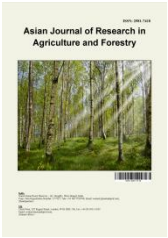

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Evaluating the Efficacy of Insecticide on the Management of Onion Thrips (*Thrips tabaci*, Lindemann) in Northwestern Zone of Tigray

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Ethiopia has enormous potential to produce the onions throughout the year both for domestic use and export market. It is also the most cultivated and high market value of vegetable crops in Tigray Northern Ethiopia. However, the productivity of onion is highly constrained such as insect pests, diseases, lack of improved verities, lack of improved management practices etc. The major insect pest of onion is Onion thrips and important pests especially in areas where onions are grown under irrigation. The purpose of this study was to test the insecticide chemicals application and application frequency on the Onion production technologies. Therefore, field experiment was

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conducted to evaluate the insecticide chemical applications with frequency application in 2017 and 2018 under irrigation conditions. Thirteen treatments were used three different insecticide types namely Karatae 5% EC, Dimethote 40%EC, Profit72%EC with four different spraying frequency and untreated (control) laid out in Randomized Complete Block Design (RCBD) with three replications. The current findings showed that the profitable yield was obtained Karatae 5% EC (1st spray) (14.25 t ha^{-1}) followed by Profit72%EC (4th spray) that is (20.25 t ha^{-1}) and the obtained profit was 128053 &181788 birr per ha with the maximum Marginal Rate of Return of 3025 & 2417% respectively in Tselemti woreda. In Medebaayzana woreda also, the profitable yield was obtained Karatae 5% EC (1st spray) (25.79 t ha^{-1}) followed by Karatae 5% EC (4st spray) at (27.75 t ha^{-1}) & Dimethote 40% EC (3rd spray) at (25.78 t ha^{-1}) and 231976, 249463 & 231544 birr per ha obtained profit with the maximum Marginal Rate of Return of 2634, 2395 & 2311 % respectively. Therefore, Karatae 5% EC (1st spray) in Tselemti & Medebayzana woreda & Profit72%EC (4th spray) in Tselemti woreda and Dimethote 40% EC (3rd spray) in Medebayzana woreda was profitable preventive Onion Thrips for Onion production in the studies area.

Keywords: Insecticides; onion; thrips; yield.

1. INTRODUCTION

"Onion *(Allium cepa)* also known as the bulb onion or common onion, is the most widely cultivated species of the genus *Allium in* the world. The crop has been used as food since time immemorial. It is believed that *Allium cepa* had been domesticated independently in several places and occupied vast areas in west Asia. It probably originated from Central Asia between Turkmenistan and Afghanistan where some of its relatives still grow in the wild. Onion from Central Asia, the supposed onion ancestor had probably migrated to the Near East. The history of onions dates back at least to 600 BC. Onions have been cultivated for more than 4000 years for food and flavor and also for health and religious purposes. Most of the botanists believed that it has its origin in areas including Iran, Pakistan, and the mountainous countries in the north" [1,2]. "It is a recently introduced bulb crop in the agriculture commodity of Ethiopia and it is rapidly becoming a popular vegetable among producers and consumers" [3, 4].

"Ethiopia has enormous potential to produce the onions throughout the year both for domestic use and export market. Onion is grown in Ethiopia primarily for its bulb which is used for flavoring the local stew, 'wot'. It is also used almost daily as a spice and vegetable in the local dish regardless of religion, ethnicity, and culture" [5]. **"**Consumption of onions has been increasing significantly in the world partly because of the health benefits they possess" [6]. "It is the most indispensable vegetable crops used as condiments in most Ethiopian cuisine. It is one of the oldest known and an important bulbous vegetable crop grown in Ethiopia. It is used in preparation of different foods and in therapeutic medicine in the country. It is valued for its distinct pungency or mild flavour and also consumed universally in small quantities and used in many homes almost daily, primarily as a seasoning for flavoring of dishes, sauces, soup, and sandwiches in many countries of the world.The diverse agro-climatic conditions that prevail in the country provide the opportunity of producing onion bulb, seeds and cut flower for local use and export market" [5]. "Onion is also widely cultivated as a source of income by many farmers in many parts of the country" [3,7].

