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RESPONSE OF WHEAT CULTIVARS TO BREAD YEAST WITH DIFFERENT CONCENTRATIONS AND APPLICATION TIME

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SUMMARY

The experiment commenced in the crop season of 2021–2022 at two experimental locations—first at the Department of Field Crops, College of Agriculture and Forestry, University of Mosul, Iraq, and the second was at a farmer's field in Dohuk Governorate, Iraq. The presented study assessed the two wheat cultivars (Rasheed and Buhouth1) and their response to different concentrations of bread yeast (0, 4, and 8 g L^{-1}), as the wheat plants incurred spraying with yeast powder. The experimental layout used the randomized complete block design (RCBD) with three replications. According to the results, cultivar Rasheed showed significant superiority for plant height (49.4 and 50.2 cm), spike length (6.9 and 7.3 cm), and spikes $plant^{-1}$ (5.7 and 6.1 spikes $plant^{-1}$), and Buhouth1 cultivar was substantially superior for grain yield (18.6 and 20.6 g $plant^{-1}$) and harvest index (34.77% and 40.26%) for both locations. Also, from the results, the time of adding bread yeast in the booting stage was superior for characteristics: spikes $plant^{-1}$ (5.9 and 5.7), grain yield (19.1 and 20.9 g $plant^{-1}$), and harvest index (34.85% and 40.42%), whereas the time of addition in the tillering stage was superior for the 1000-grain weight (36.97 and 36.66 g) and biological yield (58.4 and 56.0 g) for both locations. The bread yeast concentration findings revealed a considerable advantage of the concentrations at 4 and 8 g L^{-1} (they did not differ significantly from one other) over the absence of bread yeast concentration of 0 g L^{-1} in the tillers $plant^{-1}$, spike length, spikes $plant^{-1}$, and biological yield. In the harvest index %, the concentration above 4 g L^{-1} was best for the two locations. Most binary and triple interactions of the components in this investigation revealed substantial changes, particularly when their part involved spraying with bread yeast for the two experimental locations.

Keywords: Wheat (*Triticum aestivum* L.), yield-related traits, environmental locations, *Saccharomyces cerevisiae*, yeast

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Key findings: Cultivar Rasheed showed significant superiority for plant height, spike length, and spikes plant^{-1}, while Buhouth1 cultivar superiority was in grain yield and harvest index for both locations. On adding time of bread yeast, the time of addition in the booting stage was superior in the characteristics of spikes plant^{-1}, grain yield, and harvest index, whereas the time of addition in the tillering stage was superior in the characteristics of 1000-grain weight, biological yield, and the conc. of 4 and 8 g L^{-1} compared with 0 g L^{-1}**.**

INTRODUCTION

The wheat crop is one of the oldest known to man, undergoing cultivation and improvement for thousands of years, as Mesopotamia was one of the first places for wheat emergence. Wheat is the first of many valuable cereal crops worldwide because of its nutritional importance, as it provides about 20% of the protein and calories consumed by humans (Wolde *et al.* 2019). Furthermore, the uses of wheat grain are numerous as a raw material in various food businesses (bread, pasta, pastries, cookies, and so on) and straw generated from the wheat crop as animal fodder (Tadesse *et al.,* 2019).

Despite the progress of agriculture and the production of this crop in Iraq, its cultivation still suffers from many problems that have led to a decrease in its grain yield per unit area; thus, it has become a priority to find various modern means to increase production and improve the economy. Among the most vital of these means choosing the appropriate cultivar, as indicated by Harfe ***(*** 2017). When evaluating two cultivars of bread wheat (HAR1685 and Shehan), the significant superiority of the Shehan cultivar surfaced, as the average grain yield was 2966 kg ha^{-1}) and biological yield was 9236 kg ha^{-1}, while the cultivar HAR1685 gave a significant superiority in the harvest index trait amounting to 34%. Mahajan *et al.* (2018) discovered a substantial variation between the cultivars in the majority of the attributes; the cultivar 1994-NIAW outperformed the other types in plant height, tillers plant^{-1}, spike length, grains spike^{-1}, 1000-grain weight, grain yield, and harvest index in bread wheat.

