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RESEARCH ARTICLE

Effect of sowing dates and fertilization treatments on productivity of barley crop under Upper Egypt conditions.

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Abstract

A study was conducted during 2016-2017 and 2017-2018 seasons at the Experimental Farm, Faculty of Agriculture, South Valley University, Qena, Egypt, with the objective to study the effect of different date of sowing and fertilization treatments on productivity of barley cultivar Giza 121. The experiment was in a split-plot arrangement was based on a randomized complete block design (RCBD) with three replications. Three sowing dates were assigned to the main plots and thirteen fertilization treatments to the sub-plots. There was a significant effect of the interaction between sowing dates and fertilization treatments on study traits (plant height, spike length, spike weight, number of spikes/m^2, 1000-grain weight, grain yield/plant, grain yield per feddan and straw yield per feddan). The highest values of previous traits were recorded under sowing barley cultivar Giza 121 at 15th of November and applied of 75% recommended NPK + biofertilization + humic acid.

Keywords: Biofertilizer; humic acid; NPK; Sowing date.

1. Introduction

Barley (*Hordeum vulgare* L.) is cultivated successfully in a wider range of environmental conditions of all over the world. In Egypt, it is grown in some areas as a winter cereal crop which is cultivated mainly for grain production. It can also be grown as a dual purpose crop for providing good quality fodder as well as grains. The cutting at early stage at about 50-55 days after sowing provides good quality of fodder particularly in lean period (Mid December to mid-January) for feeding to the animals Singh *et al.* (2017).

Date of sowing is one of the important factors for higher production as it determines the optimum time of sowing of the crop. An optimum time of sowing enhances the efficiency of barley by exploiting growth factors in an effective manner. As dual purpose barley plant provides green fodder during lean period, the right time of sowing for availability of green fodder for longer time should be optimally utilized and therefore, the effects of various dates of sowing on dual purpose barley are quite remarkable (Singh *et al.*, 2017). Very early planting may expose the crop to higher temperature at tillering stage while late planting may results in low biomass production and poor grain development due to higher temperature conditions at the time of maturity (Nass *et al*., 1975; Ram *et al*., 2010). Early sowing date of barley recorded higher yield in comparison to late sown crop (Chaudhary *et al.*, 2017; Pal *et al.*, 2018; Potterton and McCabe, 2018; Amarjeet *et al.*, 2020; Al Myali *et al.*, 2020). Delay in planting decreases barley grain yield (Bavei and Vaezi, 2012; Devi *et al.*, 2018)

In order to meet the food demands of a growing world population, agriculture sectors have been increasingly using chemical fertilizer. Chemical fertilizers are mainly a

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mixture of substances, such as nitrogen, phosphorus and potassium. The excess uses of chemical fertilizers in agriculture are costly and also have various harmful effects (Santos *et al.*, 2012).

In this regard, organic fertilizers and biofertilizers have become alternative sources (Odgerel and Tserendulam, 2016). As compared to chemical fertilizers, biofertilizers are eco-friendly and cost effective. Biofertilizers contain various microorganisms that provide all kinds of micro and macro elements via nitrogen fixation, phosphate and potassium solubilization or mineralization, release of plant growth promoting substances, production of antibiotics and biodegradation of organic matter in the soil (Goel *et al.*, 1999; Sinha *et al.*, 2010). When biofertilizers are used continuously for many years, parental inoculums become sufficient for further multiplication (Youssef and Eissa, 2014), hence they participate in nutrient cycling and benefit crop productivity (Sing *et al.*, 2011). Main benefits of biofertilizers are cheap source of nutrients, suppliers of microelements, suppliers of organic matter, counteracting negative impact of chemical fertilizers, secretion of growth hormone (Gaur *et al.*, 2010). Organic, bio and minerals fertilization are considered among the most important cultural practices for increasing barley productivity and improved quality parameters. Modern agriculture, which largely depends on chemical fertilizers, pesticides, herbicides etc., though increased production, has adversely affected the soil productivity and environmental quality. The combined use of organic and inorganic fertilizers not only increases the crop yield but also improve the physical and biological properties of soil (Shashidhar *et al.*, 1995)

The application of nitrogen alone and biofertilizer treatment significantly increased grain yield and grains per spike of barley cultivars (Al-Otayk, 2009). The application of urea, compost and biofertilizer as well as their combinations significantly, increased grain yields, grain weight/spike and 1000-grain weight (Helmy *et al.*, 2013). The combination between treatments of NPK (at half dose) + FYM + biofertilizers recorded the highest grain yield, straw yield and grain protein content of wheat crop (Abd El-Lattief, 2014).