"The productivity of onion in Ethiopia is lower than the Africa average and that of the world due to many factors such as insect pests, diseases, lack of improved verities, lack of improved management practices etc. China, Russian Federation, and Turkey are the leading producing countries of onion and show 26, 2.31, and 2.22% share, respectively from the global production. Average onion production of the World is 19% while the shares of Europe, Asia, American, Africa and Ethiopia are 35, 18, 32, 15 and 10 t/ha respectively" [8].

"Onion thrips, *Thrips tabaci* L. (Thysanoptera: Thripidae) is polyphagous and have been recorded on more than 300 species of plants. Onion thrips is originated in the Mediterranean region. It was first found in Hawaii in 1915, currently it is found all over the world where onion is grown" [9]. "It is a major insect pest in most onion growing areas of Ethiopia. Large number of thrips kills onion seedlings, while damage to older plants by thrips may cause crops to mature early and,

subsequently reduce yields. Adult and nymphal stages (immature) of thrips feed by rasping the leaves and other tissues of plants to release the sap, which they then consume with a punch and suck behavior that removes leaf chlorophyll causing white to silver patches and streaks" [10].

"Thrips of vegetable crops are known to be serious pests on a wide range of fruit, vegetable, flower, and agronomic crops. Thrips are members of the order Thysanoptera, which contains a number of genera and species. Among species of thrips that attack onions are onion thrips (Thrips tabaci) and the only major pest of onions. This pest is important especially in areas where onions are grown under irrigation" [11]. "Thrips is damage is usually measured as an overall reduction in bulb size and weight of onions. The injury caused by thrips' rasping of the leaves enables various plant pathogens to gain entry, thus increasing disease problems. In addition, thrips carry plant pathogens on their mouth parts from one plant to another. In onions, entire fields can be destroyed, especially in dry seasons. Onion thrips incidence was a major problem and leaf blast seriously affected all cultivars but no control measures were taken" [12].

"In Ethiopia, it is an important insect pest that affect onion yield by direct feeding as well as reducing the quality and quantity by rasping the leaves and other tissues of onion crops to release the nutrients. Yield losses due to onion thrips recorded 33 and 26-57%" [11]. Merene [13], similar studies at Upper Awash Agro Industry Enterprises revealed yield losses of 10 to 85% due to onion thrips in Ethiopia. In Toke Kutaye district, West Shoa, Ethiopia the yield losses due to onion thrips ranged from 0 to 36.44% were recorded [14,15].

Generally, onion production is still very low in Ethiopia as compared to the other countries of the World. It could be attributed to the problem of insect and disease pests particularly onion thrips and white root rot disease, respectively. Similarly, Even though onion is becoming the popular vegetable crop in all districts of Northwestern Zone of Tigray within a short period of time, the problem of onion thrips threatened the production and productivity of the crop and the present research is designed to test and recommend effective and economical chemical management methods for onion thrips.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The experiment was conducted at Tselemti & Medebayzana woreda specific location at Maitsebri and at Selekeleka Shire-Maitsebri Agricultural Research Center (SMARC) research stations respectively during 2017 & 2018 under off season condition. Tselemti woreda specific location Maitsebri research station is located 400 km west of Mekelle and 85 km from Shire along the way Shire to Gondar (Fig. 1). The research station lies at latitude $13^0$05' North and longitude $38^0$08' East and has an altitude of 1304 m.a.s.l. The Agro-ecological zone of the woreda is hot to warm-moist lowlands and Tepid to cool-moist mid highlands with 2.65% 'Dega' (cool highland), 19% 'Weinadega' (mid highland) and 78.35% 'Kola' (hot lowland). The mean annual temperature ranges from a minimum of 18.4^{o}C (November-January) to an average annual maximum of 32.7^{o}C (February-May). It is a low altitude area with average (6 years) annual rainfall of 1176.7 mm. Generally, rainfall starts in June and ends in September [16].

Medabayzana woreda specific location selekeleka research station is also located at 378 km west of Mekelle and 22 km from shire to east direction along the way Shire to Axum (Fig. 2). The research station lies at 14°6′43″ N, 38°27′50″E, and at an altitude of 1951 m above sea level. The mean annual rainfall is 680 mm. The rainy season extends from June to September and the maximum rain is received in the months of June to August.