Hassanein *et al.* (2018) discovered a substantial difference between two bread wheat cultivars (Misr-2 and Sids-12), with the cultivar Misr-2 varying in plant height, tillers plant^{-1}, spikes plant^{-1}, and biological yield. Lozhkin *et al.* (2020) conducted a study on five cultivars of wheat (B200, B205, B209, B Niva, and Luch25). The study discovered the quantity and grains spike^{-1} and 1000-grain weight are proportionate to their lengths. The two cultivars, B209 and B Niva proved to have the best productivity indicators, as they achieved the highest value for the 1000-grain weight and biological yield. Al-Hiti and Al-Ubaidi (2021) found that the genotype Babylon-86 was superior to the other genotypes for plant height, tillers plant^{-1}, 1000-grain weight, spikes plant^{-1}, and grain and biological yields.

Abd al-dahi and al-Taweel (2021) did a comparative study of five genotypes imported from wheat (Atlhagy, Nano, Uramy, Miki3, and Ouhassan) and a local cultivar (Svevo), indicating the genotypes Ouhassan, Atlhagy, and Nano were superior over the other cultivars for grain yield. Meanwhile, the Atlhagy cultivar was superior for biological yield, the Ouhassan cultivar in grain yield, and the Uramy cultivar for 1000-grain weight. Past studies observed variances between the cultivars in most of the studied traits (Ali, 2021; Ali *et al.,* 2021; Abdulqader *et al.,* 2021; Abdelrazzaq and Ali, 2022; Ali *et al.,* 2023; Ali *et al.,* 2023). Feeding the plant by fertilizing it with organic ingredients that are safe for the environment and inexpensive are vital for expanding wheat (*Saccharomyces cerevisiae*). This study led to the application of a biological fertilizer, an extract of bread yeast *Saccharomyces cerevisiae*, which has shown to be useful on various crops by enhancing and boosting growth and yield characteristics.

Bread yeast consists of eukaryotic unicellular microbes multiply by simple division or budding. According to Maunder (2006), bread yeast includes 16 amino acids, 13 vitamins, and carbohydrates, most of which are nutrients that the plant needs. The discovery of yeast extracts to stimulate cell division and the synthesis of nucleic acids and proteins also found that yeast generates auxins, gibberellins, and cytokinins. Knowingly, plant hormones play a significant role in the germination, development, and differentiation of plant tissues, as well as determining the extent to which plants respond to their surroundings (El-Tohamy *et al.,* 2008). Zaki *et al.* (2007) demonstrated that when wheat plants incurred treatment with bread yeast at a concentration of 0.2 g L^{-1}, there was a considerable effect in the spikes $plant^{-1}$, grains $spike^{-1}$, 1000-grain weight, and grain yield, compared with plants untreated with bread yeast (0 g L^{-1}).

Hammad and Ali (2014) discovered a substantial variance in the concentration of bread yeast utilized (0, 3, and 6 g L^{-1}) spraying on wheat plants after 25 and 15 days. They discovered a superior concentration In 6 g L^{-l} for the tillers $plant^{-1}$ in two adding dates. Baqir and Al-Naqeeb (2018) found that when they studied the influence of baking yeast, the highest significant concentrations (0, 1, and 2 g L^{-1}) emerged in the 1000-grain weight trait and the harvest index. Mohamed *et al.* (2018) declared remarkable spike length, 1000-grain weight, grain yield, and biological yield when the yeast concentration exceeded 10 g L^{-1} compared with the other parameters (0 and 5 g L^{-1}) in a study on the effect of yeast on the yield of bread wheat (*Triticum aestivum* L).

