Effect of Irrigation Scheduling and Chemical Fertilizer on the Yield of Onion at Megech-Seraba Irrigation Scheme

Ertiban W.

Gondar Agricultural Research Centre, Amhara Agricultural Research Institute, Ethiopia

Abstract

Experiment to study the interaction effects of irrigation and fertilizer on yield of onion was carried out at Megech-Seraba irrigation scheme, Denbiaworeda, Amhara Region, Ethiopia. The experiment was laidout in a Randomized Completet Block Design (RCBD), and investigated in 2011/12 and 2012/13irrigation seasons. Totally six treatments were tested: two irrigation depths (ID) namely: 31mm and 25mm were combined with three NP fertilizer levels (50/46, 50/138, 100/138, kg/ha). P_2O_5 fertilizer was applied to each plot at transplanting and N fertilizer was applied in two splits; at transplanting and 45 days after transplanting. All the necessary management practices were made the same for each plot. Data were analyzed using SAS statistical software to determine variance and LSD at 5% level of significance. Soil nutrient information, agronomic and economic data were collected. The soil analysis result showed that, generally the soil status of the area is good for onion production under irrigation condition. For instance, the pH of the soil in the study area is found to be6-7 which suits best for onion cultivation. The ANOVA for the agronomic data revealed that there was no significant interaction effect between irrigation water depth and N/P_2O_5 fertilizers. The biological yield result indicated that the use of 100/ 138 kg/ha N/P_2O_5 fertilizers gave significantly higher onion total yield. However, there is no significant difference between irrigation depths. On the other hand, the partial budget analysis gave a different result from the biological result, the partial budget analysis revealed that application of 50/ 46 kg/ha N/P_2O_5 fertilizers with 25 mm/7 days irrigation interval can benefit farmers more among other treatments. Therefore, this result (50/ 46 kg/ha N/P_2O_5 fertilizers with 25 mm/7 days irrigation interval) is recommended for the area.

***Keywords**:* Irrigation Scheduling, fertilizer, onion

1. INTRODUCTION

Onion (Allium cepa L.) is a high cash value crop with a very shallow root system, and in the world trade it ranks second in importance next to tomato among the vegetable. It needs frequent irrigation and fertilizer to maximize yield (Enyachew et al, 2016 and Halvorson et al, 2008). It is used in every home almost daily. It is useful in flavoring and seasoning many dishes. Onion has also an important role as a medical herb in many communities, and is claimed to minimize high blood pressure and other heart disease (Sani and Jaliya, nd).

Onion production, which can easily be undertaken by in small farming, may play an important role in poverty reduction programs and food security initiatives. It can provide employment opportunities and a source of income. Horticultural crops are well adapted for small-scale production units and can provide aid for people at the individual household level while they also offer opportunities for export market and earnings of foreign currency.

In Amhara region the cultivation of onion has been going on in different small and medium scheme irrigation sites. In Rib irrigation command areas the farmers have been practicing onion production in the last few decades. The local variety which is called shallot is also a common practice in Gondar Zuria Destrict. Recently this practice has been widely spreading in Denbia Destrict. Therefore, to maximize the production and productivity of onion, Gondar Agricultural research center (GARC) has done an experiment on fertilizer and water requirements of onion at Megech irrigation command area. However, fertilizer requirements may be affected by amount and frequency of irrigation water. On the other hand water use efficiency is highly dependent on plant nutrient and, supply. Therefore, any plant input factor that increases economic yield will improve the water use efficiency or vise-versa.

Appropriate irrigation water application and method can improve nutrient use efficiency (Ardell, *et al.*, 2002). To investigate the relationship of fertilizer rate and water amount, interaction of water and fertilizer was studied for onion with the objectives of (i) determining optimum rate of N and P fertilizer combined with optimum amount of water (ii) evaluating the interaction effect of chemical fertilizer and water amount on the yield.

2. MATERIALS AND METHODS

The study was conducted on farmers' fields for two years in Megech irrigation site. Megech site is located in Denbia district, North Gondar administration, of the Amhara National Regional State, Ethiopia, on 37.30º longitude and12.25º latitude. The area receives an average precipitation of 900 mm per annum, with maximum rainfall occurring from June to September accounting more than 85% of the annual rainfall received. The average daily temperatures range from 18.7°C to 23°C with a mean value of 20 °C.

The experimental design was RCBD in factorial arrangement with three replications. There were three rates of N and P recommended fertilizer amounts combined with two recommended amount and frequency of water. The fertilizer rates were 50 kg/ha N & 46 kg/ha P_2O_5; 50 kg/ha N & 138 kg/ha P_2O_5 and 100 kg/ha N & 138 kg/ha P_2O_5; the amount and frequency of water were 25mm and 31mm applied every 7 days.

