Asian Journal of Advances in Agricultural Research

Volume 24, Issue 4, Page 16-26, 2024; Article no.AJAAR.114893
ISSN: 2456-8864

Field and Economic Evaluation of Barley Productivity as Affected by Seed Rates and Slow-release Nitrogen Fertilizer Levels under Rainfed Conditions

Sally E. El-Wakeel [a], Mohamed Mansour [a*], Ashgan M. Abd El-Azeem [a], Sahar A. Ebrahim [b] and Tahany Noreldin [c]

[a] *Barley Research Department, Field Crops Research Institute, Agricultural Research Center, Egypt.*
[b] *Central Laboratory for Design and Statistical Analysis Research, Agricultural Research Center, Egypt.*
[c] *Water Requirements and Field Irrigation Res. Dept, Soils, Water and Environment Res. Institute, Egypt.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAAR/2024/v24i4499

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/114893

Original Research Article

Received: 24/01/2024
Accepted: 27/03/2024
Published: 29/03/2024

ABSTRACT

A field experiment was conducted at the north western coast of Egypt under rainfed conditions to study the effects of seed rates (70, 95 and 120 kg ha^{-1}) and nitrogen fertilizer treatments (0, 35, 70 and 105 kg N ha^{-1}) of Ensiabeen-40% N as slow-release fertilizer compared with 105 kg N ha^{-1} as

**Corresponding author: Email: barley_breeder@yahoo.com;*

Ammonium nitrate (33.5%N) on productivity of barley cultivar Giza134. This investigation was conducted during 2019/2020 and 2020/2021 winter growing seasons. The treatments were laid out in a split plot design, with three replications. Plant height, spike length, number of grins spike^{-1}, number of spikes per m^2, 1000 grain weight, biological and grain yield were recorded. In addition, total income and net return (LE)/hactare were calculated. The results indicated that mean squares due to seasons, seed rates, nitrogen levels and their interactions were significant for most studied traits. Mean performance of the studied traits as affected by seasons, seed rates and nitrogen levels showed that, the most desirable values were obtained by SR_1 for spike length (6.13cm), number of grains spike^{-1} (48.78 grain) and 1000 grain weight (42.15g), from SR_2 for Biological yield (6.02 ton ha^{-1}) and grain yield (1.85 ton ha^{-1}) and from SR3 for plant height (78.28cm) and number of spikes m^{-2} (180.11 spike). For nitrogen level effects, N4 recorded the most favorable values for all studied traits; plant height (81.48cm), spike length (6.33cm), number of grains spike^{-1} (49.99 grain), number of spikes m^{-2} (187.60 spike), Biological yield (6.88 ton ha^{-1}), grain yield (2.12 ton ha^{-1}) and 1000 grain weight (42.89g). Grain yield exhibited highly significant and positive correlation with each of plant height (r= 0.833**), spike length(r=0.621**), number of grains spike^{-1} (r=0.768**), number of spikes m^{-2}(r=0.880**) and weight of 1000 grains (r= 0.661**). The most contributing variable in the total variation of grain yield were number of spikes m^{-2}, number of grains spike^{-1} and spike length. These variables contributed by 92.9% in the grain yield variation. The results also indicated that, the highest values in the total income were 19149 and 24990 pound.hec^{-1} respectively, and net return were 9492 and 15498 pound.hec^{-1} obtained from the interaction between seed rate of 5kg ha^{-1} (SR_2) and 105 unit of slow release fertilizer (N_4) during the two growing seasons. It could recommend this treatment to maximize the total income for the farmers in such location.

Keywords: Barley; seed rate; nitrogen levels; slow release; yield potential; economic evaluation; net return.

1. INTRODUCTION

Cereal crops included many important crops among of them barley (*Hordeum vulgare*). Based on production area, barley is the fifth among cereal crops, but in terms of yield per unit area, it is the third. The potential yield of the experimental evaluation increase significantly compared to the actual mean productivity [1]. Poor weed control, poor soil fertility, improper crop rotation, late sowing, and the use of unimproved local varieties all contribute to low productivity under rainfed conditions. Most farm animals use barley grains alone or in combinations with other feed ingredients. Due to its high content of amino acids, proteins, lysine, and fibers, barley has recently gained popularity as a food ingredient due to its high nutritional value as well as malt industry [2].

"In general, barley is grown under harch environments because of its conservative water use" [3]. "Under low rainfall environments. barley is more likely than wheat for forage as well as grain yield production. Barley is the best choice in the risky conditions especially in arctic or sub-arctic regions and in subtropical zones" [4]. The marginal rainfall area of the countries that have a typical Mediterranean climate such as Egypt is adapted to grow barley. Limited water supply in semi-arid areas causes soil water deficit and this is an important plant stress factor [5]. "Seed rate and fertilizers, particularly those containing nitrogen, are the major inputs affecting the yield and quality of barley" [6]. In spite of the hazard using of fertilization on barley under rainfed areas, application of nitrogen (N) is economical in most years [7,8]. In Egypt, barley productivity under rainfed conditions is very low, therefore, improving the recommended package of barley production under this condition such as seed rates and N fertilizer levels are very important for maximizing grain yield and total income of unit area of barley. So, this experiment was conducted.