AL-Shamary and Huthily (2019) investigated the effect of three yeast concentrates (0, 3, and 6 g L^{-1}) on the wheat plant. The results revealed substantial variations in the grains $spike^{-1}$, spikes $plant^{-1}$, grain yield, and biological yield when the concentration approached 6 g L^{-1}), giving the highest significant rate of these features compared with the other two concentrations (0 and 3 g L^{-1}). In bread yeast's time of application to wheat plants, Hammad and Ali (2014) discovered that when they employed two dates in addition to bread yeast (the first date 25 days after germination and the second date 15 days later), the first date exceeded the tillers $plant^{-1}$, plant height, and spikes $plant^{-1}$ characteristics. Superiority from the second date was in terms of grains $spike^{-1}$, 1000-grain weight, grain yield, and biological yield. In this regard, this experiment sought to assess the effect of spraying with dry bread yeast concentration and dates on the yield and growth of two wheat cultivars.

MATERIALS AND METHODS

The research was operational in two sites: the first was in the Department of Field Crops - College of Agriculture and Forestry, University of Mosul experimental field, where the sowing of seeds transpired on November 15, 2021. The second location was in a Dohuk governorate in a farmer's field, where the sowing of seeds ensued on November 17, 2021. The rainfall rates of the two experimental locations appear in Table 1.

Seeking to stimulate wheat crop plants of two cultivars (Rasheed and Buhouth1) and determine their reactions to different concentrations of bread yeast *Saccharomyces cerevisiae* (0, 4, and 8 g L^{-1}), sprinkling the wheat plant with the bread yeast powder with the concentrations until completely wet occurred two times during the tillering stage and the booting stage. The RCBD layout had three replications, and each replicate contained 12 experimental units (2 m long and 1 m wide, with one experimental unit containing five lines), with the seeds planted at a rate of 300 seeds/m^2 at a gap of 0.5 m between each experimental unit.

Table 1. Rainfall rates (mm) for two experimental locations.

Locations	December	January	February	March	April	May
Mosul, Iraq	64	71.5	8	14.5	21	37
Duhok, Iraq	89	123	167	37	29	44

The following characteristics bore averaging across 10 plants for each experimental unit, i.e., tillers plant^{-1}, plant height (cm): Measured from the ground surface to the apex of the spike maturity; the spike length (cm): lengths measured from the base of the spike to the top; spikes plant^{-1}: counted after removing and weighing complete spike grains; 1000-grain weight (g) determined; biological yield (g plant^{-1}): indicating the weight of the plant's entire dry matter (grains + straw); grain yield: a plant from which seeds were harvested and gathered; harvest index %: is (grain yield / biological yield) × 100. The data underwent statistical analysis using the SAS program and the least significant difference test to compare the arithmetic averages at a probability threshold of 5%, according to the RCBD.

RESULTS AND DISCUSSION

Substantial variations were evident between the cultivars used, and the cultivar Rasheed showed significant superiority for tillers plant^{-1} (5.4 tillers plant^{-1}), plant height (49.4 cm), spike length (6.9 cm), and spikes plant^{-1} (5.7 spikes plant^{-1}) (Table 2). The superiority of the cultivar Rasheed for spikes plant^{-1} was due to the advantage of this cultivar's tillers plant^{-1} and plant height having a positive correlation between these characteristics. Meanwhile, the Buhouth1 cultivar was superior in the traits of 1000-grain weight (37.05 g), grain yield (18.6 g), and harvest index (34.77%). However, nonsignificant variations in biological yield occurred between the two studied cultivars. The reason for the superiority of the Buhouth1 cultivar in its harvest index is due to the dominance of this cultivar for its most essential component of the harvest index, which is grain yield. In turn, it results in the excellence of the Buhouth1 cultivar in the 1000-grain weight. The finding aligns with Harfe (2017), Mahajan *et al.* (2018), Hassanein *et al.* (2018), Lozhkin *et al.* (2020), and Al-Hiti and Al-Ubaidi (2021).

