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Research Article

Effect of Integrated Inorganic and Organic Fertilizers on Yield and Yield Components of Barley in Liben Jawi District

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Barley is an important food and beverage crop in the highlands of Ethiopia, although intensive cultivation and suboptimal fertilizer application have caused nutrient depletion and yield decline. With this in view, integrated inorganic and organic fertilizer sources on yield and yield components of barley were studied. Ten treatments involving the sole NP, vermicompost, conventional compost, and farmyard manure based on N equivalency were laid out in a randomized complete block design with three replications in 2015 and 2016 cropping seasons. Significantly higher grain yield and biomass yield of barley were obtained with the application of sole recommended NP and the integrated use of 50 : 50% vermicompost and conventional compost with recommended NP. Mean grain yield of 2567 and 2549 kg·ha^{-1} barley was obtained from application of 50 :50% conventional compost and vermicompost based on N equivalence with recommended NP fertilizer rate, which markedly reduce the cost of chemical NP fertilizer required for the production of barley. The economic analysis confirmed the profitability of the integrated use of 50 : 50% conventional compost and vermicompost with recommended NP fertilizer for barley production. Therefore, the integrated use of 50 : 50% conventional compost and vermicompost based on N equivalency with recommended NP fertilizer was recommended for sustainable barley production in Chelia district and similar agroecology.

1. Introduction

Barley (*Hordeum vulgare* L.) ranks fourth among cereals in the world and is grown annually on 48 million hectares in a wide range of environments [1]. Ethiopia, the second largest barley producer in Africa, accounts for about 25 percent of the total production in the country [2]. CSA [3] reported that barley is the fifth most important cereal crop after teff, wheat, maize, and sorghum in total production in the country. The majority of barley production is food barley with its share estimated to be 90 percent compared with malt barley [4]. However, the national and regional yield of barley has remained below 1.3 t·ha^{-1} [3], whereas the potential yield goes up to 6 t·ha^{-1} at experimental plots [5]. This lower yield of food barley is attributed to lack of improved varieties and poor soil fertility management [6]. Soil fertility is the most limiting factor for barley production in the highlands of Ethiopia [7, 8]. Furthermore, in Ethiopia, low productivity of barley is due to low soil fertility and poor agronomic practices [9]. Tolera et al. [10] reported that low productivity of barley is mainly due to traditional methods of production and poor soil fertility. The recommended fertilizer rate for barley production in the central highlands of Ethiopia, in the form of di-ammonium phosphate, is mainly at rates of 9/10 to 18/20 kg·N/P ha^{-1}, which are suboptimal rates for barley production [11]. Woldeyesus et al. [8] reported that the application of P fertilizer increases N use efficiency and thus mines soil N when N is in short supply. However, chemical fertilizer usage by the resource-poor subsistence farmers in Ethiopia is insignificant and inadequate [12]. However, Getachew et al. [13] reported that continuous applications of inorganic fertilizers alone resulted in deterioration of soil health in terms of physical, chemical, and biological properties of the soil. Organic fertilizer application has been reported to improve crop growth by supplying plant nutrients including micronutrients as well as improving physical, chemical, and biological properties of the soil, thereby providing a better environment for root development by improving the soil structure [14].

Thus, the application of inorganic or organic fertilizers alone did not bring a sustainable increase in yields [15]. MoA [16] reported that research efforts on how to use farmyard manure (FYM) together with low rates of mineral fertilizers could be one alternative solution for sustainable fertility management for barley production. Likewise, Shata et al. [17] suggested that by the use of mixed chemical and organic fertilizers not only production can be kept at optimum level, but also the amount of chemical fertilizers to be used can be reduced, which had negative impacts on cost production and environments. Abay and Tesfaye [18] found higher barley biomass yield of 8259 and 8065 kg·ha^{-1}, and other agronomic parameters at Adiyo and Ghimbo were obtained with the application of 5 t·ha^{-1} FYM in combination with 75% inorganic NP.