For that reason, the current study was performed to assess the effect of sowing dates and fertilization treatments on productivity of barley under Upper Egypt conditions.

2. Materials and methods

2.1. Experimental site description

The study was carried out at the Experimental Farm of South Valley University, Qena, Egypt during the two growing seasons 2016/2017 and 2017/2018 to evaluate effect of sowing date and fertilization treatments on productivity of barley cv. Giza 121 under Upper Egypt conditions. The farm is located at an altitude of 79 m above mean sea level and is intersected by 26°10′ N latitude and 32°43′ E longitude. Soil physical and chemical properties as depicted in Table 1. Detailed climatic parameters for Qena are given in Table 2.

2.2. Experimental treatments and design

The experiment was in a split-plot arrangement was based on a randomized complete block design (RCBD) with three replications. Sowing dates (D_1-sowing at 1^{st} of November, D_2-15th of November and D_3-1^{st} of December) were assigned to the main plots, fertilization treatments (T_1- 0.0 as control, T_2-NPK recommended {65 kg N+150 kg P_2O_5+24 kg K_2O /Faddan}, T_3- Biofertilizer, T_4- Humic acid, T_5-75% of NPK + biofertilizer, T_6- 50% of NPK + biofertilizer, T_7- 25% of NPK + biofertilizer, T_8- 75% of NPK + humic acid, T_9- 50% of NPK + humic acid, T_{10}- 25% of NPK + humic acid, T_{11}- 75% of NPK + biofertilizer + humic acid, T_{12}- 50% of NPK + biofertilizer + humic acid, and T_{13}- 50% of NPK + biofertilizer + humic acid) assign in sub plot.

2.3. Cultural practices

The seeds were sowed on the 17th of November in at rate of 60 kg / faddan in both seasons. Nitrogen fertilizer of urea (46.5% N) was applied in three doses, 20% at sowing, 40% before the first irrigation and the last 40% applied at the second irrigation. Superphosphate fertilizer (15.5 % P_2O_5) was applied before sowing. Potassium sulphate (48% K_2O) was applied during seedbed preparation. Nitrogen, phosphor, and potassium were applied as per treatment combination. Humic acid was added at rate of 2 kg / faddan on soil application after one month from sowing. Mixed bacterial biofertilizer containing nitrogen fixers (NFB, *Azotobacter chroococcum* and *Azospirillum lipoferum*), phosphate dissolving bacteria (PDB, *Paenibacillus polymyxa* and *Bacillus polymyxa*) and potassium dissolving bacteria (KDB, *Bacillus cereus*) was utilized in the present study.

Table 1. Some physical and chemical properties of the experimental site in 2017/ 2018 and 2018/2019.

Soil property		2017/2018	2018/2019
Sand (%)		66.70	74
Silt (%)		21.30	16.6
Clay(%)		12	9.4
Soil texture		Sandy loam	Sandy loam
pH (1:1; Soil : Water suspension)		7.93	8.12
Organic matter(%)		0.3	0.4
EC (ds m^{-1})		9.95	4.62
CaCO3 (%)		5.8	6.5
Soluble Cations and anions (m mol L-1)	K+	0.80	0.60
	Ca++	11.5	9.5
	Mg++	11.3	10.2
	H CO-3	20.00	16.00
	Cl-	27.50	28.50
	SO--4	23.2	20.2

Table 2. Minimum, maximum and mean daily temperature at South Valley University from sowing to harvesting date in both seasons.