2.2 Experimental Treatments, Design and Procedure

Thirteen treatments were used three different insecticide types namely Karatae 5% EC, Dimethote 40%EC, Profit72%EC with four different spraying frequency and untreated (control) (Table-1). The treatments were laid out in Randomized Complete Block Design (RCBD) with three replications. Each experimental plot has a plot size of 2.0 m*2.0 m, separated by 1 m between plots and 1.5 m b/n blocks. Each plot was consisted 5 double rows of 2.0 m length with a spacing of 5 cm between plants, 40 cm between rows and 20 cm between double rows with testing onion variety was Bombey Red. Gross area 38 m * 9 m (342 m^2) and Net area 26 m * 6 m (156 m^2) was used for each location. All management practices (ploughing, cultivation, watering, weeding and others) was applied uniformly to all plots.

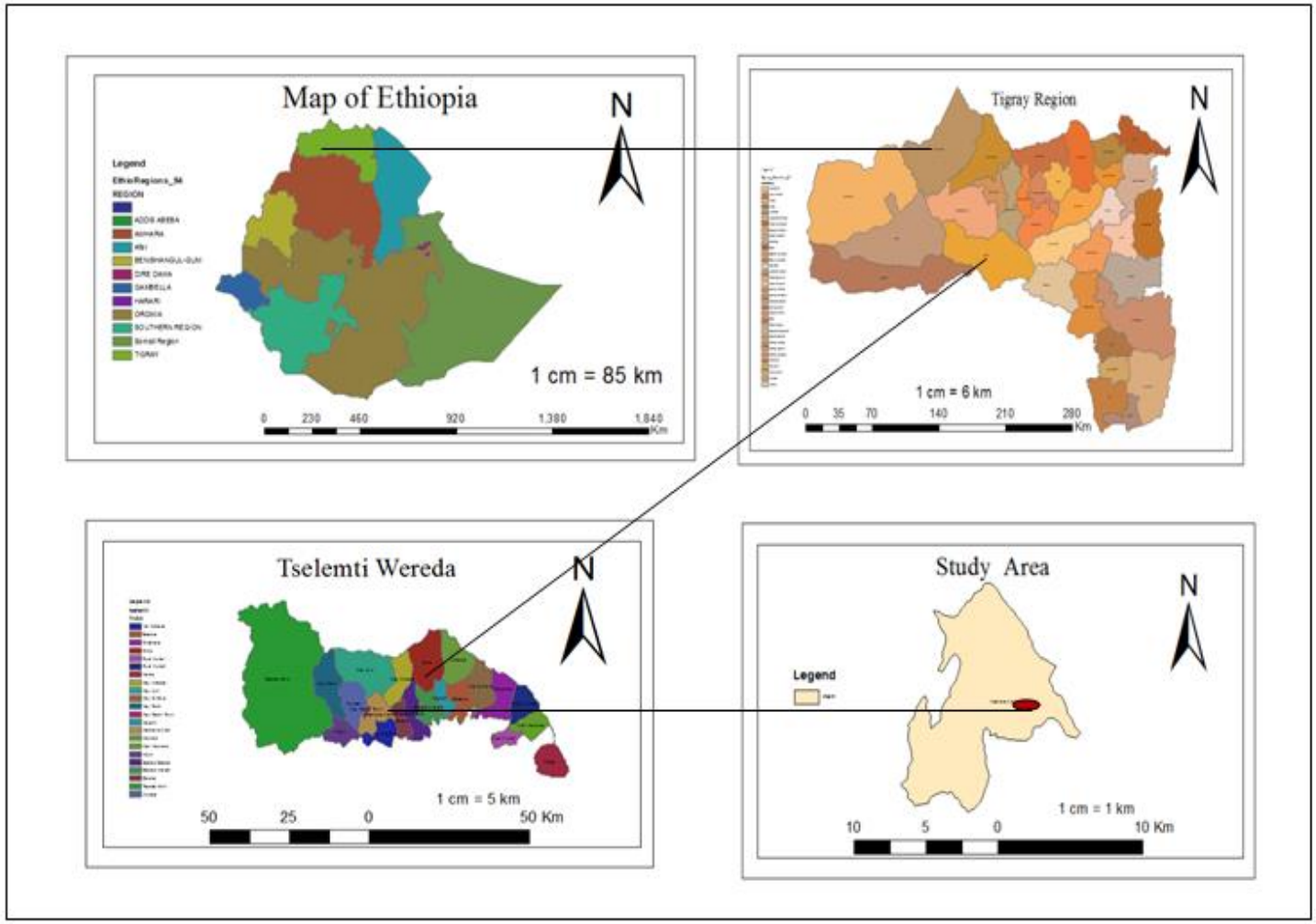

Fig. 1. Maps of the country, Tigray region, tselemti woreda and Maitsebri station