Regarding the time application of yeast, it was notable that the addition toward the booting stage is preferable in terms of the tillers plant^{-1} (5.2), plant height (48.6 cm), spike length (6.8 cm), spikes plant^{-1} (5.9), grain yield (19.1 g), and harvest index (34.85%). The booting stage may be the superior time of adding bread yeast due to the positive effect of bread yeast when added, reflecting favorably on these characteristics. On the other hand, adding yeast at the tillering stage was superior for 1000-grain weight (36.97 g) and biological yield (58.4 g) because yeast contains many compounds that are growth regulators and better stimulants, reflecting positively on most of the studied traits. Results were consistent with Hammad and Ali (2014), Ali (2021), Ali *et al.* (2021), Abdulqader *et al.* (2021), Abdelrazzaq and Ali (2022), and Ali *et al.* (2023).

On adding yeast concentration, the 4 and 8 g L^{-1} concentrations were significantly superior compared with not adding yeast (0 g L^{-1}) treatment in the parameters, tillers plant^{-1}, plant height, spike length, spikes plant^{-1}, 1000-grain weight, biological and grain yields, and harvest index. The superiority in most traits is due to concentrations four and eight ably penetrating plant cells, sustaining their survival, supplying the meristematic tissues their requirements for construction and division, thus activating plant metabolism throughout its development, including photosynthesis and its requirements, as reflected in all studied traits. The findings align with Zaki *et al.* (2007), Hammad and Ali (2014), Baqir and Al-Naqeeb (2018), Mohamed *et al.* (2018), and AL-Shamary and Huthily (2019).

The advantage of the cultivar Rasheed and the addition of bread yeast in the stage of straw creation in the features of the number of branches had the binary interactions between the cultivars and the phases of addition determining them (Table 2). Similarly, Rasheed cultivar, when added with the bread yeast in the lining stage, exceeded the spike length (6.7 cm). The interaction between the Buhouth 1 cultivar and bread yeast spraying during the booting stage was superior for spikes plant^{-1}, biological yield (68.1 g), and grain yield (21.7 g).

Table 2. Effect of cultivars, bread yeast concentrations, and application time and their interactions on yield- related traits of wheat at the location of Mosul, Iraq.

