EFFECT OF SEED SIZE AND SEEDING RATES ON YIELD ATTRIBUTES OF TRITICALE Var. ADMIRAL

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ABSTRACT:

A factorial in randomized complete block design (RCBD), with three replicates, including three seeding rates (200,250, and300seeds.m^{-2}), and three grain size grades of Admiral variety of triticale whole (ungraded), thousand seed weight (TSW) 47.32g, heavy seeds 54.04g and light seeds 40.18g; for two successive growing seasons 2019-2020 and 2020-2021. The results revealed that spike length resembled number of spikelets per spike, grain density and number of grain per spike as seeding rate 200 with whole seeds attained highest value. Great differences between the two seasons were obvious, which was attributed to shortage in rainfall in the second season(407.1mm and 165.4mm). The interaction of seeding rate 200 with heavy size seeds resulted in maximum biological yield (6233 kg.ha^{-1}). The interaction of target seed rate 200 with heavy seeds resulted in maximum grain yield(2895 kg.ha^{-1}). Harvest index was highest value for interaction of seed rate 300 with light seed size which was(4.8). Thousand kernels weight give superior weight for the interaction of rate 200 seeds with heavy grade size(52.02g), the second season was clearly obvious as heavy grade resulted in heavier seeds significantly(14.88g) although it was very small atrophic seeds due to shortage of rainfall. Protein content as percentage was significantly affected by seeding rate, seed grade and their interaction for the first season protein% at 200 seeding rate surpassed other rates(12.04%). Seed grade of whole ungraded seeds resulted in higher protein(12.25%). With respect of the interaction, the highest values was (13.03%) for whole seeds with target rate 200 seeds.m^{-2}.

Keywords: Rainfall, biological, target, index, grades

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تأثير حجم البذور ومعدلات البذار في صفات حاصل القمح الشيلمي صنف ادمرال

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المستخلص:

تم إجراء تجربة عاملية بتصميم القطاعات العشوائية الكاملة(RCBD) وبثلاث مكررات، تضمنت ثلاثة معدلات بذار(200، 250،300 بذرة.م$^{-2}$)، وثلاثة أحجام بذور صنف ادمرال للقمح الشيلمي درجة كاملة(غير مدرجة)، وزن ألف بذرة(TSW 47.32غم)، بذور ثقيلة(54.04غم) وبذور خفيفة(40.18غم)؛ لموسمين زراعية متتاليين 2019–2020 و2020–2021. أظهرت النتائج أن طول سنبلة, عدد السنيبلات لكل سنبلة, كثافة البذور في السنبلة مع عدد البذور في السنبلة حيث بلغ تداخل معدلات البذار معدل البذر 200بذرة مع البذور الكاملة غير المدرجة أعلى قيمة. وظهرت اختلافات كبيرة بين الموسمين، ويعزى ذلك إلى نقص الأمطار في الموسم الثاني(407.1 و 165.4ملم) لموسمي الزراعة 2019–2020 و2020–2021 على التوالي. أظهرت النتائج الخاصة عن تداخل معدل البذر 200 مع البذور ذات الحجم الثقيل أقصى إنتاج بايولوجي(6233 كغم هكتار$^{-1}$). وقد أدى تداخل معدل البذرة المطلوبة 200 مع البذور الثقيلة إلى إنتاج أقصى حاصل حبوب(2895 كغم هكتار$^{-1}$). كان دليل الحصاد أعلى قيمة لتداخل بين معدل البذرة 300 مع حجم البذرة الخفيفة والتي كانت(4.8). أعطى وزن الألف بذرة وزنًا فائقًا لتداخل معدل 200 بذرة مع درجة البذور الثقيلة(52.02)، وكان الموسم الثاني واضحًا حيث نتج عن الدرجة الثقيلة بذور أثقل معنوياً (14.88) على الرغم من أنها كانت بذور ضامرة صغيرة جدًا فيما يتعلق بالتداخل. محتوى البروتين كنسبة مئوية تأثر معنويا بمعدل البذار ودرجة حجم البذور وتداخلها للموسم الأول. نسبة البروتين عند 200 بذار تجاوزت المعدلات الأخرى (12.04%). أنتجت درجات حجم البذور الكاملة غير المدرجة أعلى نسبة بروتين (12.25%). فيما يتعلق بالتداخل كانت أعلى قيمة(13.03%) للبذور الكاملة غير المدرجة مع معدل بذار200بذرة للمتر المربع.

