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Effect of seeding rates on the performance of some wheat (*Triticum aestivum* L.) genotypes under Fayoum conditions

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ABSTRACT

A field experiment was conducted during 2017/2018 and 2018/2019 seasons at the research farm (Dar El-Ramad), of Faculty of Agriculture, Fayoum University, Egypt, to investigate the effects of three seeding rates S_1 = 45 kg/fed., S_2 = 60 kg/fed. and S_3 = 75 kg/fed on the performance of five genotypes of wheat (*Triticum aestivum* L): namely, G_1 (Sids12), G_2 (Sakha93/Gimmeiza5-2), G_3 (Sakha93/Gimmeiza5-4), G_4 (Sakha93/Sids1-3) and G_5 (Gimmeiza5/Giza168-7) for growth, yield, and its components. A split-plot design was used with three replicates. The seeding rates were allotted to the main plots and wheat genotypes to the sub-plot. The results indicated that there were significant differences in all growth traits at all growth stages and yield parameters between seeding rates and also wheat genotypes. First seed rated (45 kg/fed.) possessed the superiority in most traits in all growth stages and yield parameters followed by S_2 (60 kg/fed.). G_4 and G_3 gave the highest values for most growth traits i.e. tillers number, no. of leaves, total leaf area and dry matter and yield such as plant height, tillers number, spike length, number of spikelet's spike^{-1}, grains weight/spike, 1000-grain weight, grain yield (ard/fed), and protein content (%). The interactions, between two factors (S x G), were significant for most of the characters under study in most growth stages or periods, as well as, yield parameters. The genotypes G_4 and G_3 were more superior under first seeding rates, S_1 (45 kg/fed) for most traits at growth stage and yield parameters. These

results provide evidence that agronomic performance and end-use quality traits are greatly influenced by the wheat genotypes under seeding rates.

Key words: Wheat, seeding rates, Wheat genotypes, growth, yield and yield components.

1. INTRODUCTION

Wheat is the most important winter cereal and food grain crop in the world and in Egypt. Wheat is primarily used as a staple food that provides more protein 10-15% than any other cereal crop. Moreover, its straw is employed as animal feed. Wheat has a wide range of environments that affect overall performance, particularly grain yield, climatic factors over which producers have little control (such as precipitation, temperature, day length), soil types and management practices (such as fertilizer, herbicides, fungicides, irrigation, sowing date, and seeding rate) Total cultivated area in the world 214.3 million ha^{-1}, total world production 734.1 million tons. While in Egypt cultivated area was 3.13 million feddan and it's producing 8.8 million tons, it covers less than 55 % of local consumption (FAO, 2018).

In Egypt condition, increasing wheat production is considered as one of the most important strategic goals in order to decrease the great gap between production and human consumption especially under the yearly increase in the population with a more rate than production. Solving these problems needs pressing hard to increase wheat yield. It can happen in some ways. Seed rate played a very important role in providing to the proper space required by plants for efficient utilization of air, water, solar energy, space, and nutrient (Baviskar et al. 2016), therefore, the crop yield and quality of the crop may be improved at great extent.

Planting method plays an important role in the wheat plants compete with each other and with the weed species, which ultimately affects crop growth and development. Absorption of photo-synthetically active radiations has also been found to be influenced by planting methods. The selection of suitable planting method for wheat depends upon the time of planting, availability of soil water at planting time, amount of residue in the field, and availability of planting machines. Wheat are often sown by different techniques i.e., line sowing by drilling, broadcasting, and raised bed planting.

Seed rate is one among the foremost important agronomic factors which require great emphasis for the utmost yield of crops. High seed rate increases the competition among crops for common resources particularly water, nutrients, and sunlight which ends up in inferiority and low yield.

