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Influence of macro nutrients (N and P) on growth and yield of barley (*Hordeum vulgare* L.)

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Abstract

The experiment was conducted at experimental area of Student's Experimental Farm, Department of Agronomy, Sindh Agriculture University Tandojam during 2017-18 to assess the influence of macro nutrients (N and P) on growth and yield of barely for ix fertilizer level and two barely varieties (Clipper and Local variety) in a three replicated randomized complete block design. The results showed that maximum tillers per plant (236 m^2), plant height (109.2 cm), spike length (16.8 cm), grains $spike^{-1}$ (33.00), seed index (51.4 g) and grain yield (3153 kg ha^{-1}) were recorded by Clipper variety. However, the fertilizer levels expressed that maximum tillers (251 m^2), plant height (118.9 cm), spike length (18.4 cm), grains $spike^{-1}$ (35), seed index (57.7 g) and grain yield (3159 kg ha^{-1}) were noted in F_6 = 80-40 NP kg ha^{-1}. In case of interaction, Clipper variety x F_6 = 80-40 NP kg ha^{-1} produced maximum tillers (268 m^2), plant height (124.3 cm), spike length (21.3 cm), grains $spike^{-1}$ (37), seed index (59.0 g) and grain yield (3283 kg ha^{-1}). However, local variety × F_1 = 00 (No fertilizer) manifested minimum tillers (206 m^2), plant height (83.9 cm), spike length (9.4 cm), grains $spike^{-1}$ (26), seed index (38.3 g) and grain yield (2755 kg ha^{-1}). It was concluded that growth and yield, particularly grain yield was considerably affected by fertilizer levels. It was indorsed that Clipper × F_6 = 80-40 NP kg ha^{-1} was suitable combination for getting more and more yield of barley crop.

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Introduction

Barley (*Hordeum valgare* L.) is one of the chief cereal crop in the globe and is also significant for the livelihood of the farmers. This crop is annually cultivated in different areas in the world (Hayes *et al.*, 2003). It is able to replace hexaploid wheat owing to its tolerance to water scarcity and salinity. The crop secures the fourth rank in the total production of cereals all over world after wheat, rice and maize. It performs well than the rest of the crops under adverse conditions.

In our Country, the crop barley is brought under agriculture for the purpose of grain and straw because it is utilized for both humans as meal and for animals as fodder.

Nitrogen is the most essential nutrient for the growth and development of plants as to increase the production worldwide (Zapata and Cleenput, 2003; Miao *et al.*, 2006). For this, good N management strategies have been vital, because they provide huge economic profits to farmers, landlords and researchers (Oikeh *et al.*, 2007; Worku *et al.*, 2007).

Three plant nutrients named Nitrogen, phosphorous and potassium are regarded as the most important macronutrient (Obidiebube *et al.*, 2012). The role of P is that it has an effect on root growth, promotes nutrients use and as a result, make an improvement in the flower blossom, fertilization and yield (Rahimi *et al.*, 2012). It also helps in photosynthesis, formation of macromolecules and energy transfer (Sharma *et al.*, 2013).

Plants which achieve a large extent of P at a primary phase, they will mature more quickly than the plant getting it in a less quantity (Teng *et al.*, 2013). Sarker *et al.* (2015) in wheat, Usman (2013) in rice and Minapour *et al.* (2013) in maize also conducted an experiment with the impact of N and P yield and its components. The uptake of N affects the above ground biomass (Abeledo *et al.*, 2008). Hence, this investigation was thus put into practice to assess the effect of macronutrients like N and P on the growth and yield and know about the most proper combination of N and P in order to get maximum grain yield of barely.

