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ORIGINAL ARTICLE

Effect of Np Fertilizer and Moisture Conservation on the Yield and Yield Components of Haricot Bean (*Phaseolus Vulgaris* L.) In the Semi Arid Zones of the Central Rift Valley in Ethiopia.

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ABSTRACT

On farm trial on NP fertilizer rate and moisture conservation practice determination for haricot bean was conducted at Melkassa and Wolenchiti for two consecutive years. Five NP fertilizer rates and two-land preparation techniques (flat and tied) were laid out in a split plot design with three replications. Analysis over two years showed that grain yield was significantly ($P<0.05$) affected by the application of NP fertilizer and land preparation technique in both locations. Application of 69 kg/ha P_2O_5 and 27 kg/ha N and using tie-ridging gave the highest grain yield 1133 kg/ha and 938 kg/ha in 2005 and 2006, respectively at Wolenchiti. However, the highest grain yield (1627 kg) was, obtained at 92 kg/ha P_2O_5 and 36 kg/ha N in 2005 where as 46 kg/ha P_2O_5 and 18 kg/ha N gave a better yield (412 kg) than other treatments in 2006 when flat planted at Melkassa. At Wolenchiti, the net economic return was higher (271.9 birr/ha) at the rate of 23 kg/ha P_2O_5 and 9 kg /ha N with tie ridging whereas at Melkassa 69 kg/ha P_2O_5, 27 kg /ha N and in flat planting resulted high net return of 816.8bir/ha when the rainfall is better in the season.

Key words: Fertilizer rate, Moisture Conservation, Semi Arid

Introduction

Haricto Bean (*Phaseolus Vulgaris* L) is the most important pulse crops grown in central southern, eastern and Western lowland and mid altitudes of Ethiopia. Besides, its use as a readily available source of protein for farmers, it is also an important cash crop and export commodity that generate foreign exchange for the country. It is predominantly grown for cash in the central rift valley, but in other parts it is a major staple food supplementing the protein source for the poor farmers who cannot afford to buy expensive meat [4].

Low soil fertility has been repeatedly reported as one of the major factors affecting bean production in the central rift valley of Ethiopia. Generally, the most critical production limiting nutrients in the dryland areas of Ethiopia including the central rift valley are nitrogen and phosphorus, provided there is enough moisture [3,5]. About two decades ago several experiments were conducted[6] to determine the effect of nitrogen and phosphorus application on bean production. A tentative recommendation of the results indicated that 40 to 70 kg P_20_5/ha and 20 to 30 kg N/ha are optimal for bean production. However, the soil at the trial sites were not analyzed for availability of nutrients and results might have been biased by high residual effects since NP exhaustion trials were not carried out under on-station condition were the trails were executed. Furthermore, recent NP fertilizer trails conducted under on-station conditions even with cereals did not give significant response for either nutrient [5].

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On other crops like maize and sorghum, field trials were conducted to determine the effect of moisture conservation with and without fertilizer application in the semi arid areas of Eastern Ethiopia. The result of these experiment indicated a substantial yield increase from water conservation practices. On average, yield increase of more than 50% was attributed to the water conservation practices under unfertilized condition. However, in terms of absolute yield, the combination of moisture conservation and use of fertilizers gave the highest attainable yield [7]. In this central rift valley previously fertile soils are avoided for haricot bean to minimize lodging and weed infestation [8]. However, a recent survey indicated that fertilizer use on haricot bean in this area is increasing, now being second to tef in this respect[2]. 84% of growers in the wet zone and 53% in the dry zone use chemical fertilizer (Diammonium Phosphate) rates comparable with tef and maize. Realizing, the increased response of the bean crop to the two essential nutrients, farmers in the Central Rift Valley do apply varying rates of available commercial fertilizers in recent years (PPB team, Habtu, Setegne, Personal Communication) which also strengthen the above mentioned fact. Therefore, the experiment was conducted to determine agronomically suitable NP fertilizer levels and appropriate moisture conservation technique for bean in the arid zones of the central rift valley of Ethiopia.