Raising wheat production through increasing the productivity per unit area is thus an important national target. Improving productivity could be achieved by cultivating high yielding cultivars coupled with improved agronomic practices such as sowing technique and seed rates treatments. Therefore, this investigation was established to study the performance of some wheat genotypes under different seeding rates under the environmental conditions of the Fayoum governorate.

2. MATERIALS AND METHODS

Experimental site

Two field experiments were conducted in 2017/2018 and 2018/2019 seasons, the experimental farm of Faculty of Agriculture, at (Dar El-Ramad), Fayoum University, Egypt. The objective of this research was to study performance of some wheat genotypes under different seeding rates. Soil texture was sand (21.73%) clay (42.92%) silt (35.36%); a surface soil sample (0-30cm) was collected before planting and analyzed the physic-chemical characteristics during both seasons (pH= 7.37, O.M. = 2.03%, ECe = 1.92 ds/m and $CaCO_3$ %= 7.02%).

Table (1): List and pedigree of the five bread wheat genotypes including one released variety

Cod No.	Genotypes	Pedigree
G1	Sids12	BUS//7C//ALD/5/MAYA74/ON//1160.147/3/BB/GLL/4/CHAT"S"/ 6/MAYA/VUL//CMH74A.630/4*SX. SD720096-4SD-1SD-1SD-0SD.
G2	96 X 42 2	(Sakha93/ Gimmeiza5 -2).
G3	96 X 42 4	(Sakha93/Gimmeiza5 -4).
G4	96 X 95 3	(Sakha93/Sids1 -3).
G5	42 X 15 7	(Gimmeiza5/Giza168 -7).

Treatments and experimental design

The experimental layout was a split-plot system based on randomized complete block design (RCBD) with three replications. Treatments were divided into three levels of seeding rates(S) and five wheat genotypes (G). Seeding rates and wheat genotypes were randomly allocated within the main and sub-plots, orderly. Seeding rate was specified as the following three treatments: S_1 = 45 kg/fed., S_2= 60 kg/fed. and S_3 = 75 kg/fed. and wheat genotypes were sids12 used as control, G_2,G_3,$G_4$and G_5,the last four lines were selected from F6 generation developed by Ghallab, 2006 (Table 1 are the pedigree for this genotypes). The 15 treatments were replicated three times, making a total of 45 plots (plot area was 7.5 m^2).

Cultural practices

Sowing dates were 15 and 21 November in the first and second seasons, respectively. The preceding summer crop was maize (*Zea mays, L.)* in both seasons. In the two experiments N fertilizer was added on the form of ammonium nitrate (33.5% N) at rate of 80 kg N/fed., was added in three doses. The first dose (20 kg N/fed.) was added at sowing time, the second dose (30 kg N /fed.) was added before the 1st irrigation (21 days after sowing) and the third dose (30 kg N / fed.) was added before 2nd irrigation (after 21 days of the 1st irrigation). Phosphorus fertilizer was applied in the form of calcium superphosphate (15.5% P_2O_5) at the rate of 150 kg super phosphate calcium/fed., added during the soil preparation. Potassium fertilizer was applied before sowing (during seedbed preparation) at rate of 50 kg/fed., in the form of potassium sulphate (48% K_2O). The first Irrigation was applied at 21 days after sowing then plants were irrigated every 21 days till the dough stage. All other agricultural treatments for wheat production were carried out as recommended by the Ministry of Agriculture.

Studied traits

A. Growth traits

Five plants were chosen from each sub-plot at 70, 91 and 112 days after wheat planting to determine: Plant height (cm), number of tillers $plant^{-1}$, number of leaves/plant, total leaf area/plant (cm^2), flag leaf area/plant (cm^2), dry matter accumulation/plant (g), The growth analysis criteria calculated by the basic formulas found by Redford (1967) as the follows:

Crop growth rate (CGR): $\frac{(W2-W1)}{(T2-T1)}$ (gm/day)

Leaf area ratio (LAR): $\frac{(A2-A1)\ (\text{Loge } W2- \text{Loge } W1)}{(\text{Loge } A2- \text{Loge } A1)\ (W2-W1)}$

Where: W_1, A_1 and W_2, A_2 refer to total dry weight and leaf area at the first period (T_1) and second period (T_2) of sampling, respectively.