Treatments	Tillers $plant^{-1}$	Plant height (cm)	Spike length (cm)	Spikes $plant^{-1}$	1000-grain weight (g)	Biological yield (g $plant^{-1}$)	Grain yield (g $plant^{-1}$)	Harvest index (%)
Cultivars								
Bahoth 1	4.5	45.9	6.2	5.0	37.05	54.5	18.6	34.77
Rasheed	5.4	49.4	6.9	5.7	35.10	54.1	17.7	32.87
time of application								
Tillering stage	4.7	46.7	6.2	5.3	36.97	58.4	17.2	32.99
Booting stage	5.2	48.6	6.8	5.9	35.98	50.2	19.1	34.85
$LSD_{0.05}$	0.38	1.64	0.52	0.51	0.912	2.19	1.01	1.790
Conc.								
0	4.4	43.3	6.0	4.9	33.70	46.5	15.4	33.62
4	5.1	48.2	6.7	5.6	35.98	57.3	19.8	36.25
8	5.4	51.5	7.0	5.6	38.54	59.2	19.2	32.59
$LSD_{0.05}$	0.47	2.01	0.63	0.63	1.117	2.69	1.24	2.193
cultivars × time application								
Bahoth 1× Tillering stage	4.7	44.2	5.9	4.8	37.79	68.1	21.7	31.83
Bahoth 1 × Booting stage	4.3	47.7	6.7	6.5	36.30	41.0	15.5	34.15
Rasheed × Tillering stage	5.7	53.0	6.4	5.3	34.55	48.7	16.5	37.72
Rasheed × Booting stage	5.1	45.8	7.5	5.7	35.65	59.5	18.9	31.58
$LSD_{0.05}$	0.54	2.32	0.73	0.72	1.289	3.10	1.44	2.532
cultivars × conc.								
Bahoth 1× 0	4.1	43.8	5.8	4.7	34.98	49.7	17.0	34.67
Bahoth 1 × 4	4.6	49.3	6.3	5.2	37.11	55.8	19.0	35.33
Bahoth 1 × 8	4.9	52.9	6.4	5.2	39.05	58.1	19.7	34.32
Rasheed × 0	4.6	42.7	6.2	5.2	32.43	43.3	13.8	32.56
Rasheed × 4	5.2	47.2	7.8	4.9	34.84	58.7	20.5	35.17
Rasheed × 8	5.9	50.0	7.9	6.1	37.03	60.2	18.7	30.87
time of application × conc.								
Tillering stage × 0	4.6	43.8	5.8	4.8	32.68	48.9	16.5	34.22
Tillering stage × 4	5.1	49.3	6.8	5.6	35.57	62.8	21.9	34.87
Tillering stage × 8	5.8	53.7	6.4	5.5	39.67	63.6	19.8	30.92
B.S × 0	4.1	42.7	6.1	5.1	34.72	44.1	14.3	33.01
Booting stage × 4	5.1	47.2	6.6	5.5	36.38	51.8	18.6	36.68
Booting stage × 8	4.9	50.3	7.7	5.8	37.42	54.8	18.6	34.27
$LSD_{0.05}$	0.66	2.84	0.90	0.89	1.579	3.80	1.76	3.101
cultivars × time of application × conc.								
Bahoth 1 × Tillering stage × 0	4.2	40.5	5.5	4.3	33.27	60.3	19.4	32.19
Bahoth 1 × Tillering stage ×4	4.7	44.1	6.1	4.9	36.74	70.4	21.2	30.13
Bahoth 1 × Tillering stage × 8	5.1	48.0	6.1	5.3	38.89	73.7	24.9	33.78
Bahoth 1 × Booting stage × 0	4.0	43.9	6.0	5.1	36.68	39.1	14.5	37.16
Bahoth 1 × Booting stage ×4	4.5	47.9	6.5	5.6	37.49	41.2	16.8	40.52
Bahoth 1 × Booting stage × 8	4.5	51.3	6.7	5.1	39.21	42.6	15.1	35.47
Rasheed × Tillering stage × 0	5.1	47.1	6.1	5.3	32.10	37.5	13.5	36.26
Rasheed × Tillering stage ×4	5.1	54.5	7.4	7.7	34.41	55.1	20.6	37.51
Rasheed × Tillering stage × 8	6.3	57.3	6.7	5.7	41.45	53.5	15.3	28.67
Rasheed × Booting stage × 0	4.2	41.5	6.3	5.1	32.76	49.1	14.2	28.86
Rasheed × Booting stage ×4	5.3	46.5	6.8	5.5	35.28	62.4	20.4	32.84
Rasheed × Booting stage × 8	5.3	49.3	8.3	6.4	35.62	64.0	22.2	34.68
$LSD_{0.05}$	0.94	4.01	1.27	1.25	2.233	5.37	2.49	4.386

The results revealed that the interaction of cultivars and bread yeast concentrations gave a substantial superiority of the interaction of the cultivar Rasheed while spraying bread yeast with an 8 g L^{-1} (Table 2). For the tillers $plant^{-1}$ (5.9), spikes $plant^{-1}$ (6.1), and spikes $plant^{-1}$, nonsignificant difference showed from the concentration of 4 g L^{-1}), and a considerable superiority was evident for the interaction of Buhouth1 with the level of bread yeast at an 8 g L^{-1} concentration for the plant height (52.9 cm) and 1000-grain weight (39.05 g) traits, and the superiority of yeast concentrations 4 and 8 g L^{-1} for biological and grain yields for both cultivars Buhouth1 and Rasheed.

Results of the interaction between time application and bread yeast concentrations a considerable superiority showed when adding a concentration of 8 g L^{-1} in the tillering stage for tillers $plant^{-1}$ (5.8), plant height (53.7 cm), 1000-grain weight (39.67 g), and biological yield (63.6 g). However, it did not differ significantly from the concentration 4 g L^{-1} for biological yield (62.8 g). For the same stage superiority, the 4 g L^{-1} concentration of bread yeast in the grain yield was 21.9 g, while the concentration (8 g L^{-1}) exceeded the spike length when added in the booting stage.

