

Yield and Economic analysis of Onion under Different Pesticides Application

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Research Article

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Abstract

Onion is an important vegetable crop, which has produced worldwide including Tigray region of Ethiopia for its daily uses and economic benefits. However, the production levels of this crop still far below its potential, this is attributed to a number of constraints among which are pests and diseases infestation. In Ethiopia, using pesticides to manage pests in the growing of fruits and vegetables is a standard practice and important for managing economic loss. The objective of the study was initiated with assessing the economic benefits of pesticides application on onion (*Allium Cepa* L.) production and its yield under irrigated farming system in Keyh Tekli District, Tigray Region, Ethiopia. In the experimental part ten different pesticide types were tested. The experiment was laid down in randomized complete block design (RCBD) with three replications. All important data were collected and analyzed by using genstat software. And also an economic analysis was carried out using partial budget analysis, to indicate economically superior treatments over the control treatment by estimating the variable costs and benefits based on the current local market prices. The results of the research revealed that, Profit 72% EC were the effective insecticide for the management of onion thrips under field conditions recorded significantly higher bulb yield of (22.8ton/ha) than rest of the other evaluated treatments except dimethoate 40% EC (18.8ton/ha) which were statistically similar with each other whereas the lowest yield was recorded from the Farate insecticide 13.4 ton/ha statically the same with untreated plot. Therefore application of Profit 72% EC and dimethoate 40% EC increased the yield of onion significantly and based on the cost benefit analysis they are economically feasible.

1. Background

Onion, *Allium cepa*, belongs to the Alliaceae family. Notable cultivated representatives include chives (*Allium schoenoprasum*), green onion (*Allium Chinese*), onion (*Allium cepa*), leek (*Allium ampeloprasum*) and garlic (*Allium sativum*). However, onion is the most widely grown *Allium* species with over 9.2 million acres planted globally (Ashley, 2019). It is an important vegetable crop, which has produced worldwide including of Ethiopia for its daily uses and economic benefits. The beginning of its production was traced back to the introduction of planting material in 1970s from Sudanese and recently it has produced intensively and by now smallholder farmers in most parts of the country and rapidly becoming acceptable by producers and consumers (Habtamu, 2017).

Onion is one of the most important vegetable crops in Ethiopia which is used almost daily as a spice and vegetable in the local dish regardless of religion, ethnicity, and culture. 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 (Geberetsadkan et al, 2018). The production of cash crops like onion proved to be income generating for farmers, especially for those cultivated in limited lands or small holder farmers (Bewuketu, 2016).

Currently, it is widely grown by small-holder farmers and commercial growers throughout the year for local use and export market. Onion contributes significantly to the national economy, apart from

overcoming local demands. Despite to its lower productivity, which brings below the world average, onion is becoming as the sources of livelihood for many peoples who have engaged in the production and trading. The main reason for this lower productivity of the crop is most probably due to pests and diseases and also their failure of cost effective management.

To increase the production and productivity of agriculture, inputs such as pesticides have been the driving forces. Pesticides are used in agriculture to protect crops from pests and diseases, with indiscriminate pesticide use having several adverse effects on the environment (Ashley, 2019). Pesticides are unparalleled in their ease of use, efficacy, and efficiency when compared to cultural and biological management tactics alone. They are relatively easy to apply, cost-effective and sometimes the only option to control pests (Chala, 2022). Pesticides enable farmers to avoid a 78%, 54% and 32% loss in fruits, vegetables and cereals, respectively (Tudi et al., 2021).

Therefore, Pesticides application should be harmonized with economic threshold information and pest biology. The goal of this research is to provide additional information on the response of chemical pesticides and their economic return during onionthrips management and their associated plant pathogens, as well as describe methods to improve onion thrips management in onion.

2. METHODOLOGIES

2.1 Description of study areas

The experimental part of this study was conducted in Adiha Kebele of Keyh tekli District located at central Zone of Tigray during the 2023/24 under irrigated farming. The experimental site was situated at 13°, 77'59716" N latitude and 39°, 10', 4142" E longitude and at the altitude of 1646 meter above sea level. The mean annual rainfall of the area is 350–700 mm. The mean maximum and minimum annual temperature of the area is 41 – 24°C respectively. The soil type is sandy followed by sandy loam. It is agro-ecologically characterized as hot to warm sub-moist low land.