Yield of barley is the integrated effect of many variables influencing plant growth during the season. Growth analysis and relative contribution studies perhaps help interpreting the results and may lead the plant breeders to get better cultivars and good evaluation for the agricultural practices.

Correlation is an important statistical approach that used to facilitate strategies for high yield. It is also used to examine the direct and in direct contribution of the yield components.

Procedure of stepwise multiple linear regression aims to construct a regression equation including the variable accenting for the majority of the total yield variability. Kole [9], Zaefizadeh [10] and AbdEL-Mohsen [11] used correlation and regression in barley.

The objective of the current research were to determine the most important variables and their relative contribution in the variation of barely yield.

2. MATERIALS AND METHODS

2.1 Treatment and Experimental Details

A field experiment was conducted at the North western coast of Egypt (marsa matroh government) under rainfed conditions during 2019/2020 and 2020/2021 winter growing season. The treatments were comprised of two factors: three seed rates (SR1= 70, SR2= 95 and SR3= 120 kg ha^{-1}) and five nitrogen fertilizer treatments (N1= 0, N2= 35, N3= 70, N4= 105unit (kg) ha^{-1} of Ensiabeen-40% N as slow-release fertilizer and N5=105 unit(kg) ha^{-1} of Ammonium nitrate 33.5%N). Nitrogen was applied as one dose during soil tillage. Barley cultivar Giza 134 was selected for this experiment.

The treatments were arranged in a split plot design, with three replications. The main plots were assigned to seed rates, while the sub plots were allocated to nitrogen levels. Grains were hand drilled. Each genotype was sown in 10 rows ,2.5m long, spaced with 20 cm among rows, the Plot size was $5m^2$.

2.2 Soil Sampling and Analysis

Before planting soil samples were randomly taken from the experimental site at a depth of 30 cm using an auger and the samples were mixed thoroughly to produce one representative composite sample. Physical and chemical soil properties were measured in the soil samples as revealed in Table 1.

The data of temperature, relative humidity (%) and Rainfall during the two growing seasons are given in Table 2. The temperature at Marsa Matruh site during the two growing seasons ranged from 11 to 24. Marsa Matruh received 184.2 and 210.9 mm of rainfall in the first and second seasons, respectively. Increasing the rainfull rate in the second season led to an increase in the averages of the studied traits compared to the first season.

2.3 Data Collection

The data for Plant height, spike length, number of grains $spikes^{-1}$, number of spikes m^{-2}, 1000-grain weight, biological and grain yield were recorded.

Table 1. Physical and chemical soil analysis at the experimental site during 2019/2020 and 2020/2021 growing seasons

	2019/2020 season	2020-2021 season
EC	0,52	0.20
PH	8.38	8.8
Sand %	89	94
Caco3 %	25%	18%
N	19 ppm	15 ppm
P	7 ppm	5 ppm
K	120 ppm	140 ppm

Table 2. Maximum and minimum temperature, relative humidity (%) and Rainfall during the two growing seasons at Marsa Matruh location

Month	Temperature				Relative humidity (%)		Rain-fed (mm)	
	2019/2020		2020/2021		2019/2020	2020/2021	2019/2020	2020/2021
	Max	Min	Max	Min				
Nov	24	18	21	17	67	63	10.3	9.6
Dec	19	15	19	14	61	65	24.2	25.3
Jan	15	11	18	13	62	67	88.6	104.6
Feb	17	12	17	12	63	68	20.6	36.8
Mar	19	13	18	13	60	64	39.6	34
Apr	21	14	22	15	55	64	0.9	0.6

2.4 Statistical Analysis

The data collected were statistically analyzed using ANOVA function of SAS program. After performing ANOVA the differences between the treatment means were compared by LSD test at 5% level of significance as outlined by Gomez and Gomez [12].

Simple correlation coefficients were calculated for various variables according to Steel and Torrie [13]. Stepwise regression analysis was used to determine the effective yield components as independent variables significantly contribute to the total variation in the grain yield as dependent variable.

Stepwise procedure develops a sequence of multiple regression equations in stepwise manner. One variable Is added to the regression model at each step.

The added variable I the one that cause the greatest reduction in the error sum of squares. It I also the variable that has the highest partial correlation with the dependent variable for fixed values of those variables already added, and is the variable that has the highest F value in regression analysis of variance.

Stepwise regression analysis was conducted as outlined by Draper and Smith [14].

2.5 Economic Evaluations

Total costs, Total income and net return were calculated for all treatment in Egyptian pounds (LE) using market prices of barley according to Ministry of Agriculture and Land Reclamation, Economic Affairs Sector Price Bulletin (2019/2020-2020/2021), Egypt. The barley prices were 6723 LE/ton and 6980 LE/ton of grains, 1356LE/ton and 1500 LE /ton of straw in first and second seasons, respectively.