Month	Seasons	2016/2017			2017/2018		
		Mini.	Max.	Daily mean	Mini.	Max.	Daily mean
Nov.	1-15	17.2	32.1	24.7	14.1	29.1	21.3
	16-30	14.6	27.5	21.0	13.7	26.6	19.8
	Mean	15.9	29.8	22.9	13.9	27.9	20.9
Dec.	1-15	9.8	22.9	16.4	11.7	26.0	18.5
	16-31	7.4	20.5	13.9	12.0	25.7	18.6
	Mean	8.6	21.7	15.2	11.9	25.9	18.9
Jan.	1-15	6.2	20.9	13.5	8.2	22.9	15.3
	16-31	9.1	23.0	16.0	7.3	21.5	14.4
	Mean	7.7	22.0	14.9	7.8	22.2	15.0
Feb.	1-15	8.4	32.0	15.7	8.4	23.0	15.7
	16-28	8.6	24.2	16.4	8.6	24.2	16.4
	Mean	8.5	28.1	18.3	8.5	23.6	16.1
March	1-15	13.3	27.6	20.0	15.7	33.1	24.3
	16-31	14.1	28.8	21.4	18.0	33.7	26.2
	Mean	13.7	28.2	21.0	16.9	33.4	25.2
April	1-15	18.7	33.2	25.9	18.7	34.2	26.7
	16-30	19.4	36.4	27.9	19.7	35.6	28.2
	Mean	19.1	34.8	27.0	19.2	34.9	27.1

Meteorological Authority at South Valley University, Qena

2.4. Measured traits

At harvest time, ten plants were taken from each plot to measure the follow traits: Plant height (cm), spike length (cm), spike weight (g), 1000-grain weight (g), grain yield/plant (g). The number of spikes/m^2 was calculated on one square meter. Grain and straw yields were estimated at plot basis.

2.5. Statistical analysis

The obtained data were subjected to analysis of variance according to Gomez and Gomez (1984) by MSTAT-C Computer program. Comparison between treatments means were done by least significant difference (LSD) procedures at 5% level of probability.

3. Results and discussion

3.1. Plant height (cm)

Plant height varied significantly ($p < 0.05$) as affected by used sowing dates in the two seasons (Table 3). Medium sowing at 15th of November surpassed the early (1st of November) and late (1st of December) sowing dates in this respect and gave the highest mean values of plant height in both seasons (83.89 and 81.58 cm, respectively). Higher mean value of plant height under mid-November sown crop was reported by Rashid *et al.* (2010), Dastan *et al.* (2011), Pankaj *et al.* (2015a), Kumar *et al.* (2017) and Devi *et al.* (2018). Higher mean values of plant height under November 15 sowing were probably due to exposure of the crop to much desirable weather condition as compared to other dates as the temperature reduced sharply during December. Desirable sowing dates permitted the barley crop to grow under satisfactory temperature regime in various phonological stages of growth. Plant height was reduced to 10.83 and 2.68% under December 1 sowing against November 15 sowing in the first and second seasons, respectively. Delayed sowing to December exposed the crop to higher temperature and longer day length during elongation, which might have reduced the plant height. This decline in plant height with delayed sowing date was in conformity with the findings of Dastan *et al.* (2011), Pankaj *et al.* (2015b), Kumar *et al.* (2017), Devi *et al.* (2018) and Reddy and Singh (2018).

Data in Table 3 illustrated a significant ($p < 0.05$) effect of different treatment combinations of fertilization on plant height in the two growing seasons. The highest values for this trait were obtained by T_{11} (75% NPK + biofertilization + humic acid) in both seasons. On the contrary, T_1 (Control) had the shortest plants in the two seasons (59.24 and 59.01 cm, respectively). It may be attributed due to the sufficient availability of plant nutrients like nitrogen, phosphorus and potassium to barley plant up to maturity (Kumar *et al.*, 2013; Alazmani, 2015; Kouzegaran *et al.*, 2015). Many workers noted the enhancing effect of humic acid on growth, yield, and nutrient uptake by many crops (El-Desuki, 2004; Wali *et al.*, 2018).

Data in Table 3 indicates that there was significant effect of the interaction between sowing dates × fertilization treatments (D × T) on plant height in both seasons. Sowing at 15th of November markedly improved plant height when T_{11} (75% NPK + biofertilization + humic acid) were used in both seasons. However, the shortest values of this character were obtained from the late sowing date (D_3; 1st of December) with T_1 (Without fertilization) at the two seasons.

Table 3. Average plant height as affected by sowing dates and fertilization treatments and their interactions during 2016/2017 and 2017/2018 growing seasons.