Material and methods

An experiment was conducted at Melkassa and Wolenchiti in 2005 and 2006 on representative farmers' fields where bean production is prominent. At each location one farmer's field was selected based on past crop and fertilizer history that is fields previously sown with cereals, no history of fertilization and free from sediment deposition was selected. The experiment was laid out in a split plot design with three replications. Main plot were two land preparation technique (tie ridge and flat seed bed) and the Sub – plot were five P_2O_5 and N Levels respectively [(0, 0) (23, 9) , (46, 18), (69, 27) and (92, 36)] Kg/ha assigned in or factorial combination. 20 kg of urea was added as a starter dose for all treatments. 40 x10 row and plant spacing respectively was used. A variety used was Mexican – 142.

The collected data were number of pods/plant, pods weight, biomass weight, 1000 seed weight and grain yield per plots. Composite soil samples for each treatment was collected and analyzed for selected chemical and physical properties (table 1).

Mean grain yield was also subjected to economic analysis using partial budget methodology. Average prices of haricot bean grains had been taken over two consecutive years (2005-2006). For each year the average price of the grains over three months at which prices will be lower over a year will be taken.

Result and discussion

Experimental Site

Wolinchiti Sub-Station is located 125 km east of Addis Ababa with longitude 39 ° 19' E and latitude 08 ° 44'N and an altitude of 1450 m.a.s.l. the soil type is classified as andosol. The mean maximum and minimum temperatures are 39 ° C and 25 ° C, respectively. The mean Min and Max rainfall was 750 mm and 800 mm, respectively.

Melkassa Agricultural Research center is located 115 km south east of Addis Ababa with longitude 39 ° 21' E and latitude 8° 24' N and an altitude of 1550 m.a.s.l. the soil type is classified as andosol. The mean maximum and minimum temperatures are 28 ° C and 14 ° C, respectively. The mean annual rainfall was 885.7 mm in 2005 and 790.9 mm in 2004.

At Wolenchiti, N% of the soil was 0.1603, 0.2188 and 0.1459 at the depth of 0-15cm, 15-30cm and 30-45cm, respectively. Which is more than enough for the surface and subsurface N level of most cultivated soils. Similarly the total N was sufficient for Melkassa soil. Other chemical and physical properties of the soil tasted are presented in table 1.

Yield and yield components

The combined analysis for grain yield, plant height, biomass, number of pods/plant, pods weight, number of seeds/pod and 1000 seed weight for two years (2005 and 2006) at Wolenchiti & Melkassa are presented (table 2-5).

The results showed that, at Wolenchiti (2003), grain yield and biomass weight were affected significantly ($p<0.05$) by different fertilizer rate. As the fertilizer rate increases the grain yield was also increased and the highest grain yield (1133 kg/ha) was obtained by the application of 69 kg/ha P_2O_5 and 27 kg/ha *N* in tie ridging. However, there was no significant difference for the interaction for all the parameters observed. On the other hand, yield advantages of 33% and 30% were obtained with the application of 69 kg /ha P_2O_5 and 27 kg /ha N over the control treatment (0-0 P_2O_5-N) using tie-ridge and flat land preparation techniques respectively (table 2).

There was significant difference for biomass weight, number of pods/plant and pods weight at different fertilizer rate, but not for the land preparation technique and the interaction in the year 2004. In general, an increase in grain yield and other agronomic parameters was observed as the rate of fertilizer increases till 69 P_2O_5 kg/ha and 27 kg/ha N (150 kg DAP) level. This fertilizer rate with tie ridging also gave yield advantages of 39% over the control treatment. Tie ridge moisture conservation practice was also better than flat planting for all the parameters. Therefore, application of 69 kg/ha $P_2O_5$and 27 kg/ha N (150 kg DAP) with tie ridging

gave the highest yield of haricot bean at Wolenchiti both years (table 3). This result is in agreement with the result obtained on tef fertilizer trial at Wolenchiti that showed an increase in grain yield as fertilizer was applied [1]. The net economic return is higher (271.9 birr/ha) at the rate of 23 kg/ha P_2O_5 and 9 kg /ha N with tie ridging whereas the net return of the highest yield treatment was 135.2 birr/ha (table 6). Therefore, using 23 kg/ha P_2O_5 and 9 kg /ha N with 20 kg/ha urea as a starter dose at planting is recommended for bean production around Wolinchiti.