Benefit cost ratio (b/c)= net return/cost according to Gad et al. [15] and Enas et al. [16].

3. RESULTS

3.1 Analysis of Variance

Results in Table 3 show the analysis of variance for the studied traits across the two growing seasons. Mean squares due to seed rates and nitrogen fertilization levels were highly significant ($P \leq 0.01$) for all the studied characters. Variances of seed rates and levels of nitrogen interaction were highly significant for all the characters.

3.2 Mean Performance

3.2.1 The effect of seed rates

Means of all studied traits across the seasons and seed rates performed in Table 4. Values that obtained from SR1 (70kg ha^{-1}) were the highest for spike length (5.85 and 6.41cm in first and second season respictivily), no. of grains $spike^{-1}$ (47.12 and 50.43 grain in first and second season respictivily) in both seasons and 1000 grain weight (40.23g) in the first season. Regarding, SR2 (95kg ha^{-1}) recorded desirable values for biological yield (6.58 ton/ha), grain yield (2.01 ton/ha) and 1000 grain weight (44.14g) in the second season SR3 (120kgha^{-1}) recorded the most favorable values for plant height (77.22 and 79.34cm in first and second season respictivily) and no of spikesm^{-2} (170.95 and 189.27 spike in first and second season respictivily) in both seasons, biological (5.65 ton/ha) and grain yield (1.72 ton/ha) in the first season.

3.2.2 Effect of nitrogen levels

The means of all studied traits over the two seasons as affected by nitrogen levels are shown in Table 5. The results emphasized that increasing nitrogen level led to increasing all studied traits compared to control treatment. N4 (105unit ha^{-1} of Ensiabeen-40% N) gave the maximum values for all traits in both seasons with values 79.94 and 83.41cm for plant hieght, 9.99 and 6.67cm for spike length, 47.97 and 52.01grain for number of grains/spike, 177.65 and 197.55 spike for number of spikes/m^2, 6.25 and 7.52ton for biological yield, 1.96 and 2.28ton for grain yield, 40.36 and 45.42g for 1000 grain weight in first and second season respictiviley.

3.3 Effect of Seed Rates and Nitrogen Levels Interaction

Mean performance of all the studied traits of the interaction among seasons, seed rates and nitrogen levels are shown in Table 6. Treatment Combinations of SR1 (70 kg ha^{-1}) with N4 (105 unit ha^{-1} of Ensiabeen-40% N) were the best for spike length (6.28 and 7.12cm in first and second season respictivily), no. of grains $spike^{-1}$ (49.70 and 54.72 grain in first and second season respictivily) and 1000 grain weight in both seasons (41.30 and 46.11g in first and second season respictivily). Concarning, SR2 (95kg ha^{-1}) with N4 (105 unit ha^{-1} of Ensiabeen-40% N) produce desirable results for biological yield in the second season (7.61 ton ha^{-1}) and grain yield in both seasons (1.99 and 2.38 ton ha^{-1} in first and second season respictivily) Regarding, SR3 (120kg ha^{-1}) with N4 (105unit ha^{-1} of Ensiabeen-40% N) exhibited the highest values for biological yield in the first season(6.30 ton ha^{-1}), plant height (83.11 and 85.43cm in first and second season respictivily) and no. of spikes m^{-2} (184.17 and 204.34 spike in first and second season respictivily) in the two seasons.

3.4 Correlation Analysis

The Results in Table 8 Showed that simple correlation coefficient amang grain yield and its components. The results revealed that the relationship between all possible pairs of the studied characters were highly significant. Grain yield of barley was highly significantly and positively correlated with each of pant height ($r=0.833^{**}$), spike length ($r=0.621^{**}$), number of grains/ spike ($r=0.768^{**}$), number of spikes/ m^2 ($r=0.880^{**}$) and weight of 1000 grains ($r=0.661^{**}$). The results showed clearly that the mentioned characters had great impact on the grain yield of barley. The results also cleared that highly significant and positive correlations were observed between the studied characters and each others (Table 7). These results are in agreement with those obtained by Kole [9,10], Abd El-Mohsen [11] and Sahar et al. [17].

3.5 Stepwise Regression Analysis

Data were subjected to the stepwise regression analysis to determine the most contributing variable in the total variability of barley grain yield and their relative importance. Table 8 show accepted variables and their relative contributions using stepwise regression analysis. The results indicated that number of spikes/m^2, number of grains/ spike and spike length were the most contributing variables in the total variability of grain yield of barley.

Intercept =-2.165

R^2 for studied variables $= 93.9\%$

R^2 for accepted variables $= 92.9\%$

R^2 for removed variables $= 0.0869\%$

$$\overline{R}^2 = 92.1\%$$

These variables were responsible for 92.9 % in the grain yield variation. The relative contribution of these variables in the grain yield variability were 77.4%,13.7% and 1.9%, respectively. The most important variable was number of spikes/m^2 followed by No. of grains/ spike and spike length.(Table 8) The best predication equation was:

$$\hat{Y}_t = -2.165 + 0.0101x_4^{**} + 0.061x_3^{**} - 0.117x_2^{**}$$

The results of stepwise regression analysis revealed that plant height and weight of 1000 grains were removed from the model bee of their, low relative contribution (1.00%).