2.2. Experimental Design and Treatments

The experiment was consisted of ten treatments: -Nine insecticides and one control/ only water sprayed were used in the study plot. The treatments were arranged in a simple randomized complete block design (RCBD) with three replications. Each plot is 2.4 meter wide and 2 meter long. The space in between plots and replications is 50cm & 1 meter respectively. Insecticide application was the factor investigated and evaluated its yield increment on onion and cost effective for controlling thrips in onion farming. The insecticide treatments listed above were selected based on their availability to the farmers of the area commonly applied in their daily farming irrigation activities which were easily accessible from nearby supermarkets. Insecticide treatments were applied using a manually operated knapsack sprayers of 20-liter capacity. The first application was made when thrips population reached 5–10 thrips/plant from a randomly selected sample of ten plants per plot after bulb initiation. The rate indicated in label as recommended per hectare were used for each insecticide. Spray frequency is three times, which was the

same for all treatments, with ten days interval between the applications. The list treatments were put in the following Table 1:

Table 1
Types and manufacturing rates of insecticides treatment alignments on the field

Trade name	Active ingredients	Dose of insecticides per ha (ml)	Amount of water/ha (L)
Profit 72% EC	Profenofos 72% E	750ml	200
Chlorguard 48EC	Chlorpyrifos	2000	600
Dimethoate 40% EC	Dimethoate	950	300
Farate	Lambda Cyhalothrin	500	200
Bravo5%	Lambda Cyhalothrin	400	250
Pro -star 72% EC	Profenofos 72% EC	700	300
Spectron plus	Profenofos 50% EC	700	300
(Profit +Farate)		375 + 250	200
(Profit + Bravo)		375 + 200	225
Control/water spayed			300

2.3 Management of Experimental Fields

Onion variety “Bombay Red” was used in the experiment in which dominantly produced in Keyh tekli District. First onion seedlings were raised in nursery. For that purpose, the nursery soil was plowed 2–3 times. Seeds were sown on well-prepared nursery bed and all the recommended seedling management activities were preformed according to Aklilu(2003).When seedlings attained 3 to 4 leaf stage or when they attain the height of 12 to 15 cm at the age of 35-45days, healthy and uniform seedlings were transplanted in to well prepare experimental field. Planting of onion seedlings were done using ridge planting system where the spacing between water furrows, rows and plants is 40cm, 20cm and 10cm, respectively, as recommended by Lemma and Aklilu (2003).A distance of 0.5 m and 1 m were maintained between plots and replications, respectively, to facilitate cultural practices.

2.4 Data Collection and Analysis

All necessary data for all parameters had been collected in the right time properly measured and estimated values including vegetative data: thrips counting data, data of yield components, and soil data had collected, calculated and the collected data were checked its normal distribution using Minitab

software thereafter subjected to analysis of variance (ANOVA) using Gen Stat version 18. Mean separation have carried out using Least Significant Difference (LSD) at 5% level of significance (Gomez & Gomez ,1984).

3 RESULTS AND DISCUSSION

3.1 who classification of the pesticides

Table 2

Types and doses of insecticides treatment alignments in the field experiment application In Ethiopia, using pesticides to manage pests in the growing of fruits and vegetables is a standard practice. Various classes of pesticides have been approved to combat pests,

Treatment	Insecticides	Class of pesticides	Dose of insecticides per ha (mm)	Amount of water/ha (L)
T ₁	Profit	II	750ml	200L
T ₂	Chlorguard	II	2000ml	600L
T ₃	Dimethoate	II	950ml	300L
T ₄	Farate	II	500ml	200L
T ₅	Bravo	II	400ml	250L
T ₆	Pro star	II	700ml	300L
T ₇	Spectron	II	700ml	300L
T ₈	(Profit & Farate)	II	Rated from individual	200L
T ₉	(Profit+Bravo)	II	"	225L
T ₁₀	Control			300L

*Class of insecticides (II) moderately hazardous: Sources,(WHO, 2019).