الكلمات المفتاحية: هطول الامطار، حيوي، هدف، مؤشر، درجات

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INTRODUCTION

Triticale (x *Triticosecale wittmack*) as a modern exceedingly effective species of little grains was made by crossing wheat and rye. It was planned with the thought to get a cereal, which combines great quality grain yield from wheat parent with resistance to abiotic and biotic stress (81). Cereals are the most significant cultivated crops and reason for the primary energy and protein source for both humans and animals' nutrition (67, 69). Modern varieties of triticale are rise to or predominant to other cultures for grain yield, forage and biomass production for human food, animal feed and mechanical applications (62). Protein level in triticale grain to an extraordinary degree subordinate of a variety (7). Triticale protein content between 10.4 and 13.2% (47) and also, inside 9.10 and 11.14 g/100 g^{-1}(80). The triticale could be an appropriate crop for development under biological system due to its steady yield, resistance to unfavorable conditions, resistance to infections and high competitiveness against weeds (48). Compared to wheat or corn, triticale is generally reported as having superior levels and availability of important amino acids for monogastric animals. Triticale flour yield is less than wheat, and as a softer grain it must be milled differently (21). Water insufficiency amid the period of anthesis is critical minute to typical cereal production, causing critical yield losses (27). Productive traits of winter triticale in term of spike length, number of grains per spike, 1000 grain mass and grain yield have significant effect by meteorological conditions in the years of research (13). Excessive surplus or deficit of rains and by large temperature amplitudes cause severely for the cereal yields (59). Also, one of the major variables contributing to changes in cereal yields can be contrasts in precipitation, its volume and escalated as well as dispersion over the plant developing season (68). Optimum sowing rate and progressed agricultural methods has an imperative part in expanding yield and quality of plants. Seed rates over the ideal level force nutrients, light, moisture stresses and consequently unfavorably influence crop yield whereas seed rate blew ideal level ordinarily has low yield (60). By increasing seed rate the number of grains $spike^{-1}$ is reduced (46, 57). Plant density affected on grain yield and many characteristic of triticale (87). Also, plant density influences the plant population, 1000 grain weight and straw yield (6). Harvest Index (HI) were affected highly by the main effects of variety and seed rate whereas, also above ground dry biomass yield was highly significantly affected only by the main effect of the seed rate (40). Among the results obtained by comparing the different seed rates have a significant increase in the number of spikes/m, the number of seeds per spike and grain yield by increasing the amount of seeds from 120 to 160 kg/ha, while the increase in the amount of seeds had no significant effect at each the weight of the spike seed and the weight of 1000 grains. Radiation absorbing is low at high densities and the coefficient of their photosynthetic yield is very low, on the other hand, sufficient sunlight isn't absorbed in high densities, but photosynthetic yield is exceptionally lower due to common shadowing leaves, hence, greatest sunlight retention for a period longer than a growing season is very imperative within the canopy (2). Adjust seeding rates to achieve targeted plant densities for specific triticale uses and conditions. Seed size is a critical physical pointer of seed quality that influences vegetative development and is regularly related to yield, market review components and harvest efficiency (8). For the most part, large seed has better field performance than small seed. As generally known, seed size one of the important factors in improving crop yield is planting high quality seed. The seed size plays a central part within the plant's lifetime and the impacts of seed size on diverse stages of the plant improvement play a major part on more biological activities of the plant and its environmental issues (19). Differences found in grain yields between seed fractions were statistically significant (36). Seed size of spring barley has had the impact on the intensity and the rate of first phenophases within the improvement (53, 54, 55). The seeds of a seed lot may vary by size, weight and density due to production environment and development practices. Seed size is one of the components of seed quality which influences the performance of crop. For an effective crop

