

Evaluating the Efficacy of Insecticide on the management of onion thrips (*Thrips tabaci*, Lindemann) in Northwestern zone of Tigray

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 varieties, 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 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 (4th 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 & Medebaayzana woreda & Profit72%EC (4th spray) in Tselemti woreda and Dimethote 40% EC (3rd spray) in Medebaayzana 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” (Grubben and Denton, 2004; Bagali *et al.*, 2012). “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” (Lemma and Shimeles, 2003; Dawit *et al.*, 2004).

“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” (CSSE, 2006). “Consumption of onions has been increasing significantly in the world partly because of the health benefits they possess” (Wang *et al.*, 2006). “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” (CSSE, 2006). “Onion is also widely cultivated

as a source of income by many farmers in many parts of the country” (Lemma and Shimeles, 2003; Abiti, 2007).

“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 varieties, 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” (CSA, 2015).

“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” (Brian, 2006). “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” (Straub and Emmett, 1992).

“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” (Abate, 1985). “Thrips 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” (IAR, 1980).

“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%” (Abate, 1985). Merene (2005), 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 (Bekele *et.al.*,2006; Shiberu, 2013).

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 (Figure-1). The research station lies at latitude 13⁰05' North and longitude 38⁰08' 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°C (November-January) to an average annual maximum of 32.7°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 (Metrological data, 2016).

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 (Figure-2). The research station lies at $14^{\circ}6'43''$ N, $38^{\circ}27'50''$ 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.

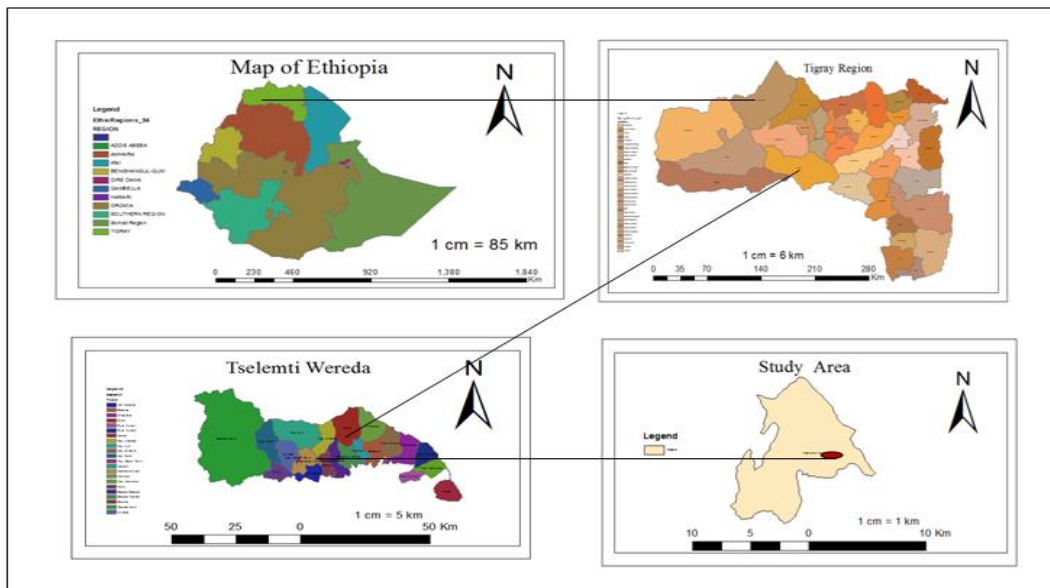


Figure 1. Maps of the country, Tigray Region, Tselemti woreda and Maitsebri station