Yield and its components traits

At harvest time Five guarded plants were taken at random from each sub-sub-plot in the three replications to determine yield and yield components: Plant height (cm), Number of total tillers/plant, Spike length of main stem (cm), Number of spikelet's/spike, Grains weight main $spike^{-1}$, Number of spikes/m^2, 1000-grain weight (g), Grain yield (ard/fed) and grains protein content percentage.

Statistical analysis

All data were subjected to an analysis of variance (ANOVA) described by (Gomez and Gomez, 1984), and differences among the means were compared LSD test at the 5% of probability ($p \leq 0.05$).

3. RESULTS AND DISCUSSION

Effect of seeding rates on growth traits performance

Seeding rates affected on different traits under this study were significant in all stages over two seasons (Table 2). Seed rate, S_1 (45 kg /fed.) produced a significant increase in all growth traits in all growth stages except plant height in early and medium stages. Increasing seed rate from S_1 (45 kg/fed.) to S_3 (75 kg/fed.) was a significant increase in plant height in early and medium stages from plant age, while at 112 days S_1 (45 kg/fed.) produced significantly tallest plants followed by S_2 (60 kg/fed.). The results with respect to crop growth rate (CGR) and leaf area ratio (LAR) Fig. 1 indicated that significantly influenced due to different seeding rates in two seasons. Increasing seed rate decreased the CGR and LAR values. These results are in harmony with those obtained by EL-Hag (2016), Bavisker *et al*. (2016), Tigabu and Asfaw (2016), Wahid and Al-Hilfy (2017) and Rai *et al.* (2018).

Wheat genotypes and check variety (Sids12) exhibited significant differences in all growth traits in all growth stages (Table 2). At all growth stages, G_3 (Sakha93/ Gimmeiza5-4) surpassed for plant height, flag leaf area, and dry matter accumulation, while G_4 (Sakha93/Sids1-3) surpassed for number tillers/plant, number of leaves/plant, and total leaf area/plant in all growth stages over two seasons. The minimum values recorded from G_1 followed by G_5, for most traits in all growth stages over two seasons. The difference in these traits among genotypes was a genetically variable and a considerable amount of variability was existed among them, revealing that successful selection for these traits would be effective for wheat improvement. The differences between CGR and LAR means induced by genotypes had a significant at first and second growth periods over two seasons (Fig.1). At two stages the highest CGR was produced by G_1 at 1st and G_3 at 2nd growth period and LAR was produced by G_5 had s significant at 1st and 2nd growth periods over two seasons. The genotypic differences were also observed by Mehasan (1999), Kamal *et al.* (2003), Bakhit *et al.* (2007), Tahir *et al.* (2009), Abdulkerm *et al.* (2015), Hefny *et al.* (2015), El Hag (2016) and Ghafari *et al.* (2017).

Table 2. Growth trait means of wheat at different growth stages, as affected by seeding rates (S) over two seasons (2017/2018 and 2018/2019)

Seeding rates (S)	Plant height Cm	No. of tillers	No. of leaves	Total leaf area cm^2	Flag leaf area Cm^2	Dry matter G	Plant height Cm	No. of tillers	No. of leaves	Total leaf Area cm^2	Flag leaf Area cm^2	Dry matter g	Plant height G	No. of tillers	No. of leaves	Total leaf Area cm^2	Flag leaf area cm^2	Dry matter g
	70 days						91 days						112 days					
S_1	65.52	3.60	17.45	369.94	35.13	2.95	88.01	3.16	19.08	577.33	44.56	5.30	108.38	3.18	17.70	744.83	42.60	8.71
S_2	67.41	3.19	15.02	330.06	33.89	2.47	89.26	2.93	16.71	530.07	41.92	4.82	105.98	3.05	16.56	708.98	42.77	7.91
S_3	67.28	2.95	14.47	306.56	32.18	2.35	90.28	3.00	17.32	472.03	42.39	4.75	104.51	2.90	15.76	648.49	39.53	7.09
LSD 5%	**1.19**	**0.20**	**0.79**	**10.02**	**1.01**	**0.22**	**0.87**	**0.11**	**1.00**	**15.25**	**1.15**	**0.19**	**1.89**	**0.07**	**0.58**	**20.76**	**0.74**	**0.29**