3.6 Economic Evaluations

3.6.1 Total income

The results in Table 9 cleared that the highest values of total income being 19149 and 24990 LE ha^{-1} resulting from combination of seed rate of 95kg hec^{-1} (SR_2) and 105 unit of slow release fertilizer (N_4) during the two seasons,followed by combination of 120kg hec^{-1} (SR_3)of seed and 105 unit N ha^{-1} was in the second rank.19065 LE.ha $^{-1}$ and 22901 LE ha $^{-1}$ in both seasons respectively.

3.7 Totat Cost, Net Return and Benefit Cost Ratio (b/c)

The results in (Table 10) showed that the highest values of total cost of barley producing 9157 and 9492 LE. ha^{-1} as a result of combination between seed rate of 95kg ha^{-1} (SR2) and 105 unit of slow release fertilizer (N4) in both seasons. On the other hand the lowest cost were 5390 and 5999 LE.ha^{-1} resulting combination between seed rate of 70 kg ha^{-1} (SR1) and N1(control) fertilize in both seasons of the study .

Regarding the net return, the results in Table 10 show that (combination between seed rate 95kg ha^{-1} (SR2) and 105 unit of slow-release fertilizer (N4) were 9992 and 15498 LE.ha^{-1}, followed by 9549 LE.ha^{-1} under seed rate 120 kg ha^{1} (SR3) and 105 unit of slow-release fertilizer (N4) at the first season, in the 2nd season the followed net return by 15085 LE.ha^{-1}seed rate 95kg ha^{-1} (SR2) and 70 unit of slow-release fertilizer (N3).

Table 3. Analysis of variance for the studied traits across the two growing seasons

SOV	df	Plant height		Spike length (cm)		No. of grains/spike		No. of spikes/m^2		Biological yield (ton ha^{-1})		Grain yield (ton ha^{-1})		1000 grain weight(g)	
		S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
Reps	2	21.10**	30.6**	0.01	0.02	8.20**	10.51**	133.41**	211.2**	0.10**	0.21**	0.01*	0.11**	0.01	0.10
Seed Rates (SR)	2	608.5**	44.8**	1.21**	0.90**	42.0**	33.00**	2236.8**	3103.4**	1.30**	1.50**	0.10**	0.13**	5.8**	6.41**
Error a	4	0.70	0.37	0.01	0.001	0.22	0.04	1.73	8.68	0.002	0.01	0.001	0.001	0. 11	0. 22
Nitrogen levels (N)	4	280.3**	284**	1.01**	1.90**	37.0**	67.43**	2134.0**	2433.8**	4.62**	11.20**	0.52**	1.01**	7.40**	9.60**
SR x N	8	10.11**	19.7**	0.01**	0.01**	0.71**	1.81**	33.32**	54.00**	0.10**	0.20**	0.01**	0.01**	0.01**	0.51**
Error b	24	0.69	0.94	0.004	0.003	0.12	0.10	1.51	5.19	0.003	0.01	0.001	0.001	0.008	0.03
Total	44														

**, ** = significant at 0.05 and 0.01, probability levels, respectively*

Table 4. Mean performance of the studied traits as affected by season and seed rates

Seed Rates	Plant height (cm)		Spike length (cm)		No. of grains/spike		No. of spikes/m^2		Biological yield (ton ha^{-1})		Grain yield (ton ha^{-1})		1000 grain weight (g)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
SR1	66.62	72.79	5.85	6.41	47.12	50.43	147.08	161.73	5.08	6.00	1.55	1.82	40.23	44.06
SR2	72.37	76.09	5.56	6.06	45.36	48.37	163.51	182.68	5.46	6.58	1.69	2.01	39.06	44.14
SR3	77.22	79.34	5.30	5.93	43.78	47.56	170.95	189.27	5.65	6.27	1.72	1.85	38.03	43.07
LSD0.05	0.85	0.61	0.08	0.03	0.48	0.20	1.33	2.99	0.04	0.10	0.03	0.04	0.05	0.14
LSD0.01	1.41	1.02	0.13	0.06	0.80	0.33	2.21	4.95	0.07	0.17	0.06	0.06	0.09	0.24

SR1=70kg ha^{-1},SR2= 95 kg ha^{-1}and SR3= 120 kg ha^{-1}

Table 5. Mean performance of the studied traits as affected by season (S) and nitrogen levels (N) interaction over the two seasons of 2019/2020 and 2020/2021