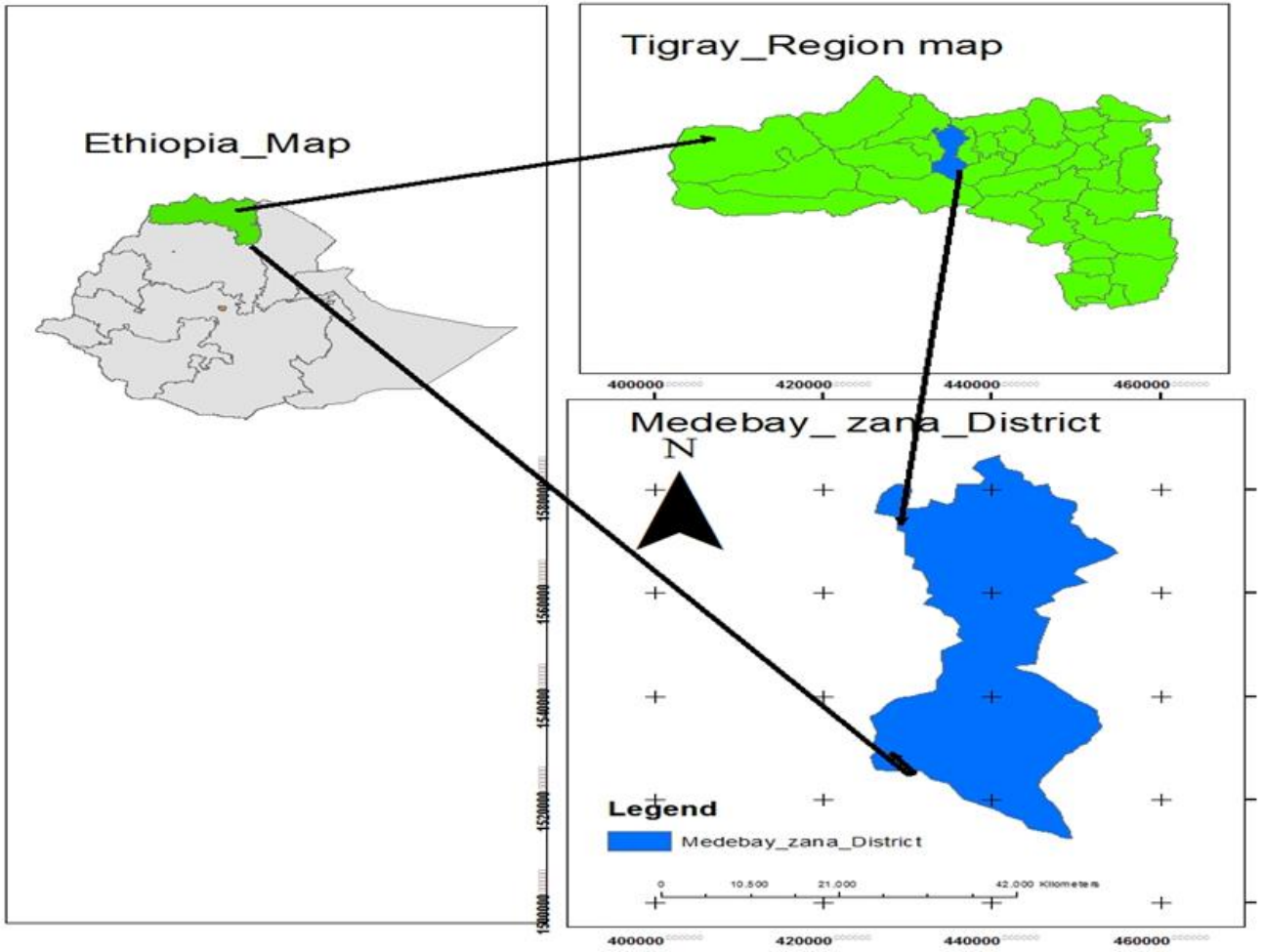

Fig. 2. Maps of the country, Tigray region, and medebayzana woreda

Table 1. Different insecticide types with different spraying frequency

S/n	Types of chemicals	Frequency of insecticide spray			
		once	Twice	3times	4times
1	Karatae 5% EC	T1	T2	T3	T4
2	Dimethote 40%EC	T5	T6	T7	T8
3	Profit72%EC and	T9	T10	T11	T12
4	Control	T13			

2.3 Data Collection

All relating data were collected from the central three rows by excluding plants from either end of the rows. For the purpose of Onion thrips data collection 6 plants per plot were selected randomly and observations Marketable yield (t ha^{-1}) and counting Onion thrips before and after spraying of insecticide chemicals were recorded periodically.

2.4 Data Analysis

The collected data was subjected to analysis of variance (ANOVA) using Gens tat 14th edition statistical computer software. Mean comparison was done using least significant difference (LSD) at 5% probability level.

2.5 Partial Budget Analysis

Partial budget analysis was employed for economic analysis of insecticide chemical application and it was carried out for combined yield data. The potential response of crop towards the chemical applications and price of the chemicals during planting ultimately determined the economic feasibility of the chemical application. The economic analysis was compute using the procedure described by CIMMYT [17].

Gross average yield (kg ha^{-1}) (AvY): is an average yield of each treatment.

Adjusted yield (AjY): Is the average yield was adjust downward by a 10% to reflect the difference between the experimental yield and yield of farmers [17].

$$AjY = AvY - (AvY-0.1)$$

Gross field benefit (GFB): Was computed by multiplying field/farm gate price that farmers receive for the crop when they sale it as adjusted yield.