Table 3. Growth trait means at different growth stages, as affected by wheat genotypes (G) over two seasons (2017/2018 and 2018/2019).

Wheat genotypes (G)	Plant height Cm	No. of Tillers	No. of leaves	Total leaf Area cm^2	Flag leaf Area cm^2	Dry matter g	Plant height Cm	No. of tillers	No. of leaves	Total Leaf Area cm^2	Flag leaf Area cm^2	Dry Matter g	Plant Height Cm	No. of tillers	No. of leaves	Total leaf Area cm^2	Flag Leaf Area cm^2	Dry Matter g
	70 days						**91 days**						**112 days**					
G_1	68.14	2.48	13.38	268.82	33.65	2.73	91.87	2.53	16.15	434.17	46.73	5.22	105.46	2.46	13.69	576.63	42.04	7.60
G_2	65.39	3.51	16.50	330.07	34.53	2.27	90.41	3.18	18.12	499.55	45.51	4.55	103.36	2.98	17.17	703.56	41.05	7.45
G_3	72.52	2.91	13.80	359.17	38.96	3.04	93.76	2.90	15.51	565.39	47.64	5.93	115.23	2.74	15.42	692.30	47.82	9.58
G_4	56.49	3.78	17.46	368.33	31.25	2.47	78.30	3.37	19.88	582.20	32.63	4.88	97.41	3.69	18.98	819.42	33.18	7.85
G_5	71.13	3.55	17.10	351.24	30.30	2.42	89.92	3.18	18.86	551.06	42.26	4.23	110.01	3.34	18.10	711.94	44.17	7.04
LSD 5%	**2.54**	**0.25**	**0.91**	**18.23**	**1.91**	**0.22**	**2.19**	**0.23**	**1.22**	**20.49**	**2.93**	**0.35**	**2.43**	**0.27**	**1.13**	**29.73**	**2.26**	**0.38**

The interaction between seeding rates and wheat genotypes (SxG) was significant at all plant ages over two seasons (Fig2.). The S1G3 interaction (seeding rate of 45 kg/fed. and Sakha93 /Gimmeiza5-4) was superior for total leaf area, flag leaf area and dry matter accumulation and S_1G_4 (seeding rate of 45 kg/fed. and Sakha93/Sids1-3) for no. of tillers/pant, no. of leaves and dry matter at all growth stages over two seasons. The differences in the Crop growth rate due to interaction between seeding rates and wheat genotypes had significantly during the two seasons at all growth periods (Fig.1). The highest CGR was obtained by G_3 (Sakha93/Gimmeiza5-4) and seed rate of 45 kg or 60 kg/fed at 1st and 2nd growth periods over two seasons respectively. The highest LAR was obtained by G_5 (Gimmeiza5/Giza168-7) and seed rate of 60 kg or 75 kg/fed at 1st and 2nd growth periods over two seasons respectively. Significant differences in this respect were also observed by Mehasan *et al.* (2009), Baviskar *et al.* (2016), and El Hag (2016).