generation, utilize of good quality seed is exceptionally basic which increase the yield by 15-20%. The degree of this increment is specifically relative to the quality of seed that is being sown (4, 5, 65). There are numerous factors influencing on triticale production and quality such as protein, seed size and seedling rates has been investigated by various researches. Seed size positively correlated with both seedling height and root collar diameter. In addition, dry environmental conditions in their natural habitat could also influence the selection of larger seeds, as this provides increased drought tolerance to cope with the changing environment and possible new pests. Depend of spring barley seed size, the biggest values of germ length and rootlet length were achieved with the seed portion of 2,8 mm, and the least values with seed portion of 2,2 mm (35). Comparable results and concluded that plants developed from large seeds had 20-30 % greater grain yield than plants grown from small seeds (75). Large seeds have had more quickly germination and have emerged more rapidly field development. Seedlings produced from large seeds of winter barley have emerged more quickly and produced higher density stands than little seeds in trial 1 (a long time 1990-1991) but not in trial 2 (a long time 1991- 1992), and plants grown from large seed were to some degree larger in spring, but seed size had no other impact on development or yield (22). The biological cooperative interaction which decreases the plant yield decreases the seed size (43). Furthermore, by increasing in seed size the potential of germination and emergence will be higher in triticale (45). Also, the effect of seed size on germination and following seedling emergence have been investigated by many researchers in various crop species/ cultivar (44). With increasing seed size spike production and density, thousand kernel weights, test weight, seed vigor and yield increased, maturity was progressed and seed moisture content at collect diminished in Croatian spring malting barleys (72). Seed size decreases by the higher or lower temperature from the optimum temperature during flowering or development (3). Crops developed from large kernels reliably yielded higher than crops grown from little kernels of the same cultivar, for both wheat (*Triticum aestivum* L.) and grain (*Hordeum vulgare*) (77). As regards, biological yield, harvest index and straw yield were not affected significantly by seed sizes and seed rates (25). There are many studies such as founded the seed size highly effected seed weight, and number of seeds per spike (63, 71, 76, 79). Utilize of large seed size and increased seeding rates can progress wheat competitiveness and give an effective means to decrease wild oat biomass and seed production (82). Sowing bread wheat with large sized seeds such seed size had significant influence for all the traits in laboratory and field with the exception of germination percentage and harvest index (1). Seed size had significant influence for all the traits in laboratory and field with the exception of germination percentage and harvest index which founded that germination rate significantly decreased by increasing seed size, but other traits significantly increased by increasing seed size (85). High grain yield was obtained with the 7 mm seed size seed size of 6 and 6.5 mm in corn (33). Seedling dry weight is positively correlated to seed protein content; small seeds (35 mg $seed^{-1}$) with high protein (4.7 mg $seed^{-1}$) produced larger seedlings than large seed (45 mg $seed^{-1}$) with lower protein (4.3 mg $seed^{-1}$) (52). Seed size not only influence emergence and establishment but also affected yield components and ultimately grain yield in wheat (10). On the basis of the above-mentioned facts, the objective of the investigation was to determine whether there are any effects of target seeding rates based on thousand kernel weights on reproductive traits of triticale Admiral variety.

MATERIALS AND METHODS

A factorial within randomized complete block design (RCBD), with three replicates, including three target seeding rates (200, 250, and 300 $seeds.m^{-2}$, adjusted on germination % and establishment 80 % (20), and three seed size grades of thousand kernel weight (TKW, whole or ungraded, with TKW 47.32 g, heavy seeds, TKW 54.04 g prepared by sieve aperture size >3.5mm and light seeds TKW 40.18 g by sieve aperture size <3.5>3mm. The experiment was conducted for two successive growing seasons 2019- 2020 and 2020-2021 at the Grdarasha Research Station of the

Agricultural Engineering Sciences College- Salahaddin University- Erbil (Latitude 36° 4' N and Longitude 44°2' E; 415 masl, within average annual rainfall range (250- 600 mm).

Land preparation

Before plowing the fallow land, representative soil samples of two kg weight was drawn from experiment field at depth of (0-30 cm) (Table 1), The fallow land was ploughed with moldboard plough during twentieth of November 2019 followed by rotavator to crush clod, pulverize and smoothen the soil for better aeration and preparation of seedbed. After that the land was divided according to the experiment layout into three blocks, of two meters apart, each consists of 9 plots with one meter distance, each of 2 m^{-2} area (2.5m length × 0.8 m width from four lines of 0.20 m distance in between). The seeds (Table 2) were sown manually on fifth of December 2019, as the seeds were dropped along within the row prepared by hand row opener at a depth of three cm with the adjusted specified target seeds.m^{-2} and then for the plot of $2m^{-2}$, thereafter covered with soil by tine hand rake.

Table 1. Some physicochemical properties of the experiment soil at Gardarah site*

Physical characters		Chemical characters	
Sand (%)	38.47	Available N (ppm)	59.67
Silt (%)	51.50	Available P (ppm)	2.01
Clay (%)	10.03	Available K (ppm)	0.94
Texture	silty clay loam	E.C. (mmhos /cm)	0.38
		pH	7.53

*Laboratory Soil and Water Department of the Agricultural Engineering Sciences College – Duhok.