Total cost: is the cost of chemicals with application of chemicals frequency used for the experiment. Their prices were based on 2017/2018 price during planting. The costs of other inputs and production practices such as labor cost for land preparation, planting, weeding, crop protection, and harvesting was assumed to remain the same among treatments.

Net benefit (NB): was calculated by subtracting the total costs from gross field benefits for each treatment.
NB = GFB – total cost

Marginal rate of return (MRR %): was also calculated by dividing change in net benefit by change in cost which is the measure of increasing in return by increasing input.

Marginal rate of return (%) = change in net benefit / Change in total cost × 100

3. RESULTS AND DISCUSSION

The mean value of the chemical application were influenced to Onion thrips applied by Profit 72% EC at 4th frequency application and highest marketable yield (21.83 t ha^{-1}) from the others experiment followed by Profit 72% EC at 3rd & 2nd frequency application (18.73 & 17.16 t ha^{-1}) marketable yield respectively in Tselemti woreda (Fig. 3). In Medebayzana woreda also Dimethote 40%EC at 4th frequency was the highest marketable yield (32.2 t ha^{-1}) followed by Karatae 5% EC at 4th, 1st and Dimethote 40%EC at3rd & 2nd frequency application marketable yield (30.8, 28.7, 28.6 & 28.1 t ha^{-1}) respectively (Fig. 4).

The results regarding chemical application Onion of thrips control was in close agreement with the reported by Singh and Kumar [18] and Kidd *et al*. [19] in the insect's paralysis and death. The loss in bulb yield due to attack of onion thrips was reported by Kendall and Capinera [20] and G.S. Dhaliwal *et al*. [21] the most serious effect of infestation by thrips was the resultant reduction in bulb yield.