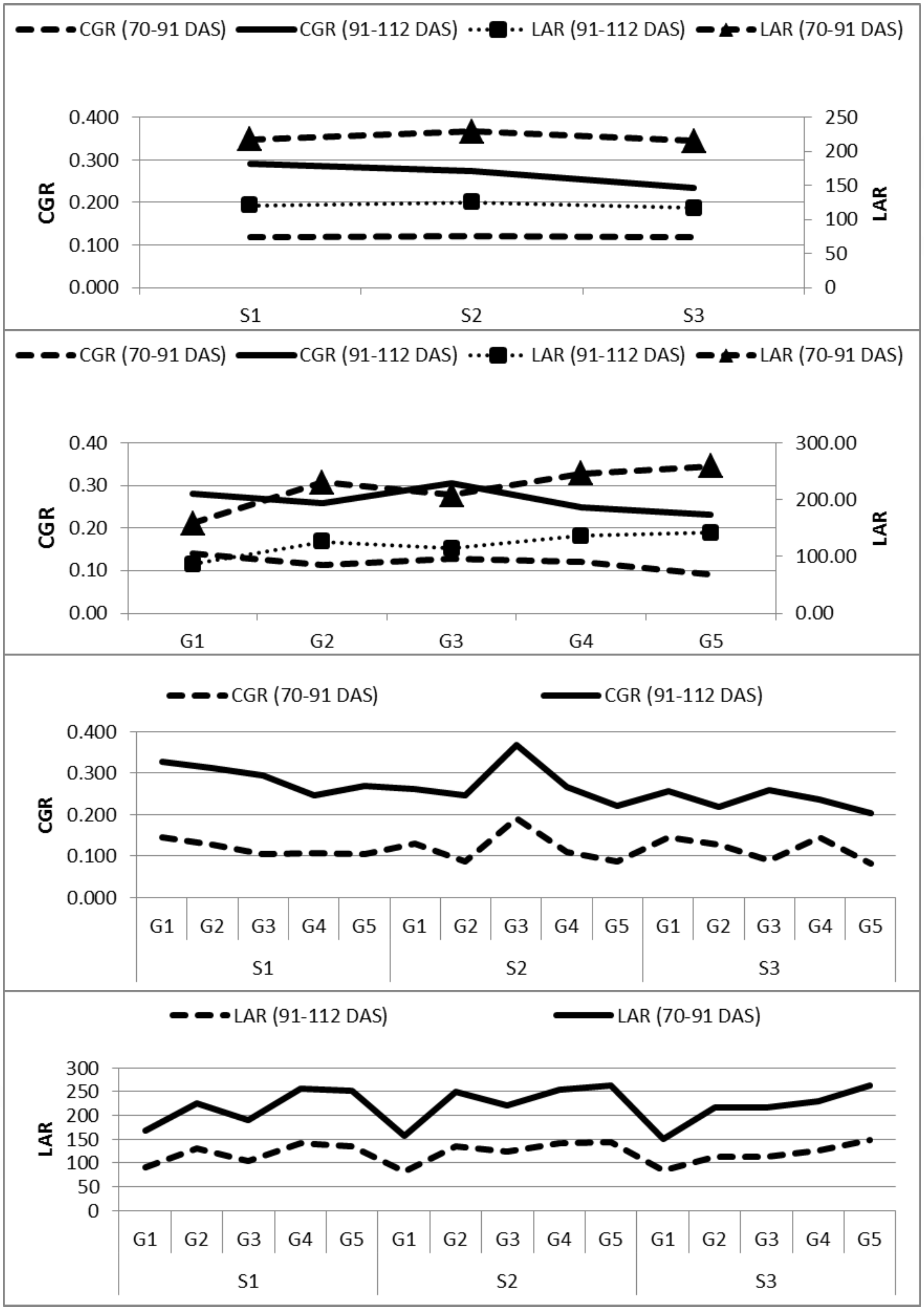

Figure 1. Crop growth rate (CGR) and leaf area ratio (LAR) means at different growth period, as affected by seeding rates (s), wheat genotypes (G) and their interactions over two seasons (2017/2018 and 2018/2019).