Fertilization Treatment (T)	2016/2017 Sowing date (D)			Mean	2017/2018 Sowing date (D)			Mean
	D_1	D_2	D_3		D_1	D_2	D_3	
T_1	55.53	69.23	52.97	59.24	63.93	60.03	53.07	59.01
T_2	79.73	89.37	79.87	82.99	91.13	91.47	90.07	90.89
T_3	71.87	80.03	64.50	72.13	66.90	68.87	65.17	66.98
T_4	73.17	82.90	69.37	75.15	65.37	67.47	63.77	65.54
T_5	77.77	84.30	73.63	78.57	91.00	88.20	87.30	88.83
T_6	75.27	83.20	75.47	77.98	77.70	83.10	86.53	82.44
T_7	70.57	82.53	77.27	76.79	81.67	82.60	84.53	82.93
T_8	78.03	83.20	76.37	79.20	87.13	87.87	81.03	85.34
T_9	78.83	81.73	77.87	79.48	82.30	82.50	78.00	80.93
T_{10}	73.97	79.27	76.53	76.59	82.30	77.23	73.07	77.53
T_{11}	82.27	95.67	85.33	87.76	93.13	91.60	91.23	91.99
T_{12}	79.53	86.47	78.90	81.63	91.07	91.63	92.37	91.69
T_{13}	74.00	86.17	78.60	79.59	82.77	87.93	85.90	85.53
Mean	74.66	83.39	74.36	77.47	81.26	81.58	79.39	80.74
LSD_{05}	D	T	D × T		D	T	D × T	
	2.89	4.56	7.92		1.67	2.82	4.88	

3.2. Number of spikes/m²

Data in Table 4 shows that sowing dates had significant influence on number of spikes/m^2 in both seasons. Number of spikes/m^2 was achieved under second sowing date (15th of November) for 285.7 and 255.0, which was drastically reduced to 213.1 and 240.3 under late sowing date (1st of December) in the first and second seasons, respectively. These results are in agreement with those obtained by Samarah and Al-Issa (2006), Singh *et al.* (2017) abd Devi *et al.* (2018).

Table 4. Average number of spikes/m^2 as affected by sowing dates, fertilization treatments and their interactions during 2016/2017 and 2017/2018 growing seasons.

Fertilization Treatment (T)	2016/2017 Sowing date (D)			Mean	2017/2018 Sowing date (D)			Mean
	D_1	D_2	D_3		D_1	D_2	D_3	
T_1	192.8	174.2	143.8	170.3	178.8	160.0	143.0	160.6
T_2	340.0	339.7	242.8	307.5	295.5	298.0	276.7	290.1
T_3	240.0	250.0	169.8	219.9	220.3	187.3	182.7	196.8
T_4	230.3	218.5	163.2	204.0	238.5	238.2	226.7	234.5
T_5	310.0	309.8	224.5	281.4	264.0	268.0	261.3	264.4
T_6	291.5	299.0	219.0	269.8	235.0	254.3	243.3	244.2
T_7	279.7	285.2	223.3	262.7	242.5	263.2	256.3	254.0
T_8	278.5	265.7	215.0	253.1	272.0	264.2	259.2	265.1
T_9	278.7	276.2	224.2	259.7	251.0	246.5	225.0	240.8
T_{10}	252.7	279.2	202.0	244.6	229.5	260.2	230.8	240.2
T_{11}	369.3	380.0	254.8	334.7	299.0	321.3	277.3	299.2
T_{12}	314.2	326.3	251.3	297.3	281.2	287.5	274.5	281.1
T_{13}	292.0	310.3	236.8	279.7	253.7	265.8	267.3	262.3
Mean	282.3	285.7	213.1	260.4	250.8	255.0	240.3	248.7
LSD_{05}	D	T	D × T		D	T	D × T	
	34.2	39.1	67.7		10.7	18.1	31.3	

Different treatment combinations of fertilization had a significant influence on number of spikes/m^2 (Table 4). The highest number of spikes/m^2 (334.7 and 299.2 in the first and second seasons, respectively) was obtained by T_{11}. Nevertheless, the lowest values of number of spikes/m^2 obtained from T_1 as control in both seasons (170.3 and 160.6, respectively). Similar results were obtained by El-Desuki (2004) and Wali *et al*. (2018).

Sowing dates × fertilization treatments gave significant influence on number of spikes/m^2 (Table 4). The highest number of spikes/m^2 (380.0 and 321.3 in the first and second seasons, respectively) was produced from $D_2 \times T_{11}$ in both seasons. The lowest number of spikes/m^2 was recorded under $D_3 \times T_1$ (143.8 and 143.0 in the first and second seasons, respectively). The results are in agreement with the findings of Baladezaie *et al.* (2011) and Reddy and Singh (2018).