3.2. Yield and Yield Parameters

Table 3
Mean comparison of the effects of insecticidal treatments on onion yields and yield components

Trade names	bulb yield ton/ha	Average Bwt(g)	Bulb diameter(cm)	Bulb biomass ton/ha
Profit 72% EC	22.8 ^a	100	6.7	5.76
Chlorguard 48EC	15.4b ^c	90	6.08	2.91
Dimethoate 40% EC	18.8 ^{ab}	83	6.39	4.58
Farate	13.4 ^c	80	6.32	2.08
Bravo5%	14.7 ^{bc}	82	6.27	3.33
Prostar 72% EC	15.9 ^{bc}	87	6.23	2.56
Spectron plus	13.5 ^c	84	6.52	2.91
(Profit &Farate)	15.1 ^{bc}	82	6.2	2.50
(Profit & Bravo)	15.5 ^{bc}	93	6.17	2.84
Control	13.4 ^c	75	6.01	1.66
LSD (0.05)	4.65	17.1	0.462	2.97
CV (%)	17.0	11.6	4.3	35.6

The soil property of the study area was in conformity with that of ATA [35], except the rate of P which was reported by ATA as very low in the study district.

Onion production is increasing in different agro-ecologies of the country in small-scale production systems being as one component of commercialization for rural and urban peoples as sources of daily income. However, its yield is underestimated, this might be due to several reasons among them infestation of diseases and pests particularly onionthrips take the lion share for lower productivity (Muluneh et al., 2019). The present results of the field experiments were shown all insecticide treatments had significantly different on reducing the infestation of thrips and increased the bulb yield comparing with untreated control. The Profit 72% EC pesticide was the effective insecticide for the management of onion thrips under field conditions and recorded significantly higher bulb yield of (22.8ton/ha) than rest of the other evaluated treatments except dimethoate 40% EC (18.8ton/ha) which were statistically similar with each other whereas the lowest yield was recorded from the Farate insecticide 13.4 ton/ha not statically different from untreated plot. In harmonized with this result (Belete,2020) reported that all insecticide treated plots which effectively reduced the thrips population increased marketable yield compared to the untreated check. In line with our study, the report of (Tadele, 2022) indicated that profit 72% EC was one of the effective insecticides for managing thrips. Besides of that our findings are in

conformity with the earlier results obtained by (Patel et al., 2010) who found profit 72% EC was effective against many sap feeding insects such as onion thrips and Chili thrips then increased the yield. Supporting our study, (Pathak et al., 2018), also reported that, profit 72% EC reduced the thrips infestation severity and increased the onion bulb yield. Our result is also in agreement with (Muhammed et al., 2018) who reported the maximum reduction in thrips population and highest onion bulb yield was obtained by application of dimethoate 40% EC pesticide on onion plants.

3.3. Partial Budget Analysis

Partial budget analysis was done by incorporating the present market based considering all the farming expenditures including fixed and variable costs of agricultural inputs. The usual variable costs and fixed costs are included in the calculation. In the current study insecticides are the only variable costs, where as the land rent, onion seeds fertilizers, labor and other materials, plus the estimated increments were in fixed costs. Based on the values and analyzed data the highest marginal rate of return (127.1) had recorded from the profit 72% EC insecticide treated plot by the application of 750ml/ha rates compared with the other over all insecticide treatments as shown in (Table 3), followed by dimethoate 40EC (99.6) and the lowest marginal rate of return (0.20) was obtained from the treatment of Farate insecticide applied plots (Table 3).

Table 4
Partial budget analysis and MRR for different insecticide types on onion bulb yield

Treatments	Treatment lists	Returns and costs				
		Total variable costs	Gross benefit	Net benefit	Net return over control	MRR (%)
T1	Profit	2200	683340	320028.9NA	279650	127.1
T2	Chlorguard	4400	562500	199788.9NA	159410	12.9
T3	Dimethoate	1600	477090	113778.9D	73400	99.6
T4	Farate	500	464580	101468.9D	61090	0.20
T5	Bravo	500	462510	96998.9D	56620	79.3
T6	Prostar	2200	454170	91058.9D	50680	33.4
T7	Spectron	2200	441660	80048.9D	39670	1.2
T8	Profit +Farate	2000	406260	42948.9D	2570	25.3
T9	Profit +Bravo	2000	402090	40478.9D	100	30.5
T10	Untreated/check	0	401490	40378.9	40378.9	#DIV/0!