At Melkassa, land preparation technique and the combined treatment (fertilizer rate by land preparation techniques interaction) significantly affected the grain yield of haricot bean in year 2005, but plant height, biomass weight, number of pods/plant, pods weight and 1000 seed weight were not significantly affected by land preparation techniques and the combined effect, however, there was significant difference for plant height and biomass by applying different fertilizer rates in the some year. The highest yield advantages over the control (30%) was obtained with the application of 46 kg P_2O_5/ha and 18 kg N/ha using tie ridge and 16% with the application of 92 kg P_2O_5 /ha 36 kg N/ha using flat planting (table 4). The highest grain yield was obtained at rate of 92 P_2O_5 kg/ha and 36 N kg/ha in flat planting and the lowest at non-fertilizer applied plots. Whereas, in year 2006, all agronomic parameters including grain yield was not significantly affected by land preparation techniques and by combined effect. However, there was significant difference only for biomass and pods weight by application of fertilizer (table 5). In general, although there was an increase in yield up to fertilizer rate of 92 kg/ha P_2O_5 and 36 kg/ha N (200 kg/ha DAP), it was sufficient to apply lower rate [69 kg/ha P_2O_5 and 27 kg/ha N (150 kg/ha DAP)] since this rate also gave a very good yield and no significant difference was seen between the two level of fertilizer. The application of 92 kg P_2O_5/ha and 36 kg N/ha (200 kg/ha DAP) with tie ridge gave yield advantage of 56% and 28% yield advantage was obtained by applying 42 kg P_2O_5/ha and 18% kg N/ha with flat planting over the control treatment (table 5). Flat planting gave better grain yield compared with tied-ridging technique in both years at Melkassa. (table 4 & 5). That is because there was lower and erratic rainfall in Melkassa and its surrounding that resulted a poor response to fertilizer for different land preparation techniques. This finding is similar to the results of maize fertilizer and soil moisture conservation trial done at Melkassa showing relatively response to applied fertilizer but not for land preparation technique [19]. However, the net economic return at Melkassa was high (816.8bir/ha) at 67 kg/ha P_2O_5 27 kg /ha (table 7). But the highest return was obtained from the control treatment showing that using fertilizer at Melkassa depends on the amount and distribution of rainfall.

Table 1: Some chemical and physical characteristics of the composite soil sample at Melkassa and Wolenchiti

Soil Characteristics	*Locations*	
	Melkassa	*Wolenchiti*
pH (1:1)	7.8	7.7
EC (dS/m)	1.3	1.3
O.M (%)	1.21	1.20
$CaCO_3$ (%)	11.2	12.3
N (%)	0.179	0.180
NO_3 (ppm)	106	107
Soil Texture	Sandy loam	Silt loam
Bulk Density (gm/cm ^{3})	1.30	1.33

Table 2: Bean grain yield and other agronomic parameters as affected by different level of nitrogen application and land preparation techniques at Wolenchiti, 2005.