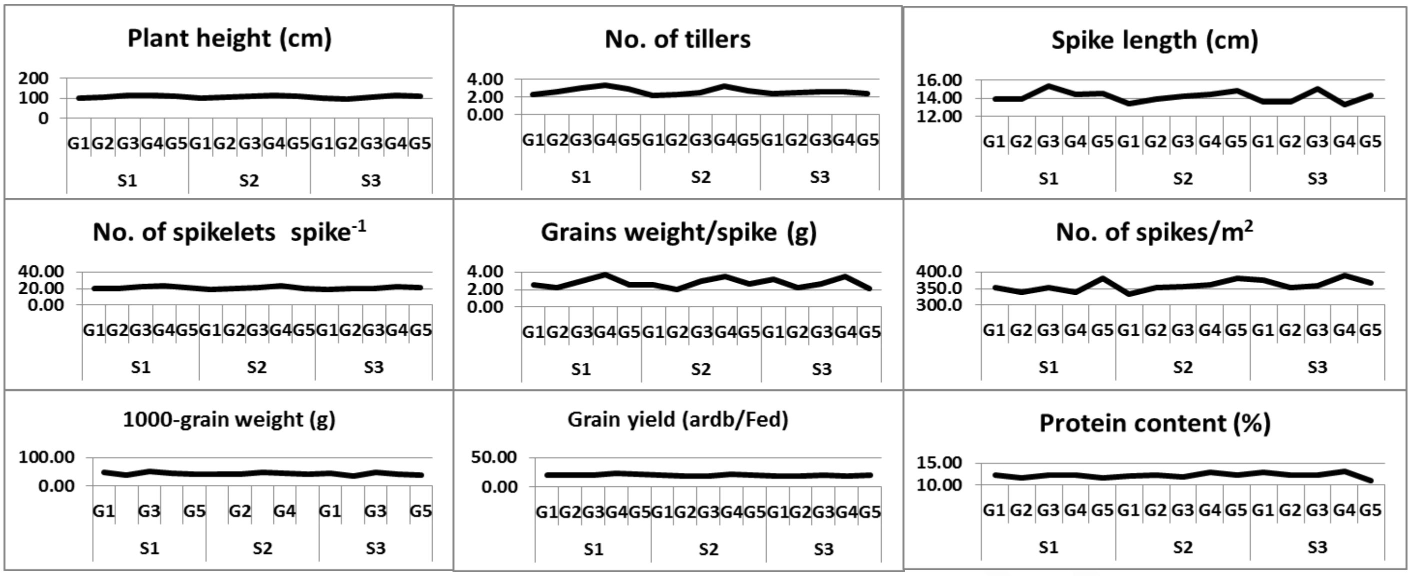

Figure 2. Growth trait means at different growth stages, as affected by seeding rates (S) and wheat genotypes (G) interactions over two seasons (2017/2018 and 2018/2019).

Effect of wheat genotypes on yield parameter performance

The results illustrated in tables (4) show the effect of seeding rates, on yield traits at harvest. Seed rates had a significant influence on all traits under this study except grains weight/spike trait was non-significant over two seasons. A decrease in the seed rate /feddan was accompanied by an increase in the average of all traits except the number of spikes/m^2 and protein content over two seasons. Lower seeding rate had better yield due to vigorous crop growth. This finding is concurrence with those found by Hussian *et al.* (2010), Tigabu and Asfaw (2016), and Tadesse *et al.* (2017). On the contrary, Ali *et al.* (2010), Iqbal *et al.* (2010), Said *et al.* (2012) and Singh *et al.* (2013) showed that the maximum yield was obtained where the moderate seed rate. El Hag (2016) reported that an increase in seeding rate increased yield.