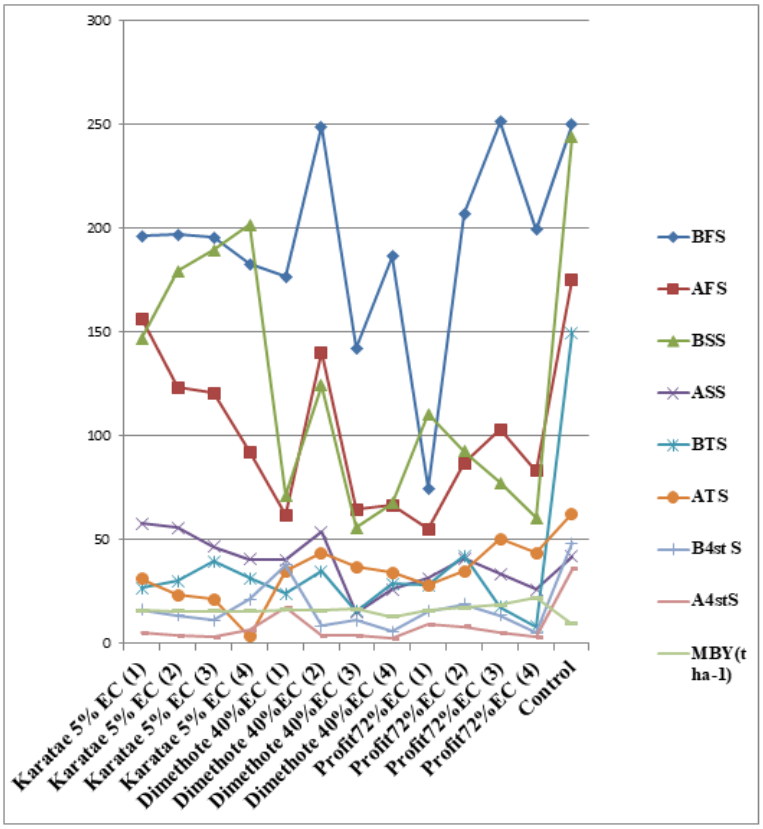

Fig. 3. Chemical application with spray frequency in Tselemti Woreda

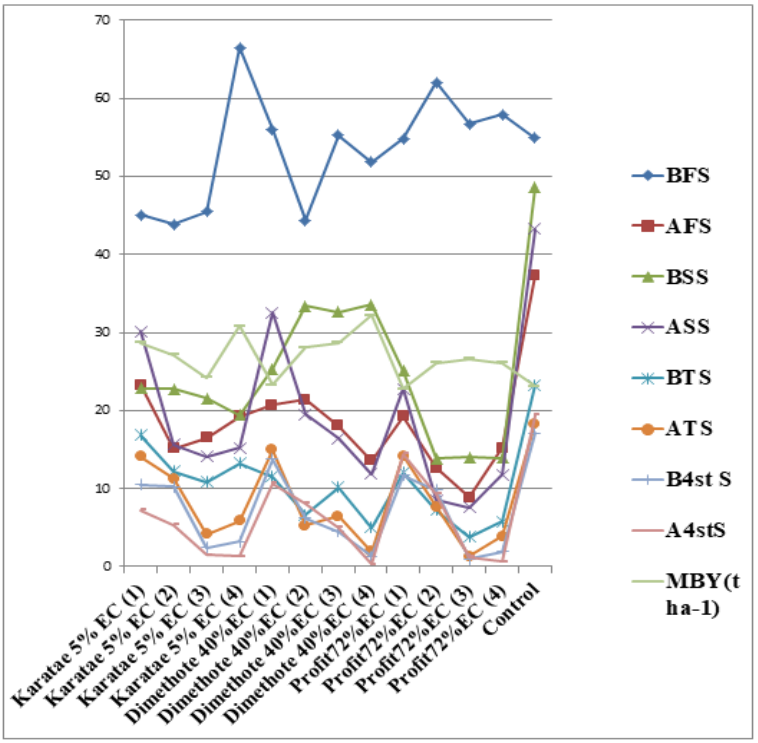

Fig. 4. Chemical application with spray frequency in Medebayzana Woreda

Picture 1. Damaging symptoms of Onion trips

Picture 2. Onion trips of Chemical threaded Onion leaves

Table 2. Partial budget analysis in Iselemti Woreda

Trt.	Chemical rates (lit)	Cost of chemical	Chemicaapp. cost	TVC	Av. Yd (kg ha^{-1})	Adj.Yd (Kg ha^{-1})	TR (for 1kg=9 birr)	NR (TR-TVC)	Do.	MRR (%)
Control	0	0	0	0	9460	8514	76626	76626		
Karatae 5% EC (1)	0.4	140	30	170	15830	14247	128223	128053	-	3025
Dimethote 40%EC (1)	1	350	30	380	16390	14751	132759	132379	-	1467
Dimethote 40%EC (3)	1	350	90	440	16650	14985	134865	134425	-	1313
Profit72%EC (2)	0.7	315	60	375	17160	15444	138996	138621	-	1653
Profit72%EC (3)	0.7	315	90	405	18730	16857	151713	151308	-	1844
Profit72%EC (4)	0.7	315	120	435	21830	20247	182223	181788	-	2417