Materials and methods

Experimental design

A filed experiment was conducted at Student's Experimental Farm, Department of Agronomy, Sindh Agriculture University Tandojam to evaluate the influence of macro nutrients (N and P) on growth and yield of barley (*Hordeum vulgare* L.). The experiment was laid out in a three replicated randomized complete block design (RCBD) with 4 m x 3 m (12 m^2) net plot size. Treatment details are as under:

Treatments = (Two factors A and B)

F_1 = 00 (No fertilizer)

F_2 = 40-20 NP kg ha^{-1}

F_3 = 50-25 NP kg ha^{-1} (recommended)

F_4 = 60-30 NP kg ha^{-1}

F_5 = 70-35 NP kg ha^{-1}

F_6 = 80-40 NP kg ha^{-1}

Factor: B = Varieties (02)

V_1 = Clipper

V_2 = Local variety

The attributes listed below were brought under an investigation with a brief methodology.

Tillers m^{-2}: The total number of fertile tillers of each plant in meter square was counted at the time of maturity.

Plant height (cm): The height of each tagged plant was measured in centimetres from the ground level to the tip of the spike excluding awns at the time of maturity.

Spike length (cm): The length of the spike of main tillers was measured in centimetres from the base of the spike to the upper most spikelets excluding awns.

Grains $spike^{-1}$: The total number of seeds from five randomly selected and tagged spikes was manually threshed and next the grains of each spike were counted.

Seed index (1000 grains weight, g): Thousand seeds from each replication per genotype were counted and weighed in grams on an electric balance in laboratory. This process was done after manual threshing of spikes.

Grain yield (kg ha^{-1}): After harvesting all the spikes from individual tagged plants, the spikes were threshed manually and separately and clean and pure seeds were brought in the laboratory. Next, the calculation was done according to the following formula.

$$\frac{\text{Grain yield (plot} - 1)}{\text{Plot size (m} - 2)} x1000$$

Statistical analysis

Statistics data was analyzed data by using software (Statistix, 2006). The minimum key difference (LSD) was applied to test the highness of the treatment on the test, where necessary.

Results and discussion

Analysis of variance and mean performance

Tillers (m^{-2})

The results for tillers m^{-2} of barley presented in Table-1 indicated the significant difference for tillers per meter. The maximum tillers (236 m^2) were recorded by Clipper variety, whereas local variety produced the minimum tillers (217 m^2). In terms of fertilizers applications, maximum tillers (215 m^2) were verified under F_6= 80-40 NP kg ha^{-1}, while the minimum tillers (206 m^2) were noted in F_1 = 00 (No fertilizer).

Moreover, Clipper variety x F_6 = 80=40 NP kg ha^{-1} manifested maximum tillers (268 m^2). However, local variety x F_1= 00 (No fertilizer) displayed minimum tillers (206 m^2). Espidkar *et al.* (2017) also studied the effects of N and P in which he told that co-inoculation increases the grain yield.

Table 1. Tillers m^{-2} of barley as affected by macro nutrients (N and P).

Treatments	Varieties		Mean
	Clipper	Local variety	
F_1 = 00 (No fertilizer)	209	203	206 E
F_2 = 40-20 NP kg ha^{-1}	218	206	212 DE
F_3 = 50-25 NP kg ha^{-1} (RD)	227	215	221 D
F_4 = 60-30 NP kg ha^{-1}	242	219	230 C
F_5 = 70-35 NP kg ha^{-1}	252	228	240 B
F_6 = 80-40 NP kg ha^{-1}	268	235	251 A
Mean	236 A	217 B	------
	Varieties	Fertilizer	V x F
SE	2.4447	4.2343	5.9882
LSD = 0.05	5.0699	8.7814	12.419

Plant height (cm)

It is internationally admitted that these three most important elements like N, P and K are extremely necessary for proper functions in the body of a plant and an increase of yield.

The results of plant height (cm) presented in Table-2. The analysis of variance showed significant values (P<0.05). The maximum height of plants (109.2 cm) was exposed by Clipper variety, however the shortest plants (99.8 cm) were maintained in local variety.

In terms of fertilizers, the longest plants (1189.9 cm) were exhibited byF_6 = 80-40 NP kg ha^{-1}, nonetheless dwarf plants (87.5 cm) were seen in F_1 = 00 (No fertilizer). Clipper variety x F_6 = 80-40 NP kg ha^{-1}created the longest plants (124.3 cm), however local variety x F_1 = 00 (No fertilizer) took the shortest plants (83.9 cm). Significant results were also in paradox with Dejene and Abera (2014).