Table 4. Effect of seeding rates on yield parameters and protein content in wheat genotypes over two seasons (2017/2018 &2018/2019)

Seeding rates (S)	Plant height (cm)	No. of tillers	Spike length (cm)	No. of spikelet's spike^{-1}	Grains weight /spike (g)	No. of spikes/ m^2	1000-grain weight (g)	Grain yield (ard/fed)	Protein content (%)
S_1	110.04	2.85	14.42	21.57	2.79	354.14	45.54	21.13	12.12
S_2	107.88	2.58	14.17	21.19	2.75	357.77	44.46	20.12	12.30
S_3	105.39	2.49	13.98	20.74	2.74	368.68	42.00	19.93	12.38
$LSD_{5\%}$	**1.86**	**0.11**	**0.13**	**0.50**	**n.s**	**3.64**	**0.62**	**0.53**	**0.13**

Where: S1 = 45 kg/fed., S2= 60 kg/fed. and S3 = 70 kg/fed.

The differences in wheat yield and its components induced by wheat genotypes were significant in both seasons (Table5). The results indicated that G_4 was surpassed in all yield traits except spike length and 1000-grains weight over two seasons followed by G_3 (Sakha93/ Gimmeiza5-4). While the lowest recorded from G_1 for plant height, tillers number, spike length, and spikelets number/spike and G_2 (Sakha93/ Gimmeiza5-2) for grains weight/spike, spikes no./m2, 1000-grains weight, and grain yield/fed. Higher grain yield of G_4, G_3 and G_5 may mainly be attributed to its distinguish in some growth traits, number of tillers, number of leaves and dry matter accumulation especially at vegetative growth stages before flowering and also superiority in the number of tillers, number of spikelet's /spike, grains weight per spike and number of spikes/m^2. The marked variations between wheat genotypes or significant effects were also obtained by many investigators among them EL-Kalla *et al.* (2010), Ibrahim *et al.* (2011), Abd El-Kreem and El-Hussin (2013), Mehasan *et al.* (2014), Hefny *et al.* (2015), El Hag (2016) and Rekani *et al.* (2017).

Table 5. Effect of five wheat genotypes on yield parameters and protein content over two seasons (2017/2018 & 2018/2019)

Wheat genotypes (G)	Plant height (cm)	No. of tillers	Spike length (cm)	No. of spikelet's spike^{-1}	Grains weight /spike (g)	No. of spikes/ m^2	1000-grain weight (g)	Grain yield (ard/Fed)	Protein content (%)
G_1	100.64	2.29	13.66	19.49	2.74	354.25	44.89	19.95	12.42
G_2	101.57	2.46	13.80	20.31	2.16	348.42	39.66	19.33	12.07
G_3	110.70	2.71	14.89	21.43	2.87	356.60	49.74	19.93	12.21
G_4	115.33	3.06	14.02	23.36	3.58	364.45	43.91	21.66	12.93
G_5	110.61	2.68	14.56	21.25	2.45	377.25	41.81	21.09	11.72
$LSD_{5\%}$	**2.31**	**0.24**	**0.49**	**0.84**	**0.24**	**7.86**	**0.66**	**0.52**	**0.33**

The interaction of S x G was significantly different for all traits over two seasons except the number of spikelets/spike (Fig3). A seed rate of 45 kg/fed. with G_4 resulted in the highest all traits except spike length, the number of spike/m^2 (340.34) and protein content (12.44), it is observed that A seeding rate less recommended rate (45 kg/fed.) for most genotypes produced the highest yields over two seasons. The significant interaction was observed also by Mehasan *et al.* (2009), Hussain *et al.* (2010), EL-Lattief (2014), Abdulkerim *et al.* (2015), El Hag (2016) and Shah *et al.* (2016**)** on the contrary Akahter *et al.* (2019) showed that the interaction effect of variety and seeding rate on yield did not vary significantly in both seasons.