Adama red variety of onion was used for the experiments. Seedlings were prepared in a nursery and transplanted to the plots after 45 days in 40cm furrow spacing, 20 and 10 cm row and plant spacing respectively. P_2O_5 and half of N fertilizer in the forms of DAP and Urea were applied at transplanting respectively. The remaining half of N fertilizer was applied 45 days after transplanting. The treatments were received equal amount of irrigation water up to establishment of the seedlings to attain equal stands of onion seedlings. The irrigation method was furrow and applied water depths for each treatment were measured using siphon tubes. The tubes were calibrated before using for water depth measurements. Other agronomic practices like plowing, harrowing, weeding, earthling up, pest control measures were done equally for each treatment when necessary.

Initial composite soil sample (0- 20cm depth) was taken before planting and analyzed for pH, available P, total N and CEC at Gondar Zonal Soil Testing Laboratory.

The following soil analyzing methods were used to determine each soil chemical parameter. Soil pH was determined in 1:2.5 soils to water suspension Cation exchange capacity (CEC), by the ammonium acetate (pH 7) method Exchangeable basic cations (Ca, Mg, K, Na) content from the ammonium acetate leachate Total nitrogen, by the Kjeldhal method Available phosphorus, by the Olsen method Organic carbon (OC), by the Walkley and Black method Texture, by hydrometer method.

To show farmers the economic advantage of fertilizer and irrigation water use for onion production, partial budget analysis (PBA) was used. Partial budget analysis is useful in comparing the impact of a technological change on farm costs and returns. This budgeting approach is called partial because it does not include all production costs, but only those which change or vary between the farmer's current production practices and the proposed one(s) (CIMMYT, 1988).

The following data were used for PBA:

- Variable costs (N and P fertilizers and water depths which vary between treatments)
- Onion yield per hectare resulting from each treatments and it was adjusted by 10% decrement for each treatment
- Farm price - prices of harvested onion which is estimated about 5.5 Ethiopian Birr per kilogram.
- The fixed costs included: land preparation, planting, weeding, seed and harvesting costs which have invested equally for each treatment

Then the main components of PBA such as, total revenue, net income, change in variable cost, change in return, marginal cost of return (it should be greater than 100%) was calculated and based on net

income and marginal rate of return decision on which fertilizer rate and water depth is more profitable for farmers was made.
Data: yield, stand count, bulb weight, bulb diameter were collected but only yield is presented here, since the other yield components were not significantly affected by water depth and fertilizers application.

3. RESULTS AND DISCUSSIONS

3.1 Soil Status of the Experiment Area

Onion can grow on most soil types. However, well drained, medium texture soils with pH 6-7 suits best for onion production (Sani and Jaliya, nd). As the table shows, the pH of the area is under the best category for onion production. On the other hand, since the irrigation method was controlled furrow, drainage and the texture condition could not be a limitation. Therefore, generally the soil condition of the area seems suitable for onion production under irrigation.

The soil analysis result shows (Table 1) high total nitrogen (TN) which is greater than 0.15% and available Phosphorous (P) is moderate (Kamanu, 2012). The soil has medium amount of organic matter (OM). For the exchangeable cations the soil has medium Na^+, high K^+ and very high Mg^+ and Ca^+.

Table 1: Soil analysis results for experimental site at Megech irrigation scheme

Parameters	PH	P/PPM	OM	TN%	CEC	Ca^+	Mg^+	Na^+	k^+	Texture
Onion	6.84	6.023	2.68	0.34	60.65	40.98	18.40	0.65	0.62	Clay loam

3.2 Onion Yield Result

The combined analysis of variance showed that the interaction effects of irrigation amount and N/P_2O_5 fertilizers have not significantly affected onion yield (Table 2). While the main effects of N/P_2O_5 fertilizers has significantly affected onion yield. However, onion yield did not respond to the main effect of irrigation depth. For yield analysis total yield was considered, since total yield is the best predictor of treatment response because it is unaffected by potential bias decision on marketable yield.

Table 2: Analysis of variance for the effects of irrigation and N/P_2O_5 fertilizer on total onion yield

Source	DF	Mean Square
N/P_2O_5 fertilizer	2	40873278.33*
IRR_Dpth	1	7137885.24^{ns}
Fertilizer*IRR_Dpth	2	16277429.63^{ns}

*N.B: * shows significant difference, ns show no significant difference*

Results of analysis showed that onion bulb yield was higher with application of 100/138 kg/ha of $N/P_2O_5$from among the applied fertilizer rates (see Table 3 below). Since onion is a shallow rooted crop, it demands high nitrogen amount during the growing seasons (Ardell*et al*, 2008), on the other hand if the amount of N applied decreases, the plant P demand will also decreases. Applying 31mm of water at 7 days irrigation interval(31mm/7) gave higher yield than application of 25mm of water at 7 days interval (25mm/7) , but there is no significant difference between the two water depth amounts. Though soil moisture condition was not monitored at the time of irrigation, the moisture difference between the two water depths application is not big. Hence, occurrence of approximately similar soil moisture conditions with applying these two treatments is expected. A drop in soil moisture was expected if it was applied below 25mmirrigation water.