(1), (2), (3), & (4) = 1^{st}, 2^{nd}, 3^{rd} & 4^{th} chemical application frequency

Table 3. Partial budget analysis in Medebayzana woreda

Trt.	Chemical rates (lit)	Cost of chemical	Chemicaapp. cost	TVC	Av. Yd (kg ha^{-1})	Adj.Yd (Kg ha^{-1})	TR (for 1kg=9 birr)	NR (TR-TVC)	Do.	MRR (%)
Control	0	0	0	0	23110.0	20799	187191	187191		
Karatae 5% EC (1)	0.4	140	30	170	28660.0	25794.0	232146	231976	-	2634
Karatae 5% EC (4)	0.4	140	120	260	30830.0	27747.0	249723	249463	-	2395
Dimethote 40%EC (2)	1	350	60	410	28050.0	25245.0	227205	226795	-	97
Dimethote 40%EC (3)	1	350	90	440	28640.0	25776.0	231984	231544	-	2311
Dimethote 40%EC (4)	1	350	120	470	32220.0	28998.0	260982	260512	-	156
Profit72%EC (2)	0.7	315	60	375	26090.0	23481.0	211329	210954	-	63
Profit72%EC (3)	0.7	315	90	405	26590.0	23931.0	215379	214974	-	69

(1), (2), (3), & (4) = 1st, 2nd, 3rd & 4th chemical application frequency

3.1 Partial Budget Analysis

The profitable yield obtained Karatae 5% EC (1st spray) (14.25 t ha-1) followed by Profit72%EC (4th spray) that is (20.25 t ha-1) and the obtained profit was 128053 &181788 birr per ha with the maximum Marginal Rate of Return of 3025 & 2417% respectively in Tselemti woreda (Table-2).

In Medebaayzana woreda also, the profitable yield obtained Karatae 5% EC (1st spray) (25.79 t ha-1) followed by Karatae 5% EC (4st spray) at (27.75 t ha-1) & Dimethote 40% EC (3rd spray) at (25.78 t ha-1) and 231976, 249463 & 231544 birr per ha obtained profit with the maximum Marginal Rate of Return of 2634, 2395 & 2311 % respectively (Table-3).

4. SUMMERY AND CONCLUSION

Generally, onion production is still very low in Ethiopia as compared to the other countries of the World. It could be attributed to the problem of insect pests particularly onion thrips greatly influenced quality, texture, taste and yield of onion production. Onion thrips is difficult to control because the mobile stages of this insect are found mainly in the narrow spaces between the inner leaves where spray coverage is difficult to accomplish. Still now the problem of this particular insect pest is existing. Therefore, it needs to focus on the management aspects of onion thrips is need attention to the research such insecticide chemical applications to prevent Onion thrips.

The profitable yield obtained Karatae 5% EC (1st spray) (14.25 t ha^{-1}) followed by Profit72%EC (4th spray) that is (20.25 t ha^{-1}) and the obtained profit was 128053 &181788 birr per ha with the maximum Marginal Rate of Return of 3025 & 2417% respectively in Tselemti woreda. In Medebaayzana woreda also, the profitable yield obtained Karatae 5% EC (1st spray) (25.79 t ha^{-1}) followed by Karatae 5% EC (4st spray) at (27.75 t ha^{-1}) & Dimethote 40% EC (3rd spray) at (25.78 t ha^{-1}) and 231976, 249463 & 231544 birr per ha obtained profit with the maximum Marginal Rate of Return of 2634, 2395 & 2311 % respectively.

Therefore, Karatae 5% EC (1st spray) in Tselemti & Medebayzana woreda & Profit72%EC (4th spray) in Tselemti woreda and Dimethote 40% EC (3rd spray) in Medebayzana woreda was profitable preventive Onion Thrips for Onion production in the studies area.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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