Effect of Integrated Nutrient Management on Bulb Yield and Economic Return of Onion (*Allium cepa* L.) at Selekleka, Northwestern Zone of Tigray, North Ethiopia

Abstract

Onion is an important crop both as a condiment and income generation for smallholder farmers in north western Zone of Tigray. However, Continuous use of inorganic fertilizers and inappropriate soil fertility management practices are among the major factors limiting onion productivity in the North Western Tigray. Therefore, a field experiment was undertaken in Selekleka district from October 2015 to June 2016 to assess the effects of integrated nutrient management on bulb yield and economic return of onion (Allium cepa L.). The treatments consisted of combinations of two rates of farmyard manure (FYM) (10 and 20 t ha^{-1}) and two rates of vermicompost (VC) (2.5 and 5 t ha^{-1}) each combined with three rates of nitrogen (25, 50 and 75) of recommended N fertilizers, RDF. In addition, 100% RDF N (69 kg N ha^{-1}), 100% (5 t ha^{-1}) of VC, 100% (20 t ha^{-1}) FYM and zero rates (unfertilized treatment) were used for comparison. The experiment was laid out in a randomized complete block design with three replications.(ANOVA) revealed that combined application of 5 t ha^{-1} VC+50% inorganic N fertilizers recorded the highest bulb yield (35.13 t ha^{-1})and economic return(246,354 Birr ha^{-1}). On the other hand, the lowest bulb yield (18.48 t ha^{-1}) and economic net return (143,018 Birr ha^{-1}) were obtained from the control. It could, thus, be concluded that, based on the partial budget analysis and bulb yield result the application of 5 t ha^{-1} vermicompost and 50 % recommended inorganic nitrogen was the appropriate combination for better onion production and economic return in the study area.

Keywords: Economic Return, Bulb Yield, Integrated Nutrient Management, Onion

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Introduction

Onion (*Allium cepa* L.) a member of Amaryllidaceae family is one of the most important mono-cotyledonous spice crop. This most widely used condiment, believed to be originated in Central Asia, possesses tremendous popularity as well as economic importance all over the world. It is currently grown in at least 175 countries worldwide with a total production of 85375 thousand metric tons (FAO, 2011).

Onion (Allium cepa L) is an important bulb crop in Ethiopia. It is recently introduced and rapidly becoming popular among producers and consumers. It is widely produced by small farmers and commercial growers throughout the year for local use and export market (Lemma and Shimeles, 2003).

The integrated nutrient management paradigm acknowledges the need for both organic and inorganic mineral inputs to sustain soil health and crop production due to positive interactions and complementarities between them (Vanlauwe *et al.*, 2002). As an export commodity, onions are key contributors to the economies of many low-income countries like Ethiopia (CACC, 2002).

Onion is considered as one of the most important vegetable crops produced on small scale in Ethiopia. It also occupies an economically important place among vegetables in the country. The area under onion is increasing from time to time mainly due to its high profitability per unite area and ease of production, and the increases in small scale irrigation areas.

A major constraint in increasing onion crop yield is the supply of integrated nutrient particularly the study areas. Continuous use of inorganic fertilizers with no supplementation of organic manure has resulted in deficiency of micro nutrients, imbalance in soil physico-chemical properties and unsustainable crop production. Use of organic manures in combination with chemical fertilizers in an appropriate proportion improves the overall soil health for sustainable onion production (Gupta *et al*, 1999). Therefore, integrated nutrient management is available strategy for sustainable onion cultivation and better economic return.

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Objective

- To find economically appropriate integrated nutrient management for onion

MATERIALS AND METHODS

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Description of the study area

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The experiment was conducted at Shire-Maistebri Agricultural Research Center (SMARC) Selekeleka Research site, in north western Tigray, northern Ethiopia during 2015-2016 (October – June). Selekeleka is located 1065 km north of Addis Ababa 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.

Treatments and experimental design

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The treatments consist of combinations of two rates of FYM (10 and 20 t ha-1) and two rates of vermicompost (2.5 and 5 t ha-1) each combined with three recommended rates (25, 50 and 75%) of inorganic N fertilizers. In addition, 100% recommended rate of inorganic N fertilizer (69 kg N), 100% (5 t ha-1) of VC, 100% (20 t ha-1) FYM and zero rates (unfertilized treatment) were used for comparison. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The gross plot size was 2 m x 3 m (6 m2). The distance between blocks were 1.5 meters whereas the distance between plots were 1m and the spacing between rows and plants were 40cm (with double rows at 20 cm) and 10cm, respectively.

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2.1 Method of Agronomic Data Collection

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Marketable yield was collected from the central three rows by excluding plants from either end of the rows. Total marketable fruit yield (kg ha^{-1}): Weight of healthy and marketable fruit yield per plot was determined and converted to kg ha^{-1}.