Limited agronomic studies in line to integrated nutrient use call to conduct research on integrated nutrient management practices and recommend best practices in order to maximize yield potential of crops such as barley [11]. Integrated use of organic and mineral fertilizers for tackling soil fertility depletion and sustainably increasing crop yields had a paramount importance [9, 13, 19]. Many research findings have shown that neither inorganic fertilizers nor organic sources alone can result in sustainable productivity [20]. Integrated soil fertility management involving the judicious use of combinations of organic and inorganic resources is a feasible approach to overcome soil fertility constraints and contribute high crop productivity in agriculture [21]. Hence, no information is available on the yield potential of improved variety with integrated nutrient management practice in ultisols of Ambo. The integrated use of chemical and organic fertilizer rate is needed to investigate in order to utilize the potential yield of improved barley variety in the area. Therefore, the objective was to determine the effect of different integrated organic and inorganic fertilizers on grain yield and yield components of barley in ultisols of Chelia districts.

2. Materials and Methods

The experiment was conducted in humid highland agroecosystems of western Oromia National Regional State, western Ethiopia. It was executed on farmers' field around Toke Kutaye in 2015 and 2016 cropping seasons. It lies between 8°9′80″N N latitude and 37°71′E longitude and at an altitude ranged from 2273 meter above sea level, receiving mean annual rainfall of 1040 mm with unimodal distribution [22]. It has a medium cool subhumid climate with the mean minimum, mean maximum, and average air temperatures of 8.9, 27.4, and 18.1°C, respectively [22]. The soil type is brown clay loam ultisols [23].

The experiment was laid out in a randomized complete block design with three replications, and the plot size was 4 m × 3 m. Ten rates of sole and integrated organic and inorganic fertilizer (T1: recommended NP (64/46 kg·NP ha^{-1}), T2: conventional compost (based on N equivalency of recommended. N), T3: farmyard manure based on N equivalency of recommended N, T4: vermicompost based on N equivalency of recommended N, T5: vermicompost (50% of treatment 4) + conventional compost (50% of treatment 2), T6: vermicompost (50% of treatment 4) + FYM (50% of treatment 3), T7: vermicompost (1/3 t/ha) + conventional compost (1/3 t/ha) + FYM (1/3 recommended), T8: vermicompost (50% of treatment 4) + 50% recommended NP, T9: conventional compost (50% of treatment 2) + 50% recommended NP, and T10: FYM (50% of treatment 3) + 50% recommended NP)) were used for HB-43 barley variety. Sole and integrated inorganic and organic fertilizer rates were applied at planting. All other agronomic management practices (ploughing four times with oxen, time of sowing (early July), seed rate (150 kg·ha^{-1}), and two times hand weeding) were applied as per recommendation for the barley production. Different agronomic parameters such as plant height was measured in cm from five plants sampled randomly from the central rows using graduated meter one week before harvesting and summed and divided by the number of plants to get the height of each plant, spike length was measured in (cm) from five plants' spikes sampled randomly from the central rows at harvesting using graduated meter, summed and divided by the number of plants' spikes to get the length of each spike, total number of tillers plant^{-1} was counted from ten plants sampled randomly from the central rows at harvesting, summed and averaged to obtain the number of tillers plant^{-1}, dry biomass yield was weighed from above ground harvested plants per plot and converted to dry biomass per hectare in kilogram, grain yield was taken by threshing the harvested plants per plots, and grain yield per plot was weighted and converted to yield in kg·ha^{-1} adjusted to 10% moisture, thousand seed weight was taken by counting 1000 seed number from the bulk of trashed grain weight at 10% moisture level and weighed using a sensitive balance expressed in gram, and harvest index was computed as a ratio of grain yield to dry biomass yield ∗ 100 and expressed in % of barley were collected. The collected data were computerized and analyzed using SAS computer software [24]. Mean separation was done using least significance difference (LSD) at 5% probability level [25].

Economic analysis such as partial budget, value to cost ratio, and marginal rate of return for barley grain yield was valued at an average open market price of EB 1200 per 100 kg for the last 5 years. Labour cost for field operation was EB 28 per man-day. The yield was adjusted down by 10% to reflect actual production conditions [26]. The cost of fertilizers (urea and DAP) was EB 1090 and 1390 per 100 kg with current market price. The cost of farmyard manure, conventional compost, and vermicompost was estimated by considering preparation, application, and its price costs 20, 40, and 30 EB·kh^{-1}.

3. Results and Discussion

3.1. Plant Height, Spike Length, and Total Number of Tillers Plant^{-1} of Barley. The mean plant height, spike length, and total number of tillers plant^{-1} of barley are indicated in Table 1. Mean plant height of barley was significantly ($P < 0.05$) affected by the sole and integrated use of inorganic and inorganic fertilizer application. Significantly taller (104 cm) mean plant height of barley was obtained from the

Table 1: Effects of the integrated use of organic and inorganic fertilizers on plant height, spike length, and total number of tillers plant^{-1} of barley in 2015-2016 cropping seasons on smallholder farmers' fields in Chelia district.