Treatments	P_2O_5 and N respectively (kg/ha)	Biomass weight (Kg/ha)	Number of pods / 5 plants	Pods weight (gm / 5 plants)	Grain yield (Kg/ha)	Seed size (1000 s.w)
Flat	0 ,0	2807	57.00	46.70	786	142.4
	23, 9	3228	56.33	50.40	941	139.1
	46, 18	5532	94.67	90.47	1066	145.0
	69, 27	4607	74.67	71.93	1024	147.2
	92, 36	5025	80.33	71.87	1207	150.2
Tied-Ridge	0 ,0	3765	69.33	61.87	854	145.2
	23, 9	5132	86.67	78.60	1057	153.3
	46, 18	5089	86.33	81.23	1017	151.9
	69, 27	6125	109.33	94.83	1133	145.4
	92, 36	5384	88.33	79.10	874	149.6
Land preparation (A)		NS	NS	NS	NS	NS
Fertilizer rate (B)		0	NS	NS	0	NS
AB		NS	NS	NS	NS	NS
CV (%)		25.19	23.96	27.46	13.96	5.2
LSD		40.71	-	-	231	-

Starter Dose = 20 kg/ha UREA * = Significant at 0.05 % NS=Non-Significant at 0.05 %

Table 3: Bean grain yield and other agronomic parameters as affected by different level of nitrogen application and land preparation techniques at Wolenchiti, 2006

Land preparation	P_2O_5 and N respectively (kg/ha)	Biomass Weight (kg/ha)	Number of pods/5 plants	Pods weight (gm)/5 plants	Grain yield (Kg/ha)	Seed size (1000s.w)
Flat	0 ,0	1672	31.67	26.63	520	142.9
	23, 9	2932	54.00	46.33	723	151.1
	46, 18	3517	64.00	54.17	859	148.8
	69, 27	4027	73.00	63.10	909	141.46
	92, 36	3440	59.33	50.40	605	146.3
Tied-Ridge	0 ,0	2620	56.33	42.97	674	136.3
	23, 9	2460	48.00	39.40	739	140.3
	46, 18	2504	47.67	39.23	669	148.8
	69, 27	3955	70.33	60.17	938	145.9
	92, 36	3619	65.33	53.03	801	158.5
Land preparation (A)		NS	NS	NS	NS	NS
Fertilizer (B)		0	0	0	NS	NS
AB		NS	NS	NS	NS	NS
CV (%)		24.67	25.56	26.70	26.55	5.86
LSD		26.26	25.20	21.98	-	-

Starter Dose = 20 kg/ha UREA * = Significant at 0.05 % NS=Non-Significant at 0.05 %

Table 4: Bean grain yield and other agronomic parameters as affected by different level of nitrogen application and land preparation techniques at Melkassa, 2005

Main plot	P_2O_5 and N respectively (kg/ha)	Plant height (cm)	Total biomass (Kg/ha)	Number of pods / 3 plant	Pods weight gm/3 plant	Number of seeds / pods	Grain yield kg/ha	1000 seeds weight (gm)
Flat	0 ,0	51.6	3958	77	52.7	5.7	1405	147
	23, 9	57.8	3820	75	67.6	5.7	1347	143
	46, 18	76.3	3820	96	87.5	6	1493	148
	69, 27	63.4	4097	74	65.6	6	1520	145
	92, 36	71.9	5000	84	89.5	5.7	1627	154
Tied ridges	0 ,0	46.4	2847	68	43	6.3	1126	140
	23, 9	53.1	3680	57	50.9	5	1413	145
	46, 18	53.9	3958	65	42.9	6	1464	134
	69, 27	57.7	3542	79	51.5	6.3	1337	136
	92, 36	63.7	4514	77	55	6	1449	145
Land preparation (A)		NS	NS	NS	NS	NS	0	0
Fertilizer rate (B)		0	0	NS	NS	NS	0	NS
AB		0	0	NS	NS	NS	0	0
CV (%)		14.38	15.9	27.7	27.69	6.6	14.56	5.47
LSD		14.83	1037	36.04	29.06	0.67	357.4	13.61

Starter Dose = 20 kg/ha UREA * = Significant at 0.05 % NS=Non-Significant at 0.05 %

Table 5: Bean grain yield and other agronomic parameters as affected by different level of nitrogen application and land preparation techniques at Melkassa, 2006