2.2 Data Analysis

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Bulb yield data variable was subjected to analysis of variance (ANOVA) using the Gen Stat statistical package (Gen Stat, 13th Edition). When ANOVA showed significant differences, mean separation was carried out using Least Significant Difference (LSD) test at 5% level of significance.

2.3 Economic Analysis

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In order to identify economically feasible recommendations, partial budget analysis was carried out according to CIMMYT (1988). The analysis was based on the data collected from the woreda office of Agriculture and Rural development. The mean prices of onion, FYM, VC and urea, in 2015/16 in the study area were 8.60, 3, 5 and 13.34 Birr kg-1, respectively, and used for calculating partial budget analysis.

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Gross average seed yield (kgha-1) (AvY): is an average yield of each treatment.

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Adjusted yield (AjY): was the average yield adjusted downward by a 10% to reflect the difference between the experimental yield and yield of farmers [2].AjY = AvY - (AvY*0.1)

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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: was the cost of Urea and DAP and labor cost for application and including transportation cost used for the experiment. Their prices were based on 2016 and 2017 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 or the difference was insignificant among treatments.

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

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

RESULTS AND DISCUSSION

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Bulb Yield

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The analysis of variance showed that a combined application of organic manure and inorganic fertilizers had highly significant ($P < 0.001$) effect on marketable bulb yield of onion (Table 1). The highest marketable yield (35.13 t ha-1) of onion was obtained from the application of 5 t ha^{-1} VC + 50% N while and the lowest (18.48 t ha^{-1}) marketable yield was recorded from nil fertilizer treated plots. The increment of marketable yield of onion by this treatment was 90% over the control and 36.7% over the 100% RDF N fertilized plots. The results indicated that, marketable bulb yield of onion is influenced by vermicompost and nitrogen fertilizers. Both vermicompost and inorganic nitrogen fertilizer produced significant increases in plant growth and marketable yield, It is evident from previous data that the highest growth and yield attributing parameters

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were recorded from application of 5 t ha^{-1} VC + 50% RDF N, followed by 5 t ha^{-1} VC + 75% RDF N; Thus, this treatment appeared to be the most favorable treatment combination compared to the other integration ratios. The superiority of the treatment may be due to the fact that it might have taken the advantage of the merits of both chemical fertilizer and vermicompost in a most poised condition. The use of nitrogen in sufficient amount early in the growing will result in increased extension of leaf surface that in turn leads to increased photosynthetic capacity of crops, thus insuring their higher growth (Yourtchi *et al*., 2013). Whereas, in vermicompost, most of the nutrients are released gradually through mineralization of the organic matter, thus constituting the action of slow-release fertilizer which supplies the plants with a gradual and constant source of nutrients (Chaoui *et al*., 2013). Besides supplying the essential nutrients, the positive effect of vermicompost on the growth of onion might be related to the presence of plant growth substances, humic acids, increased microbial diversity and activity and improvement of the physical structure of the soil (Arancon *et al*., 2004)

In agreement with the present result, Alemu (2014) reported that marketable yield of garlic was increased by 10% with increased application rate of vermicompost from 0 to 5t ha^{-1}. Similarly, Henriksen (1987) and Kumar *et al.* (1998) reported that the yield of marketable onion bulbs increased with N application.

Likewise, Sankar *et al.* (2009) also reported that the marketable bulb yield of onion was significantly improved by the addition of organic manures and application of organic growth stimulants. Furthermore, higher marketable weight of cauliflower was obtained from combined application of vermicompost with chemical fertilizers (Jahan *et al.,* 2014).

4.6. Partial Budget Analysis

Partial budget analysis is a method of organizing experimental data about the cost benefit of some changes (CIMMYT, 1988). It calculates the income and expenses based on variable cost. Partial budget of each treatment mean is presented in (Table 2).

From the final experimental data, the gross mean yield of 16 treatments was obtained. According to CIMMYT (1988), the average yield was adjusted down wards by 10%. This is for the reason that, researchers have assumed that using the same treatments the yields from the experimental plots and farmers' fields are different; hence, the average yields should be adjusted downward. Based on that hypothesis, the recommended level of 10% was adjusted for all 16 treatments to get the net adjusted yield. Then the adjusted yield was multiplied by market price to obtain gross yield benefit. Costs and benefits were calculated for each treatment level.

The different variable costs that vary among the treatments are calculated whereas costs that did not show variation among the treatments (cost of seeds, chemical sprays and labour during transplanting, irrigation, weeding) were not considered. In addition to this total variable costs and the net benefit were calculated. The purchasing price of urea, farmyard manure and vermicompost were 13.34, 3 and 5 Birr Kg^{-1} respectively. The market price of onion during the harvesting season was 8.60 birr kg^{-1}. All the variable costs were subtracted from gross benefit to obtain net benefit.