Treatments	Plant height (cm)			Spike length (cm)			Total tillers plant^{-1}		
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean
Recommended NP	108	100	104	7	7	7	5	5	5
Conventional compost (N equivalency)	101	91	96	7	7	7	5	5	5
Farmyard manure (N equivalency)	100	71	86	7	6	6	4	4	4
Vermicompost (N equivalency)	105	82	93	7	6	6	5	5	5
50 : 50% vermicompost : conventional compost	105	86	95	7	6	7	5	5	5
50 : 50% vermicompost : farmyard manure	104	71	87	7	6	6	5	5	5
33 : 33 : 33% vermicompost : conventional compost : farmyard manure	102	81	92	7	6	7	5	5	5
50 : 50% vermicompost : recommended NP	104	93	99	6	6	6	5	5	5
50 : 50% conventional compost : recommended NP	107	92	100	6	7	7	5	5	5
50 : 50% farmyard manure : recommended NP	106	78	92	7	6	7	5	5	5
LSD (%)	6.714	10.16	7.53	NS	1.03	0.64	0.971	0.923	0.57
CV (%)	3.75	7.01	6.87	7.91	9.35	8.39	11.33	11.35	9.92

NS = nonsignificant difference at 5% probability level; numbers followed by same letter in the same column are not significantly different at 5% probability level.

application of recommended NP fertilizer followed by 50 : 50% vermicompost and conventional compost with NP fertilizer (Table 1). Similarly, Woubshet et al. [27] found significantly higher plant height of barley with the integrated application of lime, balanced fertilizer, and compost in Wolmera district. Correspondingly, Mitiku et al. [28] found a significant effect of combined application of organic and inorganic fertilizers on plant height barley at Adiyo and Ghimbo with the application of 5 t·ha^{-1} farmyard manure + 75% of recommended NP and 5 t·ha^{-1} vermicompost and 75% of recommended NP. Likewise, Getachew [29] reported that the use of organic manures in combination with mineral fertilizers maximized the plant height of barley. Similar result was reported by Ofosu and Leitch [30] and Amanuliah and Maimoona [31]. Mean plant height performance of barley varied across years with higher in 2015 cropping season (Table 1), indicating variations in environmental factors (rainfall and temperature) and soil fertility status across smallholder farmers' fields. Similarly, Kassu et al. [32] found cropping season significantly affected most of the measured variables of malt barley. The mean spike length and total number of tillers plant^{-1} of barley were significantly ($P < 0.05$) affected by the sole and integrated use of NP and organic fertilizer sources (Table 1). Higher spike length of barley was obtained from the application of sole NP and 50 : 50% NP fertilizer with organic fertilizer sources. Similar result was reported by Kumar [33] and Shantveerayya et al. [34].

Significantly higher total number of tillers plant^{-1} of barley was obtained from the application of sole NP and 50 : 50% NP fertilizer with organic fertilizer sources. This indicates the easy availability of nutrients from inorganic fertilizers as compared to the gradually release of nutrients from organic fertilizer sources. Getachew et al. [35] found that the integrated application of organic with N fertilizer rate significantly improved productive tillers of barley at Holetta and Robgebeya. Likewise, the application of 5 t·ha^{-1} FYM combined with 75% inorganic NP gave the highest number of productive tiller m^{-2} (227 and 215) [28]. Kumar [33] reported that the number of total tillers plant^{-1} was significantly increased with the application of nitrogen fertilizer. The result was in agreement with the findings of Prystupa et al. [36], Iqtidar et al. [37], Sepat et al. [38], Tariku [39], and Kassu et al. [32] in malt barley.