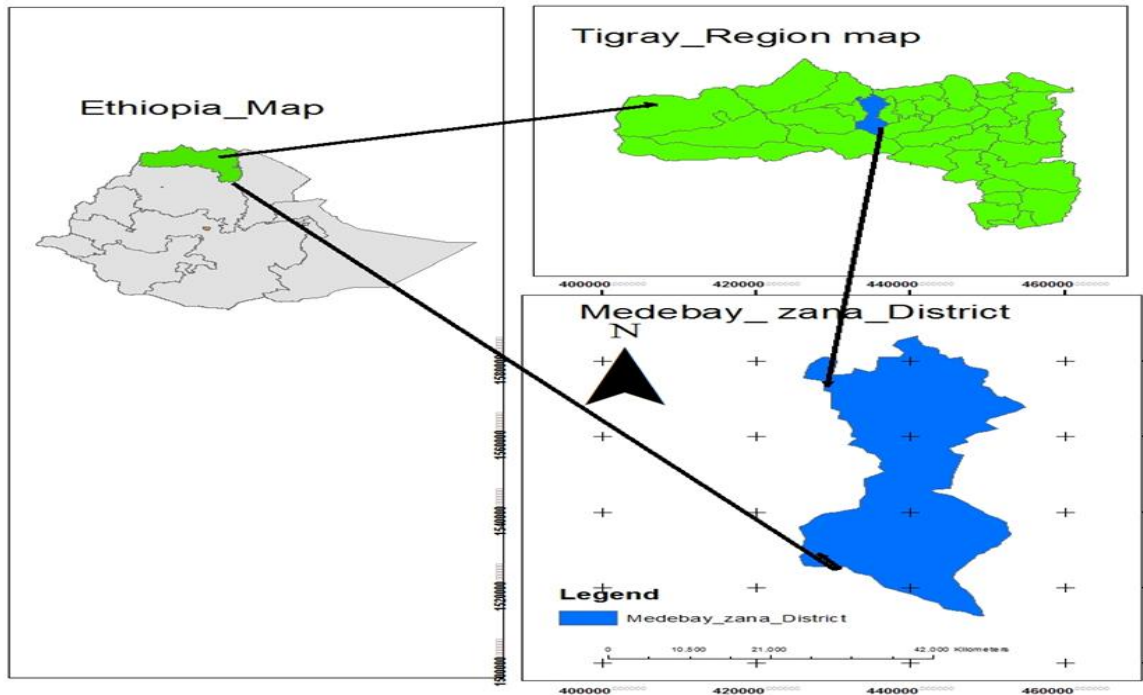


Figure 2. Maps of the country, Tigray region, and Medebayzana woreda

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 Bombay Red. Gross area 38 m * 9 m (342 m²) and Net area 26 m * 6 m (156 m²) was used for each location. All management practices (ploughing, cultivation, watering, weeding and others) was applied uniformly to all plots.

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 (1988).

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 (CIMMYT, 1988).

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

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.

$$NB = GFB - \text{total cost}$$

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.

$$\text{Marginal rate of return (\%)} = \frac{\text{change in net benefit}}{\text{Change in total cost}} \times 100$$

3. Result & 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 (Figure-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 at 3rd & 2nd frequency application marketable yield (30.8, 28.7, 28.6 & 28.1 t ha⁻¹) respectively (Figure-4).

The results regarding chemical application Onion of thrips control was in close agreement with the reported by Singh and Kumar (2011) and Kidd *et al.* (1991) in the insect's paralysis and death. The loss in bulb yield due to attack of onion thrips was reported by Kendall and Capinera (1987) and G.S. Dhaliwal *et al.* (2008) the most serious effect of infestation by thrips was the resultant reduction in bulb yield.