Table 2. Some measured traits for whole (non-graded) and size graded seeds of triticale variety Admiral

Triticale	Traits	Whole seeds ungraded	Heavy seeds >3.5 mm	Light seeds < 3.5>3 mm
Admiral variety	Hectoliter wt. ($kg.hl^{-1}$)	70.84	71.52	70.00
	1000-kernels weight (g)	47.32	54.04	40.18
	Germination (%)	94.00	94.00	94.00

Seeds source and preparation

Seeds of Triticale (X *Triticosecale wittmack*) variety Admiral were supplied by Agriculture Research Development (ARD) company at Erbil. The target seeding rates for all seed size grades were adjusted on the base of germintion% and expected field establishment 80%, (Table 3) (20), according to the formula:

$$\text{Seed rate } kg.ha^{-1} = \frac{\text{target seed number per m2 X 1000 seed weight,g X 100}}{\text{germination\% x establshment \% (80)}}$$

Table 3. Target seeding rates adjustment

Seed grade	Target rate seed.m^{-2}	TKW g	Equation factor	Ger. %	Estab. 80%	$kg.ha^{-1}$	$g.m^{-2}$	g.plot $2m^{-2}$
Whole seed	200	47.32	100	94	80	125.85	12.59	25.17
Heavy seed	200	54.04	100	94	80	143.72	14.37	28.74
Light seed	200	40.18	100	94	80	106.86	10.69	21.38
Whole seed	250	47.32	100	94	80	157.31	15.73	31.46
Heavy seed	250	54.04	100	94	80	179.65	17.97	35.94
Light seed	250	40.18	100	94	80	133.58	13.36	26.72
Whole seed	300	47.32	100	94	80	188.78	18.88	37.76
Heavy seed	300	54.04	100	94	80	215.59	21.56	43.12
Light seed	300	40.18	100	94	80	160.29	16.03	32.06

Monthly ainfall, minimum, maximum and average temperature at experiment site for two successive growing seasons Table (4).

Month	Season 2019-2020				Season 2020-2021			
	Rainfall mm	Temp. min. ^{0}C	Temp. max. ^{0}C	Average ^{0}C	Rainfall mm	Temp. min.^{0}C.	Temp. max^{0}C.	Average ^{0}C
September	0.00	24.90	36.60	31.00	0.00	26.90	38.90	33.20
October	24.70	20.20	30.90	25.30	2.30	20.00	32.50	26.00
November	4.20	11.60	22.60	16.60	37.00	13.70	21.50	18.40
December	55.10	8.50	16.10	11.90	29.30	10.10	20.20	17.10
January	97.10	5.70	13.00	8.90	42.80	5.60	12.90	9.00
February	66.30	6.90	14.20	10.30	27.50	6.80	14.80	10.80
March	127.50	11.90	20.50	16.00	26.10	11.70	20.00	15.80
Apr	21.30	15.10	24.80	20.00	0.20	17.60	28.90	23.70
May	11.60	21.30	32.30	27.20	0.20	24.30	35.30	30.30
Total	407.1				165.4			

***Data source: Meteorological Directory- Erbil province**

The following reproductive traits were recorded during (ZGS-9) according to (84) growth stage scale; for each plot ten representative plants were selected to study the following traits, mean of ten spike length (cm) from neck up to the spike tip excluding awn, mean number of spikelets per spike for ten spikes (37).

Spikelet density = $\frac{\text{spikelet number per spike}}{\text{spike length}}$.

Grain density per spike = $\frac{\text{grain number per spike}}{\text{spike length}}$

Means number of grains per spike (total number of grains of ten spikes divided by 10), mean weight (g) of grains per spike (grains weight of ten spikes divided by 10), thousand kernels weight (TKW, g), biological yield weight kg.ha^{-1} of whole plants biomass, (straw with spikes from soil level, from 0.5 m length of middle row converted to hectare):

Biological yield kg.ha^{-1} = $\frac{\text{biological yield,kg}}{\text{area harvested}}$ x 10000 (28)

Grains yield kg.ha^{-1} (from 0.5 m length of middle row converted to hectare

Grain yield (kg.ha^{-1}) = $\frac{\text{grain yield kg}}{\text{area harvested}}$ x 10000 (28)

Harvest index = $\frac{\text{grain yield (g)}}{\text{biological yield (g)}}$ x 100 (70)

Test weight kg.hl^{-1} calculated by dividing the grain mass by grain volume multiply by 100 (39)

Protein % by (Perten Inframatic 9500 NIR Grain & Flour Analyser) which specialists in quality control of grain, flour, food and feed. The device was digital and very accurate.