Land preparation	P_2O_5 and N respectively (kg/ha)	Biomass Weight (Kg/ha)	Number of pods/5 plants	Pods weight Gm/5 plants	Grain yield (Kg/ha)	Seed size (1000 s.w)
Flat	0 ,0	1412	51.67	25.30	322	158.1
	23, 9	1912	47.33	35.70	349	165.9
	46, 18	2209	36.33	39.33	412	170.8
	69, 27	2132	35.33	40.17	360	178.6
	92, 36	1699	36.67	31.26	371	179.3
Tied-Ridge	0 ,0	990	24.67	17.40	210	175.7
	23, 9	1330	37.67	22.80	255	181.6
	46, 18	1677	41.67	29.60	303	179.0
	69, 27	1382	39.67	23.23	240	183.4
	92,36	1795	35.33	32.00	328	187.2
Land preparation (A)		NS	NS	NS	NS	NS
Fertilizer (B)		0	NS	0	NS	NS
AB		NS	NS	NS	NS	NS
CV (%)		23.17	26.86	23.92	23.97	5.80
LSD		13.26		12.31		

Starter Dose = 20 kg/ha UREA * = Significant at 0.05 % NS=Non-Significant at 0.05 %

Table 6: Partial Budget Analysis On-farm Haricot Bean Fertilizer Trial at Wolenchiti

Activities	Flat planting					Tie ridge				
Treatments	T 1	T 2	T 3	T 4	T 5	T 1	T2	T3	T4	T5
Benefits										
Average Grain Yield (Qt/ha)	7.86	9.41	10.66	10.24	12.07	8.54	10.57	10.17	11.33	8.74
Gross Benefit – Grain (150 Birr/Qt)	1179	1411.5	1599	1536	1810.5	1281	1585.5	1525.5	1699.5	1311
Returns	1179	1411.5	1599	1536	1810.5	1281	1585.5	1525.5	1699.5	1311
Costs										
Ploughing 1st	150	150	150	150	150	150	150	150	150	150
Ploughing 2 nd	100	100	100	100	100	100	100	100	100	100
Seed	118	118	118	118	118	118	118	118	118	118
Planting and Fertilizer Application	80	80	80	80	80	80	80	80	80	80
Fertilizer DAP	0	125	250	275	500	0	125	250	375	500
Fertilizer UREA	50	50	50	50	50	50	50	50	50	50
Hand Weeding 1st	150	150	150	150	150	150	150	150	150	150
Hand Weeding 2nd	150	150	150	150	150	150	150	150	150	150
1Harvesting	180	180	180	180	180	180	180	180	180	180
Trashing	200	200	200	200	200	200	200	200	200	200
Transporting to Market	7.86	9.41	10.66	10.24	12.07	8.54	10.57	10.17	11.33	8.74
Total Cost	1185.9	1312.4	1438.7	1463.2	1690.1	1186.5	1313.6	1438.2	1564.3	1686.7
Net Benefit	-6.9	99.1	160.3	72.8	120.4	94.5	271.9	87.3	135.2	-375.7

Table 7: Partial Budget Analysis On-farm Haricot Bean Fertilizer Trial at Melkassa