Nitrogen levels	Plant hieght (cm)		Spike length (cm)		No. of grains/spike		No. of spikes/m^2		Biological yield (ton ha^{-1})		Grain yield (ton ha^{-1})		1000 grain weight(g)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
N1	65.54	68.42	5.10	5.46	42.60	44.77	136.69	153.15	4.33	4.69	1.31	1.43	37.93	41.94
N2	72.41	75.09	5.55	6.09	45.28	48.54	158.76	174.45	5.24	5.85	1.60	1.79	38.61	43.13
N3	76.22	78.20	5.77	6.42	46.60	50.50	169.64	186.32	5.80	7.07	1.79	2.16	39.58	44.77
N4	79.94	83.41	5.99	6.67	47.97	52.01	177.65	197.55	6.25	7.52	1.96	2.28	40.36	45.42
N5	69.78	73.03	5.44	6.02	44.65	48.12	159.82	178.01	5.35	5.96	1.62	1.81	39.06	43.51
LSD0.05	0.81	0.94	0.06	0.05	0.34	0.31	1.19	2.22	0.05	0.09	0.02	0.04	0.09	0.16
LSD0.01	1.09	1.27	0.08	0.07	0.46	0.42	1.62	3.00	0.07	0.13	0.03	0.05	0.12	0.22

N1=control (zero), N2= 35 unit ha^{-1}, N3=70unit ha^{-1},N4=105 unit ha^{-1} of Ensiabeen (40% N) as slow-release fertilizer and N5= 105unit ha^{-1} of Ammonium nitrate (33.5%N)

Table 6. Mean performance of plant height, spike length and number of grains spike^{-1}, number of spikes plant^{-1} as affected by interactions among seasons, seed rates and nitrogen levels

Seed Rate	Nitrogen levels	Plant height		Spike length (cm)		No. of grains/spike		No. of spikes/m^2		Biological yield (ton ha^{-1})		Grain yield (ton ha^{-1})		1000 grain weight(g)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
SR1	**N1**	58.34	62.71	5.36	5.67	44.14	46.04	119.99	132.01	3.81	4.37	1.16	1.32	39.10	42.18
	N2	65.42	71.76	5.86	6.35	47.14	50.10	142.70	154.32	4.80	5.52	1.45	1.71	39.80	43.34
	N3	69.99	76.18	6.12	6.71	48.69	52.26	158.08	173.65	5.61	6.96	1.73	2.11	40.77	45.53
	N4	73.29	80.09	6.28	7.12	49.70	54.72	169.83	187.32	6.20	7.56	1.93	2.29	41.30	46.11
	N5	66.06	73.20	5.66	6.17	45.94	49.04	144.83	161.34	4.96	5.59	1.51	1.70	40.20	43.13
SR2	**N1**	63.50	70.17	5.09	5.46	42.51	44.74	142.10	161.08	4.57	4.98	1.37	1.56	37.91	42.38
	N2	72.68	75.47	5.52	6.07	45.10	48.40	162.19	179.68	5.27	6.09	1.62	1.88	38.53	43.72
	N3	75.52	79.05	5.75	6.37	46.50	50.22	171.01	189.32	5.76	7.61	1.81	2.31	39.56	44.92
	N4	81.10	83.05	6.08	6.56	48.46	51.34	178.97	200.99	6.25	7.82	1.99	2.38	40.33	45.53
	N5	69.06	72.73	5.37	5.86	44.22	47.16	163.26	182.35	5.45	6.39	1.65	1.92	38.97	44.15
SR3	**N1**	72.40	74.80	4.86	5.25	41.14	43.52	147.96	166.35	4.62	4.72	1.39	1.41	36.78	41.27
	N2	78.05	79.13	5.27	5.85	43.60	47.12	171.40	189.34	5.66	5.94	1.71	1.79	37.50	42.34
	N3	79.39	83.13	5.43	6.17	44.60	49.02	179.84	195.99	6.03	6.64	1.85	2.05	38.43	43.86
	N4	83.11	85.43	5.62	6.33	45.74	49.96	184.17	204.34	6.30	7.17	1.96	2.18	39.45	44.62
	N5	73.14	74.21	5.30	6.03	43.80	48.16	171.38	190.35	5.65	5.90	1.71	1.81	38.00	43.25
Mean		**72.07**	**76.07**	**5.57**	**6.13**	**45.42**	**48.79**	**160.51**	**177.90**	**5.40**	**6.22**	**1.66**	**1.89**	**39.11**	**43.75**
LSD 0.05		**1.40**	**1.63**	**0.10**	**0.09**	**0.59**	**0.54**	**2.07**	**3.84**	**0.09**	**0.16**	**0.04**	**0.06**	**0.15**	**0.28**
LSD 0.01		**1.90**	**2.20**	**0.13**	**0.12**	**0.80**	**0.73**	**2.80**	**5.20**	**0.13**	**0.22**	**0.06**	**0.08**	**0.21**	**0.38**

SR1=70kg ha^{-1},SR2= 95 kg ha^{-1}and SR3= 120 kg ha^{-1}. N1=control (zero), N2= 35 unit ha^{-1}, N3=70unit ha^{-1},N4=105 unit ha^{-1} of Ensiabeen (40% N) as slow-release fertilizer and N5= 105unit ha^{-1} of Ammonium nitrate (33.5%N)

Table 7. Simple correlation coefficients among grain yield/ hec of barley and its components (combined over 2019/2020 and 2020/2021 seasons)