Picture-1. Damaging symptoms of Onion thrips



Picture-2. Onion thrips of Chemical threaded Onion leaves

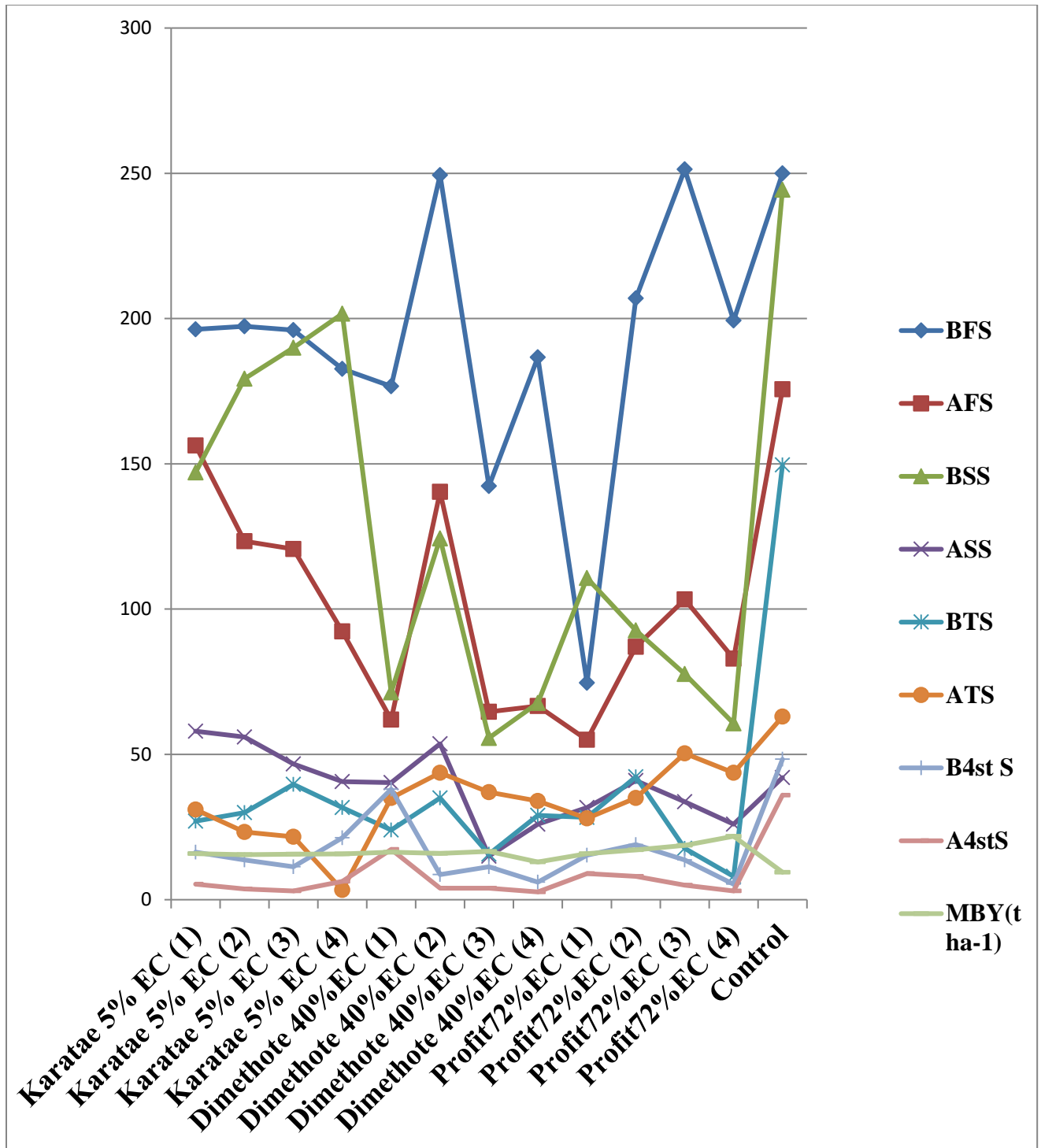


Figure-3. Chemical application with spray frequency in Tselemti Woreda

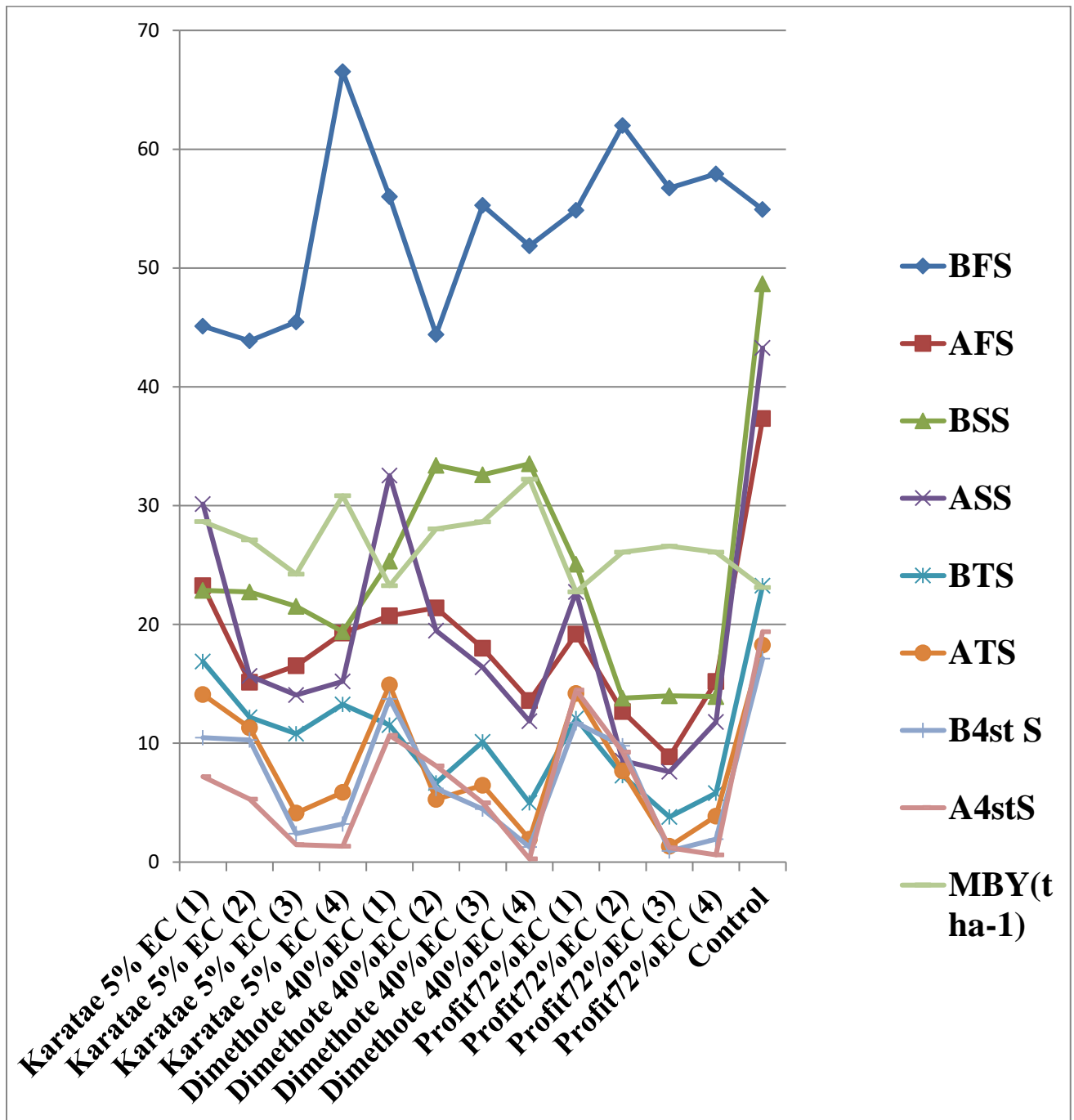


Figure-4. Chemical application with spray frequency in Medebayzana Woreda

Partial budget analysis

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)		315	120	435	21830	20247	182223	181788	-	2417

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

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).

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

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)

Option 1:

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 the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

- 1.
- 2.
- 3.

COMPETING INTERESTS

Authors have declared that no competing of interests exists.