3.2. Grain Yield and Thousand Seed Weight of Barley. The mean grain yield and thousand seed weight of barley are indicated in Table 2. Mean grain yield of barley was significantly ($P < 0.05$) affected by the integrated use of NP fertilizer and organic fertilizer sources in 2016 and combined mean (Table 2). Significantly higher mean grain yield of barley was obtained with application 50 : 50% vermicompost and conventional compost with recommended NP fertilizer followed by conventional compost and NP fertilizer indicating better contribution of integrating NP fertilizer with organic fertilizer sources. Similarly, Mitiku et al. [28] reported that the application of inorganic fertilizers (NP or NPK) with FYM gave a better yield of barley than the application of 100% inorganic fertilizers alone. Correspondingly, grain yield of malting barley was significantly increased by the combined application of organic and mineral nutrients [32]. Likewise, Assefa [40] and Getachew et al. [35] also reported similar results on barley. The application of organic fertilizer with inorganic fertilizer could directly increase yield, improve soil fertility status, and reduce the cost production. The improved yields of barley due to combined application of organic and mineral amendments resulted from positive changes to the soil, including increased soil pH, available P and total N, and possibly other macronutrients and micronutrients [32, 35]. Likewise, the combined application of inorganic and organic fertilizers was widely recognized as a way of increasing yield [41]. Higher yields were obtained with the application of compost or compost + biochar, and the highest yields were achieved in combination with moderate rates of applied N [35]. Integrated use of organic and inorganic fertilizer is economizing the input cost for barley production. The chemical fertilizer required to achieve optimum yield levels can be decreased with the application of organic fertilizers [42]. Besides, yield increase, environmental benefits, soil quality, and quality food test with the application of organic fertilizer were higher in different crops. Significant improvement in

Table 2: Effects of the integrated use of organic and inorganic fertilizers on grain yield and thousand seed weight of barley in 2015-2016 cropping seasons on smallholder farmers' fields in Chelia district.

Treatments	Grain yield (kg·ha^{-1})			Thousand seed weight (g)		
	2015	2016	Mean	2015	2016	Mean
Recommended NP	3396	1566	2481	45.24	45.23	45.24
Conventional compost (N equivalency)	3502	1563	2533	45.62	45.60	45.61
Farmyard manure (N equivalency)	3276	571	1924	42.89	42.87	42.88
Vermicompost (N equivalency)	3405	1007	2206	45.85	45.83	45.84
50 : 50% vermicompost : conventional compost	3394	1086	2240	45.38	45.37	45.38
50 : 50% vermicompost : farmyard manure	3339	666	2003	43.32	43.3	43.31
33 : 33 : 33% vermicompost : conventional compost : farmyard manure	3377	859	2118	42.62	42.6	42.61
50 : 50% vermicompost : recommended NP	3547	1551	2549	43.99	43.97	43.98
50 : 50% conventional compost : recommended NP	3630	1504	2567	43.86	43.87	43.87
50 : 50% farmyard manure : recommended NP	3372	1178	2275	42.46	42.47	42.47
LSD (%)	NS	524	382.68	NS	NS	2.409
CV (%)	9.77	26.46	14.39	5.28	5.37	4.7

NS = nonsignificant difference at 5% probability level.

the quality characteristics of the soil amended with biochar, compost and compost + biochar while the growth and yield components of barley supplemented with organic amendments and lower N fertilizer rates showing the enhanced synergistic effects of mixed treatments [35]. The second higher grain yield of barley with reduced rate of inorganic fertilizer might be due to improved nutrient use efficiency and stimulated barley growth by organic fertilizer sources, which is in agreement with the results of several findings [35, 43–45]. Therefore, the integrated use of inorganic and organic fertilizer sources has improved yield and other soil and environmental benefits, which enhance sustainable production barley.

Combined mean over years of thousand seed weight of barley was significantly ($P < 0.05$) affected with the integrated use of NP fertilizer and organic fertilizer sources (Table 2). Similarly, Abay and Tesfaye [18] reported that higher thousand grain weights (45 g and 44 g) at Ghimbo and Adiyo were obtained with the application of 5 t·ha^{-1} FYM in combination with 25% recommended rate of inorganic NP and 5 t·ha^{-1} FYM in combination with 75% recommended rate of inorganic NP, and the lowest thousand grain weights were recorded from the control plots for both locations. Likewise, Saidu et al. [46] reported higher 1000 grain weight, from the application of 5 t·ha^{-1} FYM in combination with 50% inorganic NP while the lowest from no fertilizer application. Getachew et al. [35] also found that amendment of organic with N fertilizer rate interaction significantly improved thousand grain weight barley at Robgebeya.