Variables	Plant height	Spike length	No. of grains/ spike	No. of spikes/m^2	1000grain weight	Grain yield
Plant height	1					
Spike length	0.358**	1				
No. of grains/ spike	0.449**	0.830**	1			
No. of spikes/m^2	0.924**	0.515**	0.512**	1		
1000grain weight	0.391**	0.751**	0.857**	0.529**	1	
Grain yield	0.833**	0.621**	0.768**	0.880**	0.661**	1

*** = significant at 0.01y level of significance*

Table 8. Accepted variable explaining grain variation using stepwise regression analysis over the two seasons of 2019/2020 and 2020/2021

Accepted variables	Regression coefficient	Standard error	Calculated t	prob	Cumulative R^2%	Partial R^2%
Number of spikes/m²*(x4)*	0.010	0.001	11.141	0.000	*77.4%*	*77.4%*
No. of grains/ spike*(x3)*	0.061	0.009	6.545	0.000	91.0%	13.6%
Spike length(x2)	-0.117	0.045	2.625	0.014	92.9%	1.9%

Table 9. Economic evaluation barley yield as affected by interactions, among seed rates and nitrogen levels across seasons of 2019/2021 and 2020/2021

Seed Rate	Nitrogen levels	Income of grain (pound. $ha^{-1)}$)		Income of straw (pound. ha^{-1})		The total income (pound. ha^{-1})	
		1st season	2nd Season	1st season	2nd Season	1st season	2nd Season
SR1	**N1**	7795	9213	3593	4697	11389	13911
	N2	9744	11935	4542	5867.4	14287	178 30
	N3	11625	14727	5261	7469	16887	22197
	N4	12969	15984	5790	8115.8	18760	24100
	N5	10147	11866	4678	5990.6	14825	17857
SR2	**N1**	9206	10888	4339	5266.8	13546	16156
	N2	10886	13122	4949	6483.4	15836	19606
	N3	12163	16123	5356	8162	17519	24286
	N4	13372	16612	5776	8377.6	19149	24990
	N5	11088	13401	5152	6883.8	16241	20285
SR3	**N1**	9340	9841	4379	5097.4	13721	14939
	N2	11491	12494	5356	6391	16847	18885
	N3	12432	14309	5668	7068.6	18100	21378
	N4	13171	15216	5885	7684.6	19056	22901
	N5	11491	12633	5342	6298.6	16834	18932
Mean		11128	13224	5071	6656	16200	19882

SR1=70kg ha^{-1},SR2= 95 kg $ha^{-1}$and SR3= 120 kg ha^{-1}. N1=control (zero), N2= 35 unit ha^{-1}, N3=70unit ha^{-1}, N4=105 unit ha^{-1} of Ensiabeen (40% N) as slow-release fertilizer and N5= 105unit ha^{-1} of Ammonium nitrate (33.5%N)

Table 10. Economic evaluation of barley yield as affected by interactions, (total coast, Net return and benefit cost ratio) across seasons of 2019/2020 and 2020/2021

Seed Rate	Nitrogen levels	Total cost (pound.$ha^{-1)}$)		Net return (pound.$ha^{-1)}$)		Benefi- coast ratio	
		1st season	1st season	1st season	2nd season	1st season	2nd Season
SR1	**N1**	5390	5999	5999	7912	1.10	1.32
	N2	6729	7558	7558	10272	1.12	1.36
	N3	8068	8819	8819	13378	1.09	1.52
	N4	9407	9353	9353	14747	0.99	1.58
	N5	7232	7593	7593	10264	1.05	1.35
SR2	**N1**	6540	7906	6906	8250	1.05	1.04
	N2	6979	8857	8857	10749	1.11	1.21
	N3	8318	9201	9201	15085	1.2 1	1.61
	N4	9157	9492	9992	15498	1.08	1.63
	N5	7482	8759	8759	11526	1.17	1.32
SR3	**N1**	6890	7831	7831	7108	1.1	0.91
	N2	8229	9618	8618	9267	1.04	0.96
	N3	8968	9532	9132	11846	1.11	1.24
	N4	9507	9149	9549	13752	1.00	1.50
	N5	7732	9102	9102	9830	1.18	1.08
Mean		7775	8585	8484	11298	1.08	1.30

SR1=70kg ha^{-1},SR2= 95 kg $ha^{-1}$and SR3= 120 kg ha^{-1}. N1=control (zero), N2= 35 unit ha^{-1}, N3=70unit ha^{-1}, N4=105 unit ha^{-1} of Ensiabeen (40% N) as slow-release fertilizer and N5= 105unit ha^{-1} of Ammonium nitrate (33.5%N)

The results presented in Table 10 The benefit/cost ratio recorded the highest value of 1.21 under seed rate 95 kg.ha^{-1} (SR2) and 70 unit of slow release fertilizer (N3) At the first season, meanwhile The highest benefit/cost ratio1.63 was obtained in under seed rate 95kg ha^{-1} (SR2) and 105 unit of slow-release fertilizer (N4) at the second season.

