoate 30 EC @1.5ml/L water. | 7.15 (15.32) | 1.32 (6.60) | 1.43 (6.85) | 2.0 (8.10) | 1.58 | 55.24 | 4.62 (12.31) | 1.44 (6.87) | 1.27 (6.45) | 1.59 (7.17) | 1.42 | 66.27 |
| **TO3:** Root treatment with Imidaclorprid70 WS solution @ 3 g/L of water for 30 minutes + one spray with Imidaclorprid 17.8 SL@ 0.3 ml/L of water and 2nd spray with Dimethoate 30 EC @1.5ml/L water. | 6.89 (15.03) | 0.67 (4.68) | 0.73 (4.89) | 0.89 (5.40) | 0.76 | 78.40 | 4.16 (11.68) | 0.71 (4.82) | 1.03 (5.81) | 1.10 (6.00) | 0.94 | 76.48 |
| SE. m ± | 0.06 | 0.11 | 0.08 | 0.26 | | | 0.02 | 0.09 | 0.07 | 0.14 | | |
| CD (5%) | 0.11 | 0.33 | 0.14 | 0.80 | | | 0.11 | 0.31 | 0.22 | 0.43 | | |

DAS-Days after Spray,

Figures in parenthesis are mean square transformed values

**Table 3:** Management of leaf curl disease of tomato

| Technological options | Before spray | Coccinellids | | | Mean | Before spray | Spiders | | | Mean | Yield (q/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5 DAS | 10 DAS | 15 DAS | | | 5 DAS | 10 DAS | 15 DAS | | | |
| **TO1:** Farmers practice | 1.83 (7.75) | 1.65 (7.36) | 1.92 (7.79) | 1.94 (8.01) | 1.83 | 1.26 (6.43) | 1.17 (6.19) | 1.46 (6.92) | 1.57 (7.17) | 1.40 | 87.63 | 4.61 |
| **TO2:** Seed treatment with Imidaclorprid 70 WS @ 3g/kg of seed+2 spray with Dimethoate 30 EC @1.5ml/L water. | 1.97 (8.04) | 1.75 (7.57) | 1.81 (7.70) | 2.01 (8.12) | 1.85 | 1.81 (7.70) | 1.51 (7.04) | 1.81 (7.70) | 1.95 (8.00) | 1.75 | 122.75 | 5.97 |
| **TO3:** Root treatment with Imidaclorprid70 WS solution @ 3 g/L of water for 30 minutes + one spray with Imidaclorprid 17.8 SL@ 0.3 ml/L of water | 2.11 (8.32) | 1.83 (7.75) | 1.95 (8.00) | 2.14 (8.38) | 1.97 | 1.96 (8.02) | 1.65 (8.02) | 1.97 (8.55) | 2.12 (8.34) | 1.91 | 152.52 | 6.67 |
| SE m ± | 0.04 | 0.03 | 0.02 | 0.03 | - | 0.04 | 0.04 | 0.05 | 0.08 | - | 1.78 | - |
| CD (5%) | 0.13 | 0.07 | 0.09 | 0.07 | - | 0.14 | 0.13 | 0.15 | 0.14 | - | 5.35 | - |

**Conclusion**

The present study concluded that the root treatment done with Imidaclorprid70 WS solution @ 3 g/L of water for 30 minutes followed by one spray with Imidaclorprid 17.8 SL@ 0.3 ml/L and second spray with Dimethoate 30 EC @1.5ml/L water was more effective in reduction of whitefly population to obtain higher fruit yield of tomato than by seed treatment done with Imidaclorprid 70 WS @ 3g/kg of seed and 2 sprays done with Dimethoate 30 EC @1.5ml/L water. Both the insecticides showed no or minimum suppression of natural enemies population. Hence, neonicotinoids can suitably be included in Integrated Pest Management of sucking insect pests like whitefly in tomato because of their less toxicity to predators.

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