3.3. Biomass Yield and Harvest Index of Barley. The mean biomass yield and harvest index of barley are indicated in Table 3. Mean biomass yield of barley was significantly ($P < 0.05$) affected by sole and integrated use of NP fertilizer and organic fertilizer sources. Likewise, Kassu et al. [32] reported that the total above-ground biomass of malting barley was significantly ($P < 0.001$) increased by the combined application of organic and mineral nutrients. Significantly higher mean biomass yield of barley was obtained from the sole application of NP fertilizer followed by 50 :50% vermicompost and conventional compost with NP fertilizer rates. Likewise, higher biomass (11,514 kg·ha^{-1}) yields of malting barley were obtained from the application of recommended rate of NP (36–20 kg·NP ha^{-1}) from mineral sources (DAP and urea) [32]. Similarly, the application of 5 t·ha^{-1} FYM in combination with 75% inorganic NP gave the higher biomass yield of 8259 and 8065 kg·ha^{-1} at Adiyo and Ghimbo [18]. Getachew et al. [35] also found that the interaction of organic amendment by N fertilizer rate significantly improved biomass yield barley at Holetta and Robgebeya. This revealed the easy release of nutrients from NP fertilizer as compared to organic fertilizer sources. Integrated soil fertility management involving the judicious use of combinations of organic and inorganic resources is a feasible approach to overcome soil fertility constraints and contribute high crop productivity in agriculture [21]. Yearly performance variation of biomass yield was obtained between the two cropping seasons, which might be due to the environmental variation and soil fertility status of the two farms since different farm fields were used in two cropping seasons. The result was in agreement with Kassu et al. [32].

The mean harvest index of barley was significantly ($P < 0.05$) affected with the integrated use of NP fertilizer and organic fertilizer sources. The mean harvest index of barley was ranged from 39 to 48% (Table 3). Significantly higher mean harvest index of barley was obtained from 50 : 50% vermicompost with conventional compost followed by conventional compost application. Similar result was found by Chakrawarty [28, 39, 47]. Likewise, Woubshet et al. [27] reported that harvest indices of barley ranged from 37 to 47% and showed significantly an increasing trend with increased combination of applied lime, organic and blended inorganic fertilizers in acid affected soil of Wolmera district. This might be due to increase of nutrient efficiency and supplying different available nutrients which more partitioned to grain when organic fertilizer sources are applied. Similarly, Woubshet et al. [27] stated that the application of lime with increased rate of compost and inorganic fertilizers might have increased the efficiency of barley to partition the dry matter to the seed.

Table 3: Effects of the integrated use of organic and inorganic fertilizers on dry biomass yield and harvest index of barley in 2015-2016 cropping seasons on smallholder farmers' fields in Chelia district.

Treatments	Biomass yield (kg·ha^{-1})			Harvest index (%)		
	2015	2016	Mean	2015	2016	Mean
Recommended NP	7967	4330	6148	42.68	35.56	39.12
Conventional compost (N equivalency)	7500	3833	5667	46.70	41.15	43.93
Farmyard manure (N equivalency)	7158	1526	4342	45.66	37.12	41.39
Vermicompost (N equivalency)	7458	2504	4981	45.62	40.42	43.02
50 : 50% vermicompost : conventional compost	7167	2230	4698	47.43	49.59	48.51
50 : 50% vermicompost : farmyard manure	7392	1670	4531	45.21	39.82	42.52
33 : 33 : 33% vermicompost : conventional compost : farmyard manure	7292	2126	4709	46.25	39.84	43.05
50 : 50% vermicompost : recommended NP	7817	3807	5812	45.41	40.79	43.10
50 : 50% conventional compost : recommended NP	7967	3804	5885	45.50	39.56	42.53
50 : 50% farmyard manure : recommended NP	7300	2985	5143	46.14	38.70	42.42
LSD (%)	NS	1191	845	2.831	6.2856	3.41
CV (%)	8.49	24.09	14.01	3.61	9.1	6.84

NS = nonsignificant difference at 5% probability level.

Table 4: Effects of the integrated use of organic and inorganic NP fertilizers on economic profitability of barley production on smallholder farmers' fields in Chelia district.