The result displayed in Table 3 indicated that, higher net return, 279650 ETB was recorded when the onion was treated using Profit pesticides with recommended manufacturing rate of 750ml/per hectare, followed by Chlorguard pesticide which was applied with manufacturing rate of 2000ml/ha and recorded net return of 159410 ETB. Lower net return, 100 ETB was observed when the onion was sprayed with the combined pesticides of profit and bravo. Similarly to the net return the maximum MRR, 127.1% was observed when the onion was sprayed using manufacturing rate of profit pesticide followed by 99.6% MRR recorded from onion sprayed using dimethoate pesticide with the recommended manufacturing rate of 950ml/ha. Thus, the result of the stepwise treatment comparison (also known as dominance analysis) indicated that the higher marginal rate of return 127.1% & 99.6%, profit and dimethoate pesticides respectively.

4. CONCLUSION AND RECOMMENDATION

Onion plays a central role towards income generating and nutrition security in our areas. The low agricultural yield in Ethiopia, particularly in keyh tekli district, has a several reasons. One of the main productions challenges and resulted a huge yield loss on crops particularly on the fruit and vegetable growers encounter is pests. Prevention of pest is one of the means to prevent losses in both field and storage period. Crop protection technologies allow producers to increase crop yields and efficiency of food production processes. So to fight against, Pesticides are used in the majority of agricultural production sectors to reduce pests, increase output, and enhance product quality. Pesticide use is a common practice to control pests and diseases in vegetable cultivation, but often at the expense of high market. This research study was to evaluate the effects of different pesticides on yield of onion and to estimate cost benefit of pesticide application for onion production. The research was laid out in Randomized Complete Block Design with three replications consisted of ten pesticide types. The results of analysis of variance shown that, significantly increased yield was recorded on the plots treated by pesticides of the profit and followed by dimethoate and also based on the partial budget analysis the highest marginal rate of return (MRR) was calculated from both pesticides of profit and dimethoate. Therefore, application of profit and dimethoate pesticides is recommended for increased yield of onion and economic benefit.

Declarations

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Credit authorship contribution statement:

- **Gebretnsea Gebregziabher Belete:** Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization.

Declaration of Generative AI

- I declare that I did not use any form of artificial intelligence during data analysis or writing of this manuscript.