Table 2. Plant height (cm) of barley as affected by macro nutrients (N and P).

Treatments	Varieties		Mean
	Clipper	Local variety	
F_1 = 00 (No fertilizer)	91.2	83.9	87.5 F
F_2 = 40-20 NP kg ha^{-1}	102.3	87.6	94.9 E
F_3 = 50-25 NP kg ha^{-1} (RD)	108.6	99.6	104.1 D
F_4 = 60-30 NP kg ha^{-1}	109.9	104.6	107.2 C
F_5 = 70-35 NP kg ha^{-1}	119.3	109.6	114.4 B
F_6 = 80-40 NP kg ha^{-1}	124.3	113.6	118.9 A
Mean	109.2 A	99.8 B	------
	Varieties	Fertilizer	V x F
SE	0.5114	0.8857	1.2526
LSD = 0.05	1.0605	1.8369	2.5977

Table 3. Spike length (cm) of barley as affected by macro nutrients (N and P).

Treatments	Varieties		Mean
	Clipper	Local variety	
F_1 = 00 (No fertilizer)	11.5	9.4	10.4 F
F_2 = 40-20 NP kg ha^{-1}	14.5	10.8	12.6 E
F_3 = 50-25 NP kg ha^{-1} (RD)	16.1	11.8	13.9 D
F_4 = 60-30 NP kg ha^{-1}	17.7	12.4	15.0 C
F_5 = 70-35 NP kg ha^{-1}	19.7	14.4	17.0 B
F_6 = 80-40 NP kg ha^{-1}	21.3	15.6	18.4 A
Mean	16.8 A	12.3 B	------
	Varieties	Fertilizer	V x F
SE	0.30169	0.5224	0.7387
LSD = 0.05	0.6255	1.0833	1.5321

Spike length (cm)

Nitrogen is perceived as a key element for higher yield in cereals. Spike length (cm) expressed significant variations in ANOVA. Longest spikes (16.8 cm) were demonstrated by Clipper variety, but local variety sustained the shortest spikes (12.3 cm). On the other hand, maximum spike length (18.4 cm) was given by F_6 = 80-40 NP kg ha^{-1}, shortest spikes (10.4 cm) were verified in F_1 = 00 (No fertilizer). Furthermore, Clipper variety x F_6 = 80-40 NP kg ha^{-1}articulated longest spikes (21.3 cm), nonetheless local variety x F_1 = 00 (No fertilizer) showed the minimum spike length (9.4 cm). Such results were also observed by Karamanos *et al.* (2014).

Grains spike^{-1}

Nitrogen is also very vital constituent of proteins, carbohydrates, lipids and nucleic acids. For grains spike^{-1} in Table-4, significant difference ($P<0.05$) was observed. The maximum grains spike^{-1} (33) were articulated by Clipper variety, however the minimum grains spike^{-1} (29) were noticed in local variety.

On the other hand, the most grains spike^{-1} (35) were evinced in F_6 = 80-40 NP kg ha^{-1}, nonetheless the least grains spike^{-1} (26) were offered by F_1 = 00 (No fertilizer). Furthermore, Clipper variety x F_6 = 80-40 NP kg ha^{-1} provided more and more grains spike^{-1} (37). Nevertheless, local variety x F_1 00 (No fertilizer) sustained lower number of grains spike^{-1}(26).

Positive response of P and N in the form fertilization was gotten by Amani *et al.* (2017) in number of grains rose which resulted in risen yield per plant.

Table 4. Grains spike^{-1} of barley as affected by macro nutrients (N and P).