The interaction of the Rasheed cultivar while spraying with bread yeast at an 8 g L^{-1} concentration and in the tillering stage influenced tillers $plant^{-1}$ (6.3) and 1000-grain weight (41.45 g) by the triple interaction. Meanwhile, the same superiority from the triple interaction occurred but in the concentration of bread yeast (4 g L^{-1}) for the number of spikes $plant^{-1}$ (7.7 spikes $plant^{-1}$). Also, superiority is similar of the triple interaction but with the Buhouth1 cultivar and at 8 g L^{-1} concentration on the biological yield (73.7 g $plant^{-1}$) and grain yield (24.9 g $plant^{-1}$), which did not differ from the bread yeast concentration of 4 g L^{-1}. Triple interaction was insignificant for harvest index.

Nonsignificant differences were evident for the trait tillers $plant^{-1}$ between the two cultivars, whereas the other features showed substantial variations between cultivars (Table 3). In the Duhok location, the cultivar Rasheed showed significant superiority for plant height (50.2 cm) and spike length (7.3 cm), the tillers $plant^{-1}$ (6.1), 1000-grain weight (36.44 g), and biological yield (56.6 g); however, the cultivar Buhouth1 was maximum in grain yield (20.6 g) and harvest index (40.26%). It may be due to the genetic differences between the cultivars, and thus, the characteristics of these cultivars differ. Outcomes align with results from Hassanein *et al.* (2018), Lozhkin *et al.* (2020), and Al-Hiti and Al-Ubaidi (2021).

There were nonsignificant variations in the features of the tillers $plant^{-1}$ between two time application of yeast, which was in the tillering stage superior in plant height (48.5 cm), spike length (7.2 cm), 1000-grain weight (36.66 g), and biological yield (56.0 g). It may be because the plant benefits from the bread yeast at this stage, as reflected in most of the characteristics in this site. On the booting stage of introducing yeast, it was superior in the harvest index (40.42%), which agrees to findings of Hammad and Ali (2014), Zulkiffal *et al*. (2022), and Khan *et al*. (2023).

The yeast concentrations (4 and 8 g L^{-1}) were superior compared with non-adding yeast (0 g L^{-1}) in the attributes, tillers $plant^{-1}$, plant height, spike length, spikes $plant^{-1}$, the 1000-grain weight, and biological yield (Table 3). However, the 4 g L^{-1} bread yeast concentration was significantly superior over the other concentration for the characteristics grain yield (22.3 g) and harvest index (39.73 gm). The beneficial effect of the yeast powder correlates to cytokinin, which encourages plant cell development and division, with yeast as a natural source of it. Also, its amino acid and nitrogen contents and some mineral components induce growth. This finding is consistent with that of Baqir and Al-Naqeeb (2018), Mohamed *et al.* (2018), and AL-Shamary and Huthily (2019).

There was a considerable significant variation in the binary interactions between the cultivars and time application (Table 3). Buhouth1 cultivar and time application of bread yeast in the booting stage were significantly superior in the tillers $plant^{-1}$ (5.6 tillers $plant^{-1}$) and the harvest index (40.07%), which did not differ significantly from the interaction of the

Table 3. Effect of cultivars, bread yeast concentrations, and application time and their interactions on yield- related traits of wheat at Duhok, Iraq.