From the economic point of view, it was found that, the treatment combination of 5 t ha^{-1} VC +50% RDF N (T5) gave the highest net return 246,354 Birr ha^{-1} with marginal rate of 9882% followed by 2.5 t ha^{-1} VC + 75% RDF N (T3) 226,014 Birr ha^{-1} with marginal rate of 3944%. On the other hand, the lowest net return 143,018 Birr ha^{-1} was obtained from the control. This means that for every Birr 1.00 invested in 5 t ha^{-1} VC +50% RDF N, growers can expect to recover the Birr 1.00 and obtain an additional 98.82 Birr. The current result is found to be relatively similar with the result of Patial *et al.* (1997) who reported that the highest yield, net income and cost benefit ratio were obtained with application of 4 t ha^{-1} vermicompost + 50% recommended inorganic fertilizer rates on tomato. Based on the current study the application of 5 t ha^{-1} VC +50% RDF N and 2.5 t ha^{-1} + 75% RDF N was more profitable than the other treatment combinations.

Table 2. Partial budget analysis of onion as influenced by integrated nutrient management

Treatment mbinations	Unadjusted marketable yield (t ha^{-1})	adjusted marketable yield (t ha^{-1})	gross benefit (ETB ha^{-1})	variable cost (ETB)	net benefit (ETB ha^{-1})	MRR (%)
Absolute control	18.48	16.63	143018	0	143018	0
100% RDF N	25.7	23.13	198918	2016	196902	2672
2.5 t ha^{-1} VC +						65
25% RDF N	28.04	25.24	217064	13004	204060	
2.5 t ha^{-1} VC +						411
50% RDF N	28.38	25.54	219644	13508	206136	
2.5 t ha^{-1} VC +						3944
75% RDF N	31.01	27.91	240026	14012	226014	
5 t ha^{-1} VC	27.12	24.41	209926	25000	184926^{D}	
5 t ha^{-1} VC + 25%						
RDF N	28.69	25.82	222052	25504	196548^{D}	
5 t ha^{-1} VC + 50%						9882
RDF N	35.13	31.67	272362	26008	246354	
5 t ha^{-1} VC + 75%						
RDF N	32.09	28.88	248368	26512	221856^{D}	
10 t ha^{-1} FYM +						
25% RDF N	27.28	24.55	211130	30504	180626^{D}	
10 t ha^{-1} FYM +	27.27	24.54	211044	31008	180036^{D}	

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50% RDF N					
10 t ha^{-1} FYM + 75% RDF N	27.51	24.76	212936	31512	181424^{D}
20 t ha^{-1} FYM	26.83	24.15	207690	60000	147690^{D}
20 t ha^{-1} FYM + 25% RDF N	28.14	25.33	217838	60504	157334^{D}
20 t ha^{-1} FYM + 50% RDF N	29.75	26.78	230308	61008	169300^{D}
20 t ha^{-1} FYM + 75% RDF N	30.08	27.07	232802	61512	171290^{D}

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SUMMARY AND CONCLUSION

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A field experiment was carried out at Selekeleka Research Site during from October, 2015 to June, 2016 with the aim of to assess the effect of integrated nutrient management on growth, yield, yield components and storability of irrigated onion at Selekeleka district North Western Tigray. The treatments consisted of combinations of two rates of FYM (10 and 20 t ha$^{-1)}$ and two rates of VC (2.5 and 5 t ha^{-1}) each combined with three recommended rates (25, 50 and 75%) of inorganic N fertilizers. In addition, 100% recommended rate of inorganic N fertilizer (69 kg N), 100% (5 t ha^{-1}) of VC, 100% (20 t ha^{-1}) FYM and zero rates (unfertilized treatment) were used for comparison. The experiment was laid out in a randomized complete block design with three replications. The gross plot size was 2m x 3m (6 m2). The distance between blocks were 1.5 meters whereas the distance between plots were 1m and the spacing between rows and plants were 40cm (with double rows at 20 cm) and 10cm, respectively.

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Economic analysis also revealed that integrated use of organic and inorganic fertilizers resulted in considerably higher net benefit over the control. From the economic point of view, it was found that, the treatment combination of 5 t ha^{-1} VC +50% RDF N gave the highest net return 246,354 Birr ha^{-1}with marginal rate of 9882%, followed by 2.5 VC t ha^{-1} + 75% RDF N 226,014

Birr ha^{-1} with marginal rate of 3944%. On the other hand the lowest net return 143,018 Birr ha^{-1} was obtained from the control.

Reference

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