Treatments	Varieties		Mean
	Clipper	Local variety	
F_1 = 00 (No fertilizer)	27	26	26 E
F_2 = 40-20 NP kg ha^{-1}	31	28	29 D
F_3 = 50-25 NP kg ha^{-1} (RD)	34	29	31 C
F_4 = 60-30 NP kg ha^{-1}	34	30	32 BC
F_5 = 70-35 NP kg ha^{-1}	35	32	33 B
F_6 = 80-40 NP kg ha^{-1}	37	34	35 A
Mean	33 A	29 B	------
	Varieties	Fertilizer	V x F
SE	0.4313	0.7470	1.0565
LSD = 0.05	0.8945	1.5493	2.1910

Seed index (1000 grain weight, g)

Seed index in Table-5exhibited significant values ($P<0.05$) in ANOVA. The maximum seed index (51.4) was taken by Clipper variety, nonetheless local variety demonstrated the minimum seed index (48.0 g). However, the greater values for seed index (57.7 g) were obtained by F_6 = 80-40 NP kg ha^{-1}, whereas the lowest seed index (39.9 g) was observed in F_1 = 00 (No fertilizer). It was further indicated that Clipper variety x F_6 = 8-40 NP kg ha^{-1} (59.0 g) exposed the highest seed index. However, local variety x F_1 = 00 (No fertilizer) recorded the lowest seed index (38.3 g).

Findings are in confirmation with Hagos *et al.* (2016) and Renata and Gorski (2014) in many promising result son yield and its linked attributes.

Table 5. Seed index (1000 grain weight, g) of barley as affected by macro nutrients (N and P).

Treatments	Varieties		Mean
	Clipper	Local variety	
F_1 = 00 (No fertilizer)	41.6	38.3	39.9 F
F_2 = 40-20 NP kg ha^{-1}	47.7	41.0	44.3 E
F_3 = 50-25 NP kg ha^{-1} (RD)	50.5	46.9	48.7 D
F_4 = 60-30 NP kg ha^{-1}	54.0	51.1	52.5 C
F_5 = 70-35 NP kg ha^{-1}	56.1	54.6	55.3 B
F_6 = 80-40 NP kg ha^{-1}	59.0	56.5	57.7 A
Mean	51.4 A	48.0 B	------
	Varieties	Fertilizer	V x F
SE	0.1623	0.2811	0.3976
LSD = 0.05	0.3366	0.5830	0.8245

Grain yield (kg ha^{-1})

Ample use of N minimizes the surrounding contaminations (Scharf and Alley, 2000). Table-6 indicated that this trait performed significantly ($P<0.05$). Clipper variety expressed the maximum grain yield (3153 kg ha^{-1}), however the minimum grain yield (2921 kg ha^{-1}) was noted in local variety. On the other hand, maximum grain yield (3159 kg ha^{-1}) was recorded in F_6 = 80-40 NP kg ha^{-1}, while the minimum grain yield (2859 kg ha^{-1}) was given by F_1 = 00 (No fertilizer). Moreover, Clipper variety x F_6 = 80-40 NP kg ha^{-1} stood with the highest grain yield (3283 kg ha^{-1}), whereas local variety x F_1 = 00 (No fertilizer) achieved the minimum seed yield (2755 kg ha^{-1}). Kostadinova *et al.* (2016) notified about the efficient uptake of P and N in the progress of grain yield.

Table 6. Grain yield (kg ha^{-1}) of barley as affected by macro nutrients (N and P).

Treatments	Varieties		Mean
	Clipper	Local variety	
F_1 = 00 (No fertilizer)	2984	2755	2869 D
F_2 = 40-20 NP kg ha^{-1}	3106	2884	2995 C
F_3 = 50-25 NP kg ha^{-1} (RD)	3141	2892	3016 C
F_4 = 60-30 NP kg ha^{-1}	3177	2957	3067 BC
F_5 = 70-35 NP kg ha^{-1}	3231	3006	3118 AB
F_6 = 80-40 NP kg ha^{-1}	3283	3036	3159 A
Mean	3153 A	2921 B	------
	Varieties	Fertilizer	V X F
SE	22.171	38.401	54.307
LSD = 0.05	45.980	79.639	112.63

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