Treatments	Tillers plant^{-1}	Plant height (cm)	Spike length (cm)	Spikes plant^{-1}	1000-grain weight (g)	Biological yield (g plant^{-1})	Grain yield (g plant^{-1})	Harvest index (%)
Cultivars								
Bahoth 1	5.0	45.9	6.7	5.3	34.20	51.1	20.6	40.26
Rasheed	5.0	50.2	7.3	6.1	36.44	56.6	18. 0	31.80
time of application								
Tillering stage	5.0	48.5	7.2	5.6	36.66	56.0	19.6	36.29
Booting stage	5.1	45.6	6.8	5.7	34.97	51.7	20.9	40.42
$LSD_{0.05}$	0.36	2.45	0.33	0.62	1.512	1.02	1.30	1.798
conc.								
0	4.5	43.4	6.3	5.0	33.05	49.6	18.0	36.54
4	5.2	51.5	7.5	6.1	36.60	56.5	22.3	39.73
8	5.4	49.2	7.3	5.9	36.31	55.5	20.6	37.23
$LSD_{0.05}$	0.45	3.01	0.41	0.76	1.852	1.25	1.59	2.202
Cultivars × time of application								
Bahoth 1× Tillering stage	4.9	45.7	6.7	5.2	34.51	56.2	22.9	40.74
Bahoth 1 × Booting stage	5.6	46.2	6.7	5.3	33.88	55.9	19.2	40.07
Rasheed × Tillering stage	5.0	51.2	7.7	6.0	35.43	46.1	18.5	34.13
Rasheed × Booting stage	5.0	49.1	7.0	6.9	37.55	58.3	21.0	36.02
$LSD_{0.05}$	0.52	3.47	0.47	0.88	2.138	1.45	1.83	2.542
Cultivars × conc.								
Bahoth 1× 0	4.4	42.5	6.3	4.7	31.31	46.4	18.3	39.51
Bahoth 1 × 4	5.1	48.7	7.0	5.4	34.24	52.5	22.1	42.06
Bahoth 1 × 8	5.9	46.6	6.9	5.3	35.05	54.5	21.4	39.22
Rasheed × 0	4.6	44.3	6.4	5.2	34.79	52.8	17.7	33.58
Rasheed × 4	5.2	54.4	7.9	6.5	35.96	60.4	22.6	37.39
Rasheed × 8	5.2	51.7	7.8	6.5	38.57	56.6	19.9	35.24
time of application × conc.								
Tillering stage × 0	4.4	45.0	6.6	4.9	32.42	49.8	17.8	36.05
Tillering stage × 4	5.0	50.6	7.9	5.0	35.37	59.3	23.9	40.34
Tillering stage × 8	5.4	49.7	7.3	5.9	37.14	59.0	21.1	35.50
Booting stage × 0	4.6	41.8	6.1	5.0	33.68	49.4	18.2	37.04
Booting stage × 4	5.3	52.5	7.3	6.9	39.84	53.6	20.8	39.12
Booting stage × 8	5.4	48.6	7.1	5.8	35.47	52.1	20.2	38.96
$LSD_{0.05}$	0.63	4.25	0.58	1.07	2.619	1.77	2.25	3.114
Cultivars × time of application × conc.								
Bahoth 1 × Tillering stage × 0	4.2	43.0	6.5	4.7	31.42	47.0	19.0	40.42
Bahoth 1 × Tillering stage × 4	5.0	46.3	6.7	5.7	35.50	59.5	26.0	43.69
Bahoth 1 × Tillering stage × 8	5.9	47.8	7.1	5.2	36.62	62.0	24.2	38.85
Bahoth 1 × Booting stage × 0	4.7	42.0	6.1	4.7	31.20	45.7	17.7	38.60
Bahoth 1 × Booting stage × 4	5.0	51.0	7.3	5.8	36.97	45.6	19.2	42.02
Bahoth 1 × Booting stage × 8	5.9	45.5	6.8	5.3	33.47	46.9	18.6	39.60
Rasheed × Tillering stage × 0	4.7	47.1	6.7	5.2	33.41	52.6	16.7	31.67
Rasheed × Tillering stage × 4	5.0	59.9	8.6	6.2	35.23	59.1	22.8	38.57
Rasheed × Tillering stage × 8	5.0	51.7	7.7	6.6	37.65	56.0	18.0	32.16
Rasheed × Booting stage × 0	4.4	41.6	6.1	5.2	36.17	53.0	18.8	35.48
Rasheed × Booting stage × 4	5.0	53.0	7.3	6.8	39.70	62.7	22.3	35.65
Rasheed × Booting stage × 8	5.9	51.8	7.3	6.3	37.48	57.3	21.8	38.33
$LSD_{0.05}$	0.89	6.01	0.82	1.52	3.703	2.50	3.18	4.403