3.3. Spike length

Spike length varied significantly ($P < 0.05$) as affected by studied sowing dates in the two growing seasons (Table 5). Sowing date at 15th of November surpassed the two other dates in this respect and gained the longest mean values of spike length (17.33 and 17.05 cm in the first and second seasons, respectively). Spike length was at par between other different sowing dates (early and late sowing dates). Spike length was decreased to 7.04 and 3.23% under late date (1st of December) against medium date (15th of November) in the first and second seasons, respectively.

Table 5. Average spike length as affected by sowing dates, fertilization treatments and their interactions during 2016/2017 and 2017/2018 growing seasons.

Fertilization Treatment (T)	2016/2017 Sowing date (D)			Mean	2017/2018 Sowing date (D)			Mean
	D_1	D_2	D_3		D_1	D_2	D_3	
T_1	14.23	15.20	12.93	14.12	14.37	13.50	13.37	13.75
T_2	16.73	18.07	17.13	17.31	17.73	17.93	17.83	17.83
T_3	16.13	16.73	16.00	16.29	15.47	15.60	15.70	15.59
T_4	16.20	17.33	15.50	16.34	16.33	14.77	14.60	15.23
T_5	16.37	17.57	16.23	16.72	17.47	17.87	16.97	17.44
T_6	16.07	16.73	16.00	16.27	17.20	17.60	15.70	16.83
T_7	16.20	17.37	15.90	16.49	16.60	17.17	16.80	16.86
T_8	16.53	17.50	16.73	16.92	16.93	17.80	17.33	17.35
T_9	16.23	17.40	16.13	16.59	16.73	17.30	16.10	16.71
T_{10}	14.30	17.20	15.93	15.81	16.60	17.70	17.07	17.12
T_{11}	17.63	18.87	17.33	17.94	17.77	18.50	17.93	18.07
T_{12}	17.20	17.67	17.17	17.35	17.70	18.13	17.87	17.90
T_{13}	16.33	17.63	16.50	16.82	17.33	17.83	17.23	17.46
Mean	16.17	17.33	16.11	16.54	16.79	17.05	16.50	16.78
LSD_{05}	D	T	D × T		D	T	D × T	
	0.54	0.72	1.26		0.34	0.64	1.10	

The differential behavior or length of spike due to different sowing date might be explained by the fact that sowing during higher temperature, the plant could not get congenial environment for growth and development affecting development of spike. Devi *et al.* (2018) stated that the spike length was at par among different sowing dates.

Data in Table 5 illustrated significant ($P < 0.05$) effect of treatment combinations of fertilization on spike length in both growing seasons. The longest values (17.94 and 18.07 cm in the first and second seasons, respectively) of mentioned trait were recorded by T_{11}. On the contrary, T_1 (Control) recorded the lowest values (14.12 and 13.75 cm in the first and second seasons, respectively) for this trait. Similar results were obtained by Kumar *et al.* (2017) and Wali *et al.* (2018).

Moreover, data in Table 5 focused that the interaction between sowing dates and fertilization treatments had a significant influence of spike length in both seasons. $D_2 \times T_{11}$ gained the significant ($P < 0.05$) maximum values of spike length (18.87 and 18.50 cm in the first and second seasons, respectively). The lowest spike length (12.93 and 13.37 cm) was obtained from $D_3 \times T_1$ in the first and second seasons, respectively. Similar findings were also reported by Narolia *et al.* (2013) and Reddy and Singh (2018).

3.4. Spike weight

Data in Table 6 shows that the sowing dates had a significant effect on spike weight in both seasons. Sowing under 15th of November had the highest mean values of spike weight (2.303 and 1.992 g in both seasons, respectively) compared to other dates. The late sowing date (1st of December) was reduced spike weight by 11.38 and 14.16% against medium sowing date (15th of November) in the first and second seasons, respectively.

As for treatment combinations of fertilization, these treatments affected significantly the spike weight in both seasons. Results in Table 6 indicate that the T_{11} surpassed all other treatment combinations of fertilization in both seasons. On the other hand, T_1 gave the lowest spike weight (0.890 and 0.653 g in the first and second seasons, respectively). Similar findings were also reported by El-Desuki (2004) and Wali *et al.* (2018).

Regarding the effect of the interaction between sowing dates and fertilization treatments (D × T), this interaction was significant on spike weight in both seasons. Application of T_1 markedly decreased spike weight when sown at late date (1st of December) in both seasons. But the highest spike weight (3.083 and 2.568 g) recorded when addition of T_{11} and sown under medium sowing date (15th of November) in both seasons.