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Figures

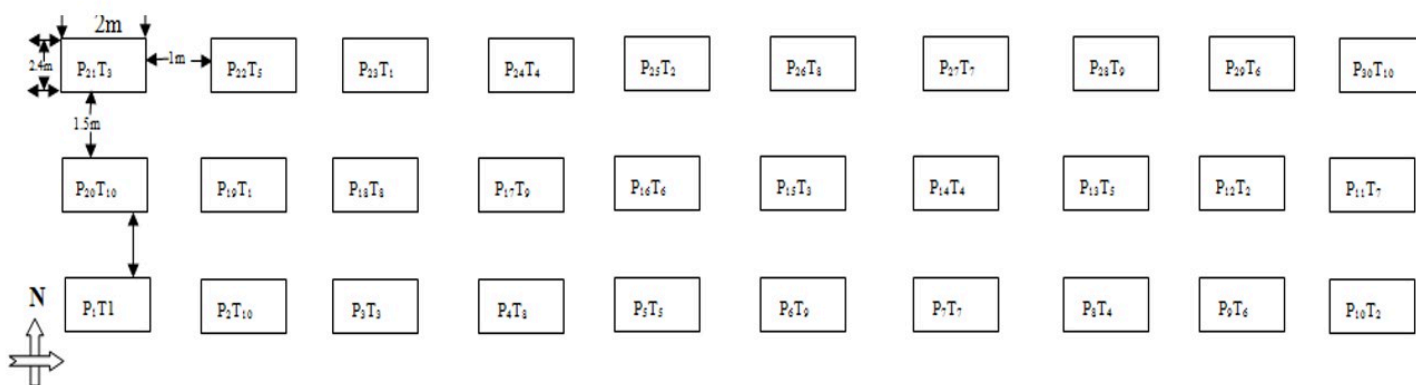


Figure 1

Field lay out of the experimental site

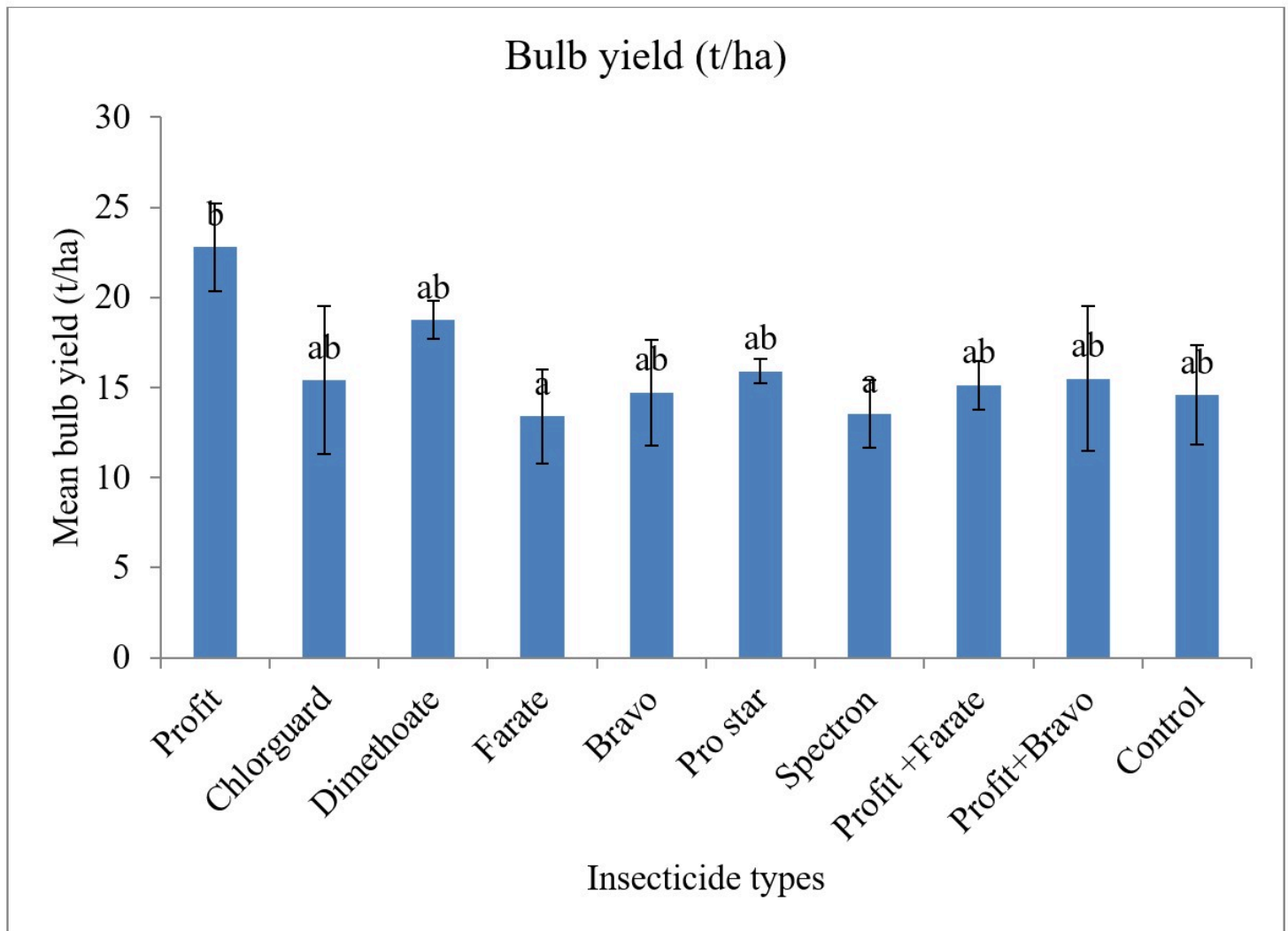


Figure 2

Effect of insecticide types on mean bulb yield of onion