Therefore, the results showed that the highest revenue and the highest net return came from the transaction seed rate 95 kg hec^{-1} (SR_2) and

105 unit of slow release fertilizer (N_4) at both seasons.

4. DISCUSSION

For seed rates: SR1 (70kg ha^{-1}) recorded the most desirable values for spike length, Number of grains $spike^{-1}$ and 1000 grain weight. Also, SR2 (95kg ha^{-1}) produced the highest values for biological and grain yield (ton/ha). Regarding, SR3 (120 kg ha^{-1}) recorded the most desirable values for plant heightand no of spikes per m^2. These results agreed with those obtained by Seadh et al. [18], who reported that “a slight increment in plant height was recorder due to increase in the seeding rate”. Bekele et al. [19] showed that “increment in barley seeding rate from 100-175 kg ha^{-1} decreased No. of grains $spike^{-1}$ by 28.2%, 1000-grain weight by 23.51%”. Haasan et al. [20] stated that “seed rate of 80 kg fed^{-1} appeared to produce the highest value in each of No. of spikes m^{-2} and grain yield fed^{-1}. while, the seed rate of 40 kg fed^{-1} recorded the highest value in each of No. of grains per spike, weight of grains $spike^{-1}$ and 1000 grain weight”. Rahi and Mihbis [21] showed that “the rate of seeds 80 kg ha-1 surpassed the characteristics of plant elevation, spike length, weight of grains/spike”.

For nitrogen fertilizer levels: Obtained results indicated that, nitrogen levels affected the all studied traits significantly. The most desirable values were recorded with N4 (105 unit ha^{-1} of Ensiabeen as slow-release fertilizer) for all studied traits comparedwith no nitrogen application treatments (control). In line with this, Rashid et al [22] indicated that plant height was linearly increased with increasing levels of N fertilization. It may be due to the effect of nitrogen which promotes vegetative growth. However, the interaction of seed and N rate hadn’t significant effects on plant height of barley. Mohammadi and Samadiyan [23] reported that nitrogen applications increase spike length of barley. Nitrogen increases vegetative growth of plants, especially at higher doses. Besides, the significant increase in number of tillers per plant, plant height, spike length, and grain yield by N contributed for the significant increase in productivity. This is in agreement with Alam and Haider [24] who indicated that “increased nitrogen level increased total dry matter”. “Nitrogen application may influence the amount formed chlorophyll, which influences cell size, leaf area and photosynthetic activity” [25]. Tanaka and Nakano [26] concluded that “grain yield increased markedly with increasing N application rate”. Abd El-Lattief et al. [27] showed that “there was a significant effect of fertilization treatments on plant elevation, spike interval, grains weight per spike, No. of spikes m^{-2}, 1000-grain weight, the grain and straw yields per feddan. The greatest amounts of previous traits were recorded when applied of 75% recommended NPK”. Gezahegn et al. [28] revealed that “the effect of N-fertilizer rates (0, 23, 46, 69, and 92 kg ha-1) showed a significant increase in the No. of the productive tiller, grains number and weight per spike and thousand-grain weight with the increase in nitrogen levels”. Haasan et al. [20] stated that “nitrogen fertilization was very effective on all yield characteristics, so any increase in N levels was followed by a significant increase in each of No. of grains/spike, grains weight/spike and No. of spikes/m2, also increased 1000-grain weight and grain yield per fed”. Jemal and Aliyi [29] indicated that “the greatest amounts of plant elevation, spike interval, No. of grains per spike, thousand seed weight, grain and straw yields were recorded from application of 92 kg N/ha”.

5. CONCLUSION

Based on the results obtained from the field and economical evaluation It could be recommended SR2 (seed rate 95 kg ha^{-1} with (N4)105 unit(kg) ha^{-1} of Ensiabeen (40% N) as slow-release fertilizer) to improve barley productivity and Increase net return yield per unit area under rainfed conditions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Habtamu A, Heluf G, Bobe B, Enyew A. Fertility status of soils under different land uses at Wujiraba Watershed, North-Western Highlands of Ethiopia. Agriculture, Forestry and Fisheries. 2014;3:410-419.
2. Aly AA, El-Deeb FE, Abdelazeem AA, Hameed AM, Alfi AA, Alessa H, &Alrefaei AF. Addition of whole barley flour as a partial substitute of wheat flour to enhance the nutritional value of biscuits. Arabian Journal of Chemistry. 2021;14(5):103112. Available:https://doi.org/10.1016/j.arabjc.2021.103112.