Table 6. Average spike weight as affected by sowing dates, fertilization treatments and their interactions during 2016/2017 and 2017/2018 growing seasons.

Fertilization Treatment (T)	2016/2017 Sowing date (D)			Mean	2017/2018 Sowing date (D)			Mean
	D_1	D_2	D_3		D_1	D_2	D_3	
T_1	1.483	0.963	0.890	1.112	0.760	0.650	0.550	0.653
T_2	2.480	2.780	2.257	2.506	2.173	2.336	2.175	2.228
T_3	1.890	1.527	1.930	1.782	1.601	1.328	1.152	1.360
T_4	2.043	1.870	1.743	1.885	1.380	1.339	1.267	1.329
T_5	2.320	2.440	2.063	2.274	2.094	2.152	1.93	2.059
T_6	2.023	2.153	1.983	2.053	1.755	1.776	1.944	1.825
T_7	2.223	2.193	1.960	2.125	1.605	2.186	1.784	1.858
T_8	2.410	2.363	2.147	2.307	2.087	2.217	1.965	2.090
T_9	2.013	2.317	2.110	2.147	1.823	2.351	1.738	1.971
T_{10}	2.297	2.537	1.957	2.264	1.942	2.257	1.323	1.841
T_{11}	2.570	3.083	2.923	2.859	2.345	2.568	2.434	2.449
T_{12}	2.493	3.013	2.487	2.664	2.197	2.435	2.069	2.234
T_{13}	2.443	2.700	2.077	2.407	1.974	2.298	1.905	2.059
Mean	2.207	2.303	2.041	2.183	1.826	1.992	1.710	1.843
LSD_{05}	D	T	D × T		D	T	D × T	
	0.189	0.316	0.544		0.245	0.280	0.520	

3.5. 1000-grain weight

Data in Table 7 reveals that the sowing dates had a significant effect on 1000-grain weight in both seasons. Heaviest 1000-grain weight was observed in November 15 sowing which was significantly heavier than December 1 but statistically at par with November 1 in 2016/2017 but in 2017/2018, it was significantly heavier than November 1 and December 1 sowing. Moreover, sowing date at 1st of December was reduced 1000-grain weight by 3.71 and 5.20% against sowing date at 15th of November in the first and second seasons, respectively. Similar results were reported by Datsan *et al.* (2011), Singh *et al.* (2017), Devi *et al.* (2018) and Reddy and Singh (2018).

Table 7. Average 1000-grain weight as affected by sowing dates, fertilization treatments and their interactions during 2016/2017 and 2017/2018 growing seasons.

Fertilization Treatment (T)	2016/2017 Sowing date (D)			Mean	2017/2018 Sowing date (D)			Mean
	D_1	D_2	D_3		D_1	D_2	D_3	
T_1	48.14	48.98	45.60	47.57	46.03	50.00	45.29	47.11
T_2	52.93	53.50	52.49	52.97	57.06	57.90	54.91	56.62
T_3	51.30	51.17	50.46	50.98	55.16	50.59	50.31	52.02
T_4	51.73	50.78	48.63	50.38	52.74	54.88	50.91	52.84
T_5	52.83	52.59	50.28	51.90	56.01	56.16	54.47	55.55
T_6	51.86	52.26	50.47	51.53	54.47	52.71	49.17	52.12
T_7	51.99	51.01	48.32	50.44	51.47	51.95	50.86	51.43
T_8	51.85	52.75	51.30	51.97	55.08	55.96	53.57	54.87
T_9	51.79	52.35	51.61	51.92	51.52	55.35	52.42	53.10
T_{10}	48.40	51.67	49.19	49.75	50.77	52.93	48.87	50.86
T_{11}	54.39	56.18	52.79	54.45	59.23	62.91	58.25	60.13
T_{12}	53.51	53.80	51.98	53.10	56.57	58.89	57.79	57.75
T_{13}	52.83	53.21	51.92	52.65	55.95	57.13	53.19	55.42
Mean	51.81	52.33	50.39	51.51	54.00	55.18	52.31	53.83
LSD_{05}	D	T	D × T		D	T	D × T	
	1.20	1.70	2.96		2.08	2.54	4.40	

As for treatment combinations of fertilization, these treatments affected significantly the 1000-grain weight in both seasons. Results in Table 7 indicate that the T_{11} surpassed all other treatment combinations of fertilization in both seasons. On the other hand, T_1 gave the lightest 1000-grain weight (47.57 and 47.11 g in the first and second seasons, respectively). It may be attributed due to the use of phosphorus solubilizing bacteria as inoculants increases P uptake. Similar findings were also reported Datsan *et al.* (2011), Singh *et al.* (2017), Kumar *et al.* (2017), Devi *et al.* (2018) and Wali *et al.* (2018).