References

- Abate T. Vegetable Crops Pest Management In: (Eds.) W Godfrey W, Bereke TT Proceedings of the first Ethiopian Horticultural Workshop, Addis Ababa, Ethiopia. 1985.
- Abiti Getaneh. Comparison of different irrigation scheduling methods for onion seed production under fertilized and unfertilized conditions at Melkassa, M.Sc thesis presented to the School of Graduate studies of Haramaya University. 2007.
- Bagali A. N., Patil H. B., Guled M. B. and R. V. Patil. Effect of scheduling of drip irrigation on growth, yield and water use efficiency of onion (*Allium cepa* L.).*J. Agric. Sci.* 2012; 25 (1): 116-119.
- Bekele E, Azerefegne F, and Abate T. Facilitating the implementation and adoption of IPM in Ethiopia. Proceedings of a Planning Workshop, ASAI/EARO, Nazerath, Ethiopia. 2006.
- Brian AN. Biology and Ecology of Onion thrips on Onion Fields. Cornell University. 2006; Pp. 2.
- CIMMYT (International Maize and Wheat Improvement Center). from Agromomic Data to Farmer Recommendations. Economics Training Manual. Completely revised edition. Mexico. 1988.
- Central Statistical Agency of Ethiopia (CSA). Report on Area and Production of Major Crops. Agricultural Sample Survey. 2015; Volume I.
- CSSE (Crop Science Society of Ethiopia). Farmers' participatory onion seed production in the Central Rift Valley of Ethiopia: achievement, constraints and its implication for the national seed system. Conference summary, The Conference of the Crop Science Society of Ethiopia, 11, Addis Abeba (Ethiopia), 26-28 Apr 2004. In: Ashenafi Woldeeslassie, Helen Teshome and Tibebe Simon. 2014. Influence of Bulb Treatment and Spacing Patterns on Yield and Quality of Onion (*Allium cepa* Var. Cepa) Seed at Humbo Larena, Southern Ethiopia. *Journal of Biology, Agriculture and Healthcare* . 2006; Vol.4, No.13.
- Dawit A., Abera D., Lemma D. and Chemdo A. Domestic vegetable seed production and marketing. Research Report No 5. EARO, Ethiopia. 2004; Pp.17.
- Dhaliwal, G.S., Ram Singh and Chhillar, B.S. Essentials of agricultural entomology. 2008;Pp 282-283.

- Grubben, J.H. and D.A. Denton. Plant resources of tropical Africa. PROTA Foundation, Wageningen; Back huys, Leiden; CTA, Wageningen. 2004.
- Institute of Agricultural Research (IAR). Awassa Station Annual Progress Report. IAR, Addis Ababa, Ethiopia. 1980.
- Kendall, D.M. and Capinera, J.L. Susceptibility of onion growth stages to onion thrips (Thysanoptera: Thripidae) damage and mechanical defoliation. *Environmental Entomology Journal*. 1987; **16**: 859-863.
- Kidd H., James and Eds, D.R. 1991. The Agrochemicals handbook Third Edition. Royal society of chemistry information service, Cambridge, U.K. 1991; Pp 10-20.
- Lemma Dessalegn and Shimelis Aklilu. Research experience in onion production, , Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia. 2003; Research Report No 55.
- Merene Y. Study on Population ecology and yield loss of onion thrips (*Thrips tabaci*) on onion in Showa Robit district of Amahara region. M.Sc. Thesis, Addis Ababa University, Ethiopia. 2005.
- Metrological data. 2016. Tigray, Mekelle Metrological data of six years average
- Shiberu T. In vitro Evaluation of Aqua Extracts of Some Botanicals against Maize Stem Borer, *Busseola fusca* F. (Lepidoptera: Noctuidae). *J Plant Pathol Microb*. 2013; 4: 179.
- Straub RW, Emmett B. Pests of Monocotyledon Crops. In: Mc Kinlay R.G. (Editor). *Vegetable Crop Pests*. Macmillan Press. U. K. 1992; Pp.213-262.
- Singh, S.K. and Udit Kumar. Population dynamics and seasonal incidence of onion thrips under north Bihar conditions. *Bihar Journal of Horticulture*. 2011; **1**: 63-65.

Wang B, Lin S, Hsiao W, Fan J and Fuh L. Protective effects of an aqueous extract of Welsh Onion green leaves on Oxidative damage of reactive oxygen and nitrogen species. Food Chem. 2006; 98:149-157.

UNDER PEER REVIEW