same cultivar. But when time application of bread yeast was at the tillering stage (40.74%), the interaction of the cultivar Rasheed and the time application of bread yeast in the tillering stage was significantly superior for characteristic spike length (7.7 cm), with the same cultivar significantly superior when time application of bread yeast was in booting stage for spikes plant^{-1} (6.9), 1000-grain weight (37.55 g), and biological yield (58.3 g).

Table 3 depicts the interaction between the two factors, cultivar and yeast concentrations. Noticeable superior interaction displayed between the Buhouth1 cultivar and the yeast concentration of 8 g L^{-1} (5.9 tillers plant^{-1}), whereas no significant variations in plant height, spike length, and spikes plant^{-1} were visible between the cultivar Rasheed with the yeast concentrations (4 and 8 g L^{-1}); however, surpassing the interaction of the cultivar Rasheed when spraying the concentration 8 g L^{-1} of yeast, giving 38.57 g in a 1000-grain weight. The same cultivar exceeded in biological yield (60.4 g) and grain yield (22.6 g) but at the 4 g L^{-1} yeast concentration in Buhouth1 cultivar significantly, giving the highest harvest index (42.06 %).

For the interaction between the two factors of time application and the bread yeast concentrations, a significant superiority emerged when adding an 8 g L^{-1} concentration at the tillering and booting stages for tillers plant^{-1} (5.4), with a notable superiority observed when adding a 4 g L^{-1} concentration at the tillering stage on the characteristics spike length (7.9 cm), grain yield (23.9 g), and biological yield (59.3 cm), which did not differ significantly from the concentration 8 g L^{-1} (59.0 cm) and harvest index (40.34%); yet, the concentration exceeded the 4 g L^{-1} when added in the booting stage for 1000-grain weight (39.84 g).

The triple interaction was evident (Table 3). The superiority of the cultivar interaction between Buhouth1 and Rasheed when spraying bread yeast with a concentration of 8 g L^{-1} in the tillering and booting stages occurred for the trait tillers plant^{-1} (5.9). The interaction of the Rasheed cultivar with the consortia was superior when sprayed at the ridge tillering stage at a 4 g L^{-1} concentration in the two characteristics of plant height (59.9 cm) and spike length (8.6 cm). The interaction of the Rasheed cultivar with the consortia was excellent when spraying bread yeast at a concentration of 4 and 8 g L^{-1}) at the booting stage, and the biological yield reached 62.7 g plant^{-1}, which did not differ in the interaction of Buhouth1 cultivar when sprayed with bread yeast at a concentration of 4 or 8 g L^{-1} (62.7 g plant^{-1}). During the tillering stage, the Buhouth1 cultivar was superior in grain yield (26 g plant^{-1}) when sprayed with bread yeast at a (4 g L^{-1} concentration at the tillering stage.

CONCLUSIONS

The results of both sites of this study confirmed the importance of the cultivar Rasheed, showing significant superiority for plant height, spike length, and spikes plant^{-1}. Meanwhile, the Buhouth1 cultivar was superior in the two most crucial characteristics (grain yield and harvest index), the ultimate goal of most agricultural research in field crops. Moreover, the best time to add bread yeast is in the booting stage, recording a significant superiority in spikes plant^{-1}, grain yield, and harvest index traits. The addition of bread yeast in the tillering stage is markedly superior in the 1000-grain weight and biological yield features. The best concentrations of bread yeast used in this study are 4 and 8 g L^{-1} for most of the traits studied. These results herald the improvement of most traits of the strategic wheat crop using the simplest materials available, which are common and inexpensive. It, in turn, works to solve an inherited agricultural problem.

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