Respecting the effect of the interaction between sowing dates and fertilization treatments (D × T), this interaction was significant on 1000-grain weight in both seasons (Table 7). Application of T_1 markedly decreased 1000-grain weight when sown at late sowing date (1st of December) in both seasons. But the heaviest 1000-grain weight (56.18 and 62.91 g in the first and second seasons, respectively) was recorded when addition of T_{11} and sown under medium sowing date (15th of November). Similar findings were also reported by Datsan *et al.* (2011), Tripathi *et al.* (2013) and Reddy and Singh (2018).

3.6. Grain yield (Ard./fad.)

Data in Table 8 shows that crop sown under November 8 recorded the highest grain yield of 14.23 and 11.96 Ard./fad., which 28.88 and 7.78% higher than the crop was sown under late (December 1) condition in the first and second seasons, respectively. The higher yield in timely sowing condition could be attributed to favorable temperature at grain development stage which in turn increased the photosynthetic rate, assimilates the supply for seed and seed growth rate in timely sown crops. Higher grain yield of barley under timely sown condition as compared to other sowing dates of barley was also reported by a number of workers **(**Singh *et al.*, 2017; Devi *et al.*, 2018; Reddy and Singh, 2018).

Grain yield of barley was significantly influenced by the application of NPK, biofertilizers and humic acid (Table 8). Among the different treatment combination of fertilization, T_{11} gave the highest yielder (17.67 and 15.47 Ard/faddan in the first and second seasons, respectively). Whereas the lowest values (5.90 and 5.65 Ard/fed.) of this trait was observed from treated with T_1 (Control) in both seasons, respectively. It may be increased due to the more availability of plant nutrients at all growth stages and application of biofertilizer and humic acid significantly seed set and seed filling efficiency (Safina, 2010, Ekin, 2010; Kumar *et al*., 2017; Wali *et al.,* 2018).

There was a significant effect of the interaction between sowing dates and fertilization treatments on grain yield/fed in both seasons (Table 8). The highest grain yield (18.95 and 16.34 Ard./fed. in the first and second seasons, respectively) was recorded under sowing at 15th of November and applied of 75% NPK + biofertilization + humic acid. However, the lowest grain yield (4.25 and 3.85 Ard/faddan) was registered from $D_3 \times T_1$ in the first and second seasons, respectively. It might be due to cumulative effect of growth and yield attributing characters owing to fertilization. Greater availability of metabolites (Phosphosynthates) and nutrients to developing reproductive structures seems to have resulted in increase in all the yield-attributing characters which ultimately improved the yield of the crop Singh *et al.* (2010). Similar findings were reported by Dastan *et al.* (2011), Mukherjee *et al.* (2012), Meena *et al.* (2012), Singh *et al.* (2013) and Reddy and Singh (2018).

Table 8. Average grain yield (Ardab/ feddan) as affected by sowing dates, fertilization treatments and their interactions during 2016/2017 and 2017/2018 growing seasons.

Fertilization Treatment (T)	2016/2017 Sowing date (D)			Mean	2017/2018 Sowing date (D)			Mean
	D_1	D_2	D_3		D_1	D_2	D_3	
T_1	4.88	8.58	4.25	5.90	6.53	6.57	3.85	5.65
T_2	15.75	17.15	13.49	15.46	14.49	15.50	13.95	14.65
T_3	10.51	11.35	6.13	9.33	8.54	6.86	4.97	6.79
T_4	10.29	13.88	6.31	10.16	7.96	10.09	8.03	8.69
T_5	15.67	15.89	10.64	14.07	12.58	13.13	12.26	12.66
T_6	14.93	15.34	9.18	13.15	10.96	11.63	13.21	11.93
T_7	13.44	12.76	10.91	12.37	11.60	11.34	11.62	11.52
T_8	15.12	14.34	11.89	13.78	11.23	14.58	13.32	13.04
T_9	14.06	12.89	11.78	12.91	12.44	12.35	11.59	12.13
T_{10}	14.31	13.65	8.72	12.23	8.50	10.13	8.73	9.12
T_{11}	19.11	18.95	14.96	17.67	15.28	16.34	14.78	15.47
T_{12}	16.33	16.06	12.61	15.00	13.22	15.00	13.81	14.01
T_{13}	14.74	14.16	10.73	13.21	12.11	11.91	13.24	12.42
Mean	13.78	14.23	10.12	12.71	11.19	11.96	11.03	11.39
LSD_{05}	D	T	D × T		D	T	D × T	
	2.28	2.20	3.80		0.64	0.98	1.68	