Activities	Flat planting					Tie ridge				
Treatments	T 1	T 2	T 3	T 4	T 5	T 1	T2	T3	T4	T5
Benefits										
Average Grain Yield (Qt/ha)	14.05	13.47	14.93	15.20	16.27	11.26	14.13	14.64	13.37	14.49
Gross Benefit – Grain (150 Birr/Qt)	2107.5	2020.5	2239.5	2280	2440.5	1689	2119.5	2196	2005.5	2173.5
Returns	2107.5	2020.5	2239.5	2280	2440.5	1689	2119.5	2196	2005.5	2173.5
Costs										
Ploughing 1st	150	150	150	150	150	150	150	150	150	150
Ploughing 2nd	100	100	100	100	100	100	100	100	100	100
Seed	118	118	118	118	118	118	118	118	118	118
Planting and Fertilizer Application	80	80	80	80	80	80	80	80	80	80
Fertilizer DAP	0	125	250	275	500	0	125	250	375	500
Fertilizer UREA	50	50	50	50	50	50	50	50	50	50
Hand Weeding 1st	150	150	150	150	150	150	150	150	150	150
Hand Weeding 2nd	150	150	150	150	150	150	150	150	150	150
Harvesting	180	180	180	180	180	180	180	180	180	180
Trashing	200	200	200	200	200	200	200	200	200	200
Transporting to Market	7.86	9.41	10.66	10.24	12.07	8.54	10.57	10.17	11.33	8.74
Total Cost	1185.9	1312.4	1438.7	1463.2	1690.1	1186.5	1313.6	1438.2	1564.3	1686.7
Net Benefit	921.6	708.1	800.8	816.8	750.4	502.5	805.9	757.8	441.2	486.8

In conclusion, it is possible to get less response of crops to applied fertilizer in moisture stress areas like Wolinchiti and Melkassa. However, practices like tie-riging that can conserve soil moisture and increase moisture availability resulting better utilization of the applied fertilizer in good rainfall season and hence increased haricot bean yield. Therefore, at Wolinchiti, it is advisable to use tie ridging as a means of soil moisture conservation while applying fertilizer in the field of haricot bean. However, at Melkassa it is better to use fertilizer for haricot bean as recommended (67 kg/ha P_2O_5 27 kg /ha with 20 kg urea as a starter dose) and tie ridging when the amount of rain fall is optimum. Otherwise, it is not economical to use fertilizer around Melkassa under sever drought.

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References

1. Abuhay, T. and A. Teshale, 1995. Review of Tef Research in the Marginal Rainfall Areas of Ethiopia: Past and future Prospects. *In*: Proceeding of the 25th Anniversary of Nazareth Agricultural Research Center: 25 years of experience in lowland crops research, 20-23 September. Nazareth, Ethiopia.
2. Aleligne Kefyalew, 1990. Farm Surveys and On-farm Research in Haricot Bean in the Middle Rift Valley of Ethiopia. Procs. of National Workshop held in Addis Ababa, 1-3.
3. Asnakew Woldeab, 1991. Soil Fertility and Management in the Dry land. pp.70-81, In: Procs. of the First National Workshop on Dry land Farming System in Ethiopia. 26-28 November. Nazareth, Ethiopia.

4. Central Agricultural Census Commission (CACC), 2002. Ethiopian Agricultural Sample Enumeration, 2001/2002: Report on the primary results of area, production and yield of temporary crops (*Meher* season private peasant holding) part I. Addis Ababa.
5. Kidane Georgis, 1987. A Review of Haricot Bean Agronomy Research in the Semi-Arid Regions of Ethiopia. Procs. of National work shop held in Addis Ababa, l-3.
6. Tadele, G.S. and Germew Eticha, 1977. Haricot Bean Fertilizer Trial. pp: 87-88, In : IAR, Progress Report for 1981/82.
7. Tamirie Hawando, 1986. Increasing Agricultural Production in Ethiopia through improved soil-water and crop management practices . pp. 243-275. In: Towards a food and nutrition strategy for Ethiopia. Proceeding of the National workshop on food strategy for Ethiopia. AUA.
8. Tilahun Mulatu and Teshome Regassa, 1987. Nazareth Mixed Farming Zone Diagnostic Survey Report, Shoa Region. Research Report No. 2. Institute of Agricultural Research, Department of Agricultural Economics, Addis Ababa.
9. Tolessa, D., B. Tesfa, N. Wakene, w. Tenaw, L. Minale, M. Tewodros, M. Burtukan and M. Waga, 2001. A Review of Fertilizer Management Research on Maize in Ethiopia. Enhancing the Contribution of Maize to Food Security in Ethiopia. *In* Proceedings of the Second National Maize Workshop of Ethiopia, 12-16, Addis