3. South African Barley Breeding Institute. Guidelines for the Production of Malt Barley under Irrigation; 2009.
4. Zhou MX. Barley production and consumption. Chapter. 2009, July;2010. DOI:10.1007/978-3-642-01279-2_1.
5. Porporato A, Laio F, Ridolfi L, Rodriguez-Iturbe I. Plants in water-controlled ecosystems: Active role in hydrologic processes and response to water stress—III. Vegetation water stress. Adv. Water Resour. 2001;24:725–744.
6. Alemu G. Response of barley to nitrogen and phosphorus applications in Welo highlands of Ethiopia.Ethiop J Nat Resour. 2001;3:19-38.
7. Mazid A, E bailey. Incorporating risk in the economic analysis of agronomic trials: Fertilizer use on barley in syria agricultural economics. 1992;7:167-184.
8. Jones MJ, A wahbi. site-factor influence on barley response to fertilizer in on-farm trials in northern syria: Descriptive and predictive models. Experimental Agriculture. 1992;28;63-87.
9. Kole PC. Variability, correlation and regression analysis third somaclonal generation of barely. Barely Gene ties Newsletter. 2006;36:44-47.
10. Zoefizadeh M, M Ghasemi, J Azimi, M khayatnezhed, B Ahadzadeh. Correlation analysis and path analysis for yield and its components inhulless barley. Advance in Environmental Biology. 2011;5(1):23-126.
11. Abd El-Mohsen AA. Correlation and regression analysis in barley. Egypt.J.Pl. Breed. 2013;6(3):205-236.
12. Gomez KA, Gomez AA. Statistical procedures for agricultural research, 2nd ed., John Wiley and Sons, New York, U S A; 1984.
13. Steel RGD, Torrie JH. Principles and Procedures of Statistics. A biometrical approach. 2nd edition. McGraw-Hill, New York, USA. 1980;20-90.
14. Draper NR, H Smith. Applied regression analysis. John Wilay and Sons, Jnc.N.Y.USA. 1980;397-402.
15. Gad MA, SM Issa, EM Mahmoud. Economic evaluation of palm production in youth graduate projects in the New Lands. Egyptian Journal of Agricultural Economics, Economic Society for Agricultural Economics. 2013;21(1):27.
16. Enas M Mahmoud, Rania FM, YA El-Gohary. Economic evaluation for the optimum seeding rate for some bread wheat genotypes_Bull. Fac. Agric, Cairo Univ. 2019;70:153-161.
17. Sahar AI Ibrahem, WAM EiD, YI El_Gohary. Economic evaluation for the effect of the irrigation rates on some bread wheat genotypes Bull. Fac. Agric, Cairo Univ. 2019;70:1-11.
18. Seadh SE, AT El- Kassaby, M Mansour, MMM El-Waseef. Response of some barley cultivars to different sowing dates, n-fertilizer and seeding rates. J. of Plant Production, Mansoura Univ. 2022;13(1):9-15.
19. Bekele S, T Yoseph, T Ayalew. Growth, protein content, yield and yield components of malt barley (*Hordeum vulgare* L.) varieties in response to seeding rate at Sinana District, Southeast Ethiopia. Intern. J. of Appl. Agric. Sci. 2020;6(4):61-71.
20. Haasan EE, AA Sarhan, AB Gaballah, ASM Ibrahim. Effect of nano-fertilizer, seeding rate and nitrogen fertilization on barley yield under Sinai conditions. J. Product. & Dev. 2021;26(3):391-413.
21. Rahi AE, AF Mihbis. Effect of N-fertilizer and rate of seeds on some growth criteria and dry matter production of barley (*Hordeum vulgare* L.). IOP Conf. Series: Earth and Environ. Sci. 2021; 923:012060. DOI:10.1088/1755-1315/923/1/012060.
22. Rashid A, UK Khan, DJ Khan. Comparative effect of varieties and fertilizer levels on barley (*Hordeumvulgare*). Pak Sci. 2007;1:1-13.
23. Mohammadi SA, Samadiyan F. Effect of nitrogen and cultivars on some traits of barley (*hordeum vulgare* l.) International journal of Advanced Biological and Biomedical Research. 2014;2:295-299.
24. Alam MZ, Hider SA. Paul NK. Yield and yield components of barley (*Hordeum valgare*L.) cultivars inrelation to nitrogen fertilizer. J Appl Sci Res. 2007;3:1022-1026.
25. Marschner H. Mineral nutrition of higher plants. Academic Press San Diego, USA; 1995.
26. Tanaka R, H Nakano. Barley yield response to nitrogen application under different weather conditions. Sci. Reports. 2019;9:8477. DOI:org/10.1038/s41598-019-44876-y.
27. Abd El-Lattief EA, MA Ali, HM Hmadi. Effect of sowing dates and fertilization treatments on productivity of barley crop

under Upper Egypt conditions. Intern. J. of Agric. Sci. 2021;3(3):192-204.

28. Gezahegn H, H Deribe, T Wato. Response of food barley (*Hordeum vulgare* L.) grain yield to the application of integrated farmyard manure and N-fertilizer rates at Gesha Woreda, Kaffa Zone, Southwest Ethiopia. Intern. J. of Bot. Studies. 2021; 6(5):665-672.

29. Jemal K, M Aliyi. Growth and yield response of food barley (*Hordeum vulgare* L.) varieties to N-fertilizer rates Inkofele District, Southeastern Oromia. J. Aqua. Res. Dev. 2021;12(7):645-667.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/114893