3.7. Straw yield/faddan

The presented data in Table 9 reveal that the studied sowing dates had a significant effect on straw yield/feddan of barely plants in both seasons. Thus, the highest mean values of straw yield/fed.; 2824.5 and 4249.3 kg / feddan were obtained from barely plants, which were sown under medium sowing date (15th of November) in the first and second seasons. The significant response of straw yield/feddan could attribute to their essential roles in plant growth. The results are in accordance with those of Chaudhary *et al.* (2017) and Devi *et al.* (2018).

Results in Table 9 point out a significant effect on straw yield/feddan due to treatment combinations of fertilization in both seasons. The application of T_{11} gave the highest values of straw yield/feddan (3386.2 and 4816.6 kg/feddan in the first and second seasons, respectively). It may be attributed due to the maximum number of tillers plant^{-1}; optimum plant height and no crop lodging were found the treatment (Ekin, 2010 and Kumar *et al.*, 2013).

Table 9. Average straw yield (kg/feddan) as affected by sowing dates, fertilization treatments and their interactions during 2016/2017 and 2017/2018 growing seasons.

Fertilization Treatment (T)	2016/2017 Sowing date (D)			Mean	2017/2018 Sowing date (D)			Mean
	D_1	D_2	D_3		D_1	D_2	D_3	
T_1	1940.7	1330.0	1278.0	1516.2	1223.3	2975.3	934.0	1710.9
T_2	2842.7	3460.0	2617.3	2973.3	3493.3	4935.3	3048.0	3825.5
T_3	2189.3	1766.0	1564.0	1839.8	1766.0	3646.7	1187.3	2200.0
T_4	1984.7	2197.3	2308.7	2163.6	2197.3	3325.3	1815.3	2446.0
T_5	2770.0	2995.3	2433.3	2732.9	2995.3	4170.0	2476.0	3213.8
T_6	2428.7	2864.0	2408.0	2566.9	2864.0	4011.3	2412.7	3096.0
T_7	2356.7	2672.0	2246.7	2425.1	2672.0	3947.3	1792.7	2804.0
T_8	2640.0	3110.0	2410.0	2720.0	3110.0	4804.0	2793.3	3569.1
T_9	2331.3	3067.7	2309.3	2569.4	3068.0	4594.0	2662.7	3441.6
T_{10}	2292.0	2924.7	2494.0	2570.2	2924.7	4086.7	2558.0	3189.8
T_{11}	3230.7	3906.7	3021.3	3386.2	4673.3	5733.3	4043.3	4816.6
T_{12}	2854.7	3440.0	2908.0	3067.6	3440.0	4843.3	3369.3	3884.2
T_{13}	2543.3	2984.7	2540.0	2689.3	3284.7	4168.7	2569.3	3340.9
Mean	2492.7	2824.5	2349.1	2555.4	2900.9	4249.3	2435.5	3195.3
LSD_{05}	D	T	D × T		D	T	D × T	
	316.6	463.9	803.5		466.6	596.2	1032.7	

The results are in accordance with those of Meena *et al.* (2011), El-Bassiouny *et al.* (2014), Kumar *et al.* (2017), Wali *et al.* (2018) and Karima-Ahmed and Hassan (2019).

Moreover, the interaction between sowing dates and treatment combinations of fertilization (D × T) had a significant effect on the straw yield/feddan in the two growing seasons (Table 9). The highest mean values of straw yield/feddan (3906.7 and 5733.3 kg/feddan in the first and second seasons, respectively) were obtained from $D_2 \times T_{11}$. The significant response can be attributing to a different trend of response, which was observed in plants application fertilization type under favorable sowing date. Similar results were obtained by Reddy and Singh (2018).

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