Treatments	Items						
	Grain yield (kg·ha^{-1})	Adjusted grain yield (kg·ha^{-1})	Gross field benefit (EB·ha^{-1})	TCV (EB·ha^{-1})	Net benefit (EB·ha^{-1})	Value to cost ratio	MRR (%)
Farmyard manure (N equivalency)	1924	1732	20779	1000	19779	19.78	
50 : 50% VC : FYM	2003	1803	21632	1350	20282	15.02	144
33 : 33 : 33 t·VC : CC : FYM ha^{-1}	2118	1906	22874	1583	21291	13.45	433
50 : 50% FYM : RNP	2275	2048	24570	1740	22830	13.12	980
Vermicompost (N equivalency)	2206	1985	23825	1750	22075^{D}	12.61	
50 : 50% VC : CC	2240	2016	24192	1875	22317^{D}	11.90	
Conventional compost (N equivalency)	2533	2280	27356	2000	25356	12.68	972
50 : 50% VC : RNP	2549	2294	27529	2115	25414	12.02	50
50 : 50% CC : RNP	2567	2310	27724	2240	25484	11.38	56
Recommended NP	2481	2233	26795	2480	24315^{D}	9.80	

D = dominated; adjusted grain yield = the grain yield barley was adjusted downwards to 10% to reflect the difference between the experimental plot yield and the yield farmers; TVC = total variable cost; MRR = marginal rate of return; barley grain price = 12 EB·kg^{-1}; NP = 14 EB·kg^{-1}; DAP = 13.9 EB·kg^{-1}; urea price = 10.90 EB·kg^{-1}; vermicompost price = 250 EB·t^{-1}; farmyard manure price = 300 EB·t^{-1}; conventional compost = 350 EB·ha^{-1}; labour cost = 28 EB·day^{-1}; VC = vermicompost; CC = conventional compost; RNP = recommended NP (100/100 kg·urea/DAP·ha^{-1}); FYM = farmyard manure; 1US$ = 27.57 EB.

3.4. Integrated Use of NP Fertilizer and Organic Fertilizer Sources on Economic Profitability of Barley Production. The value to cost ratio for NP fertilizer and organic fertilizer sources was 9.80 to 19.78 EB per unit of investment (Table 4). Correspondingly, the application of 1 : 1 compost : mineral fertilizer could enable farmers to earn a return of US$7.57 for every US$1.0 investment, which implied high profitability of malt barley due to integration of the locally available organic materials with mineral fertilizers [32]. Barley production with application of 50 : 50% conventional compost with NP fertilizer gave net profit advantage of 25,484 EB with marginal rate return of 56% followed by 50 : 50% vermicompost with NP fertilizer, and conventional compost gave net benefit of 25,414 and 25,356 EB·ha^{-1} with marginal rate return of 50 and 972% (Table 4). Tariku [39] reported that the highest net benefit of EB 58553 ha^{-1} and marginal rate of return 36.45% of barley was obtained from the application of 66.6 : 33.4% NPS : FYM followed by EB 57781 ha^{-1} and marginal rate of return 2153% of barley gained from the application of 100% NPS (Table 4). Similarly, Mitiku et al. [28] also reported that the application of 5 t·ha^{-1} FYM + 75% inorganic NP gave the highest net return with 15,859 EB·ha^{-1} at Adiyo and 13,108 EB·ha^{-1} at Ghimbo. Likewise, Woubshet et al. [27] reported that the application of lime integrated with compost and blended fertilizer (NPSB) indicated the highest net return of EB 30633 with highest marginal rate return of 667% with values to cost ratio of EB 5.49 profit per unit investment for barley production in Wolmera district. The highest marginal rate of return of 980% was obtained with the application of 50 : 50% farmyard manure: with recommended NP for barley production (Table 4). The economic analyses confirmed that barley production with the application of 50 : 50% conventional compost with NP fertilizer or 50 : 50% vermicompost with NP fertilizer was profitable for Chelia highlands.

4. Conclusion

The integrated use of inorganic NP with organic fertilizer sources significantly improved yield and yield components

of barley. Yield and yield components of barley were significantly influenced by cropping seasons indicating variation of climatic factors across different seasons, which may have been the results of temperature and rainfall distribution occurred during growing season. Significantly higher grain yield of barley was obtained from integration of 50 : 50% vermicompost and conventional compost based on N equivalence with recommended NP fertilizer application. The application of 50 : 50% conventional compost with NP fertilizer gave net profit advantage of 25,484 EB with marginal rate return of 56% followed by 50 : 50% vermicompost with NP fertilizer and conventional compost gave net benefit of 25,414 and 25,356 EB·ha^{-1} with marginal rate return of 50 and 972%. Therefore, the application of 50 : 50% conventional compost and vermicompost based on N equivalence with recommended NP fertilizer rate was recommended for optimum grain yield and economical profitable barley production in Chelia district, West Showa, Ethiopia.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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