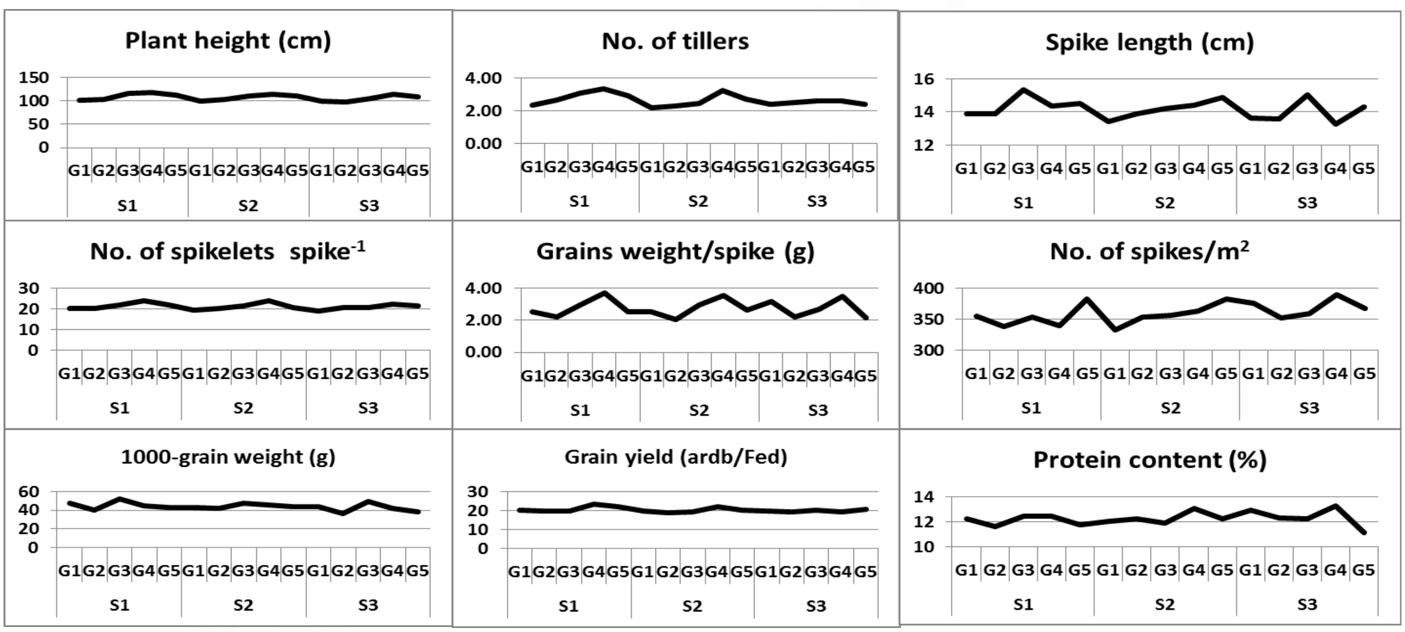

Fig 3. Yield trait means at different growth stages, as affected by seeding rates (S) and wheat genotypes (G) interactions over two seasons (2017/2018 and 2018/2019).

4. CONCLUSION

The results of this study suggest that wheat genotypes G1, G_2, G_3, G_4 and G_5 can be selected to grow under three seeding rates (S_1, S_2 and S_3). The genotypes G_4 and G_3 were more superior under first seeding rates, S_1 (45 kg/Fed) for most traits at growth stage and yield parameters. These results indicating that the quantity of seeding rates of wheat genotypes may be useful for a further cross-breeding programmer. Overall, it can be concluded that substantial variation in the seeding rate among wheat genotypes at the vegetative stage was found in this study. Grain yield associated with other parameters confirmed that it's important to use the parameters as useful selection criteria for screening the seeding rates in terms of grain yield among genotypes at the early vegetative growth stage. Most importantly, the parameters can be considered for screening wheat genotypes at different seeding rates.

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Conflict of Interest: The authors declare that there are no conflicts of interests.

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Data and materials availability: All data associated with this study are present in the paper.

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