Table 3: The effect of irrigation amount and fertilizer on total onion yield (kg/ha)

Fertilizers - N/P_2O_5 kg/ha	Yield (kg/ha)
100/138	14631[a]
50/46	12889[ab]
50/138	10942[b]
LSD (0.05)	2596.5
Irrigation depth	
25mm/ 7	12375
31mm/ 7	13266
LSD (0.05)	2120
CV (%)	24

N.B: values with different letter states significant difference between the

3.3 Partial Budget Analysis Result

Partial budget analysis was done for combined result on the bulb yield of onion. The result showed that, 31mm/7 days water application with 100/138 kg/ha nitrogen and phosphorus fertilizers has the highest net benefit, this could be considered profitable only if its rate of return is higher than 100% (CIMMYT, 1988). But as Table 4 below shows its marginal rate of return (MRR) is 12.1 % which is much less than 100%. Other rates such as (50/138,25); (100/138,25); (50/46, 31); (50/138,31) N and P_2O_5 kg/ha and irrigation water depths mm/7 days interval are marked as dominated because as their costs increased against 50/46 kg/ha N, P2O5 , 25mm/7 days interval, their net benefit did not increase, therefore all these rates are rejected. Hence, the partial budget analysis result revealed that 50/46 kg/ha N, P2O5 fertilizers with 25 mm/7 days interval irrigation water application can give a maximum benefit for farmers over the other rates.

Table 4: Partial budget analysis for the effects of irrigation and N/P_2O_5 fertilizer on total onion yield (kg/ha)

N/P kg/ha, IWD mm/7 days	Mean yield kg/ha	Adjusted yield kg/ha	TR birr/ha	GFB birr/ha	VC birr/ha	NB birr/ha	DA	MC birr/ha	MNB birr/ha	MRR (%)
(50/46,25)	13117	11805.3	64929.2	54844.2	7817.2	47026.9				
(50/138,25)	11169	10052.1	55286.6	45201.6	9243.3	35958.3	D			
(100/138,25)	12841	11556.9	63563.0	53478.0	10643.3	42834.7	D			
(50/46, 31)	12661	11394.9	62672.0	52587.0	10750.0	41836.9	D			
(50/138,31)	10715	9643.5	53039.3	42954.3	12176.1	30778.2	D			
(100/138,31)	14421	12978.9	71384.0	61299.0	13576.1	47722.9		**5758.9**	**695.9**	**12.1**

NB: TR=total revenue, GFB=gross field benefit, VC= variable cost, NB= net benefit, DA= dominance analysis, MC= marginal cost, MNB= marginal net benefit, MRR=marginal rate of return

4. CONCLUSIONS

As the soil data analysis of the site showed, pH of the soil is from slightly acidic to neutral which is suitable for onion cultivation. The other soil parameters are from medium to high, which might not have negative effect on onion cultivation if water application is properly managed. The agronomic combined data analysis of onion bulb yield (biological yield) in two consecutive harvests (during 2011/2012 and 2012/2013 years) at one site showed, the main effect of N/P_2O_5 fertilizers has significantly affected bulb yield. Therefore, applying 100/138kg/ha N/P_2O_5 gave the maximum biological bulb yield of onion. However, the irrigation depth did not significantly affect bulb yield of onion, as the applied depths didn't bring a significant soil moisture difference. Unlike the biological result, the partial budget analysis result revealed that, maximum benefit can be obtained from application of 50/46 N/ P_2O_5 with 25mm/7days irrigation. Therefore, it is recommended that

application of 50/46 kg/ha N/P_2O_5fertilizers with the irrigation amount 25mm at 7 days irrigation interval is recommended for better onion yield at Megech irrigation site.

5. REFERENCES

1. Ardell D. H., Michael E. B., Curtis A. R. and Abdel B. (2008). *Nitrogen Effects on Onion Yield Under Drip and Furrow Irrigation, Agronomic Journal.*
2. Ardell D.H., Ronald F. F., Michael E. B. and; Frank C. S. (2002). *Nitrogen Fertilizer Use Efficiency of Furrow-Irrigated Onion and Corn. Agronomic Journal.*
3. CIMMYT, 1988. *From Agronomic Data to Farmer Recommendations: An Economics Training Manual. Completely Revised Edition. Mexico. D.F.*
4. Kamanu J.K., Chemining'wa G.N., Nderitu J.H. and Ambuko, J., 2012.*Growth, yield and quality response of snap bean (PhaseolusvulgarisL.) plants to different inorganic fertilizers applications in central Kenya.Journal of Applied Biosciences* 55: 3944– 3952.
5. Sani B. M. and Jaliya M.M. (no date). *Onion production and management under irrigation. Extension Bulletin No. 204, Agric. Engineering Series No. 5.Produced and distributed by National Agricultural Extension and Research Liaison Services, Ahmadu Bello University, Zaria.*
6. ENCHALEW B, GEBRE SL, RABO M, HINDAYE B, KEDIR M, ET AL. (2016) *EFFECT OF DEFICIT IRRIGATION ON WATER PRODUCTIVITY OF ONION (ALLIUM CEPAL.) UNDER DRIP IRRIGATION. IRRIGAT DRAINAGE SYS* ENG 5:172. DOI: 10.4172/2168-9768.100017