Protein yield kg.ha^{-1} (by multiplying grains yield per hectare x protein %). (88)

Data analysis

The collected data were subjected to statistical analysis utilizing SAS version 9.1 2003 (73), Duncan's Multiple Range Test (1955) (32) was used for means comparison at 0.05 level of significant.

RESULTS AND DISCUSSION

Dry season could be a predominant cause of low yields around the world. There's an critical require for more water proficient cropping frameworks facing huge water utilization of irrigated farming and high ineffective losses through runoff and evaporation Bodner et al (16). Almost the reduction was about 50% in some traits. The role of water and adverse effect of annual rainfall shortage and drought stress on all measured traits was clearly evidence. Among the reproductive traits of triticale as affected by seeding rate and seed weight:

Spike length, cm

Spike length is a character of great significance that contributes considerably to grain yield per unit area. The results displays in (Table 5) revealed to no significant effect of seed weight or seed rate or the interaction on this trait for the both seasons with the exception of the interaction during 2019-2020 season. The interaction of seeding rates 200 with whole grade size seeds resulted in maximum spike length (12.83 cm), while the

inferior value was with the same rate with heavy grade seeds (11.36 cm), the remainder values were similar. These results contradict with the finding of Noori (64) who reported that plant density have significantly affected the spike length. And also with those of Akhter et al (6) who stated that seed rate more than 120 kg ha^{-1} significantly reduced the spike length. Such contradictory has been illustrated by researchers Bhatti et al (12) found that spike length influenced by seed size and the highest value when large size seed was used.

Table 5. Effect of seeding rate, seed size and their interaction on spike length (cm)

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW* Whole	Heavy	Light	Mean of seed rate
200	12.83 a	11.36 b	12.36 ab	12.18
250	12.06 ab	12.23 ab	12.43 ab	12.24
300	11.63 ab	12.16 ab	11.93 ab	11.91
Mean of seed grade	12.17	11.92	12.24	
Target rate seed.m^{-2}	Season 2020-2021 Seed grade based on TKW Whole	Heavy	Light	Mean of seed rate
200	7.20	7.56	6.76	7.17
250	7.16	7.40	6.90	7.15
300	7.56	8.73	7.30	7.86
Mean of seed grade	7.31	7.90	6.98	

*Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

Number of spikelets.spike^{-1}

The results of this trait resemble spike length, as the only significant effect was for the interaction during the season 2019-2020, (Table 6), seeding rate 200 with whole non-grade seeds attained highest value (76.36) while the lowest was for the same rate with both size grade heavy and light seed which were (64.13) and (63.56), respectively. This result was supported by those of Dombusch et al (30) who demonstrated that the number of spikelets/spike changes under different planting densities in wheat. Moreover, the results accord with the finding of Zareian et al (86) who indicated the spikes number of seeds with smallest size was significantly lower than other seed sizes and this reduction was by 19.7% in wheat. While it was contravenes that of Dar et al (26) who demonstrated that small seeds to medium sized ones created resulted in better germination and seedling vigor than those of bigger ones.

Table 6. Effect of seeding rate, seed size and their interaction number of spikelet.spike^{-1}

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW Whole	Heavy	Light	Mean of seed rate
200	76.36 a	64.13 b	63.56 b	68.02
250	66.36 ab	69.16 ab	68.60 ab	68.04
300	69.46 ab	66.73 ab	68.53 ab	68.24
Mean of seed grade	70.73	66.67	66.90	
Target rate seed.m^{-2}	Season 2020-2021 Seed grade based on TKW Whole	Heavy	Light	Mean of seed rate
200	19.56	24.76	17.46	20.60
250	20.80	21.46	22.23	21.50
300	21.96	23.86	19.53	21.78
Mean of seed grade	20.77	23.36	19.74	

Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

Spikelet density

The average of spikelet density (spikelet number per centimeter of spike length) shown in (Table 7) indicated to no significantly influence of target seeding rates and seed grade sizes, as well as their interaction for both

seasons. The results disagreed with Rukavina et al (72) whom noted that with increasing seed size spike production and density increased in Croatian spring malting barleys spikelet density.

Table 7. Effect of seeding rate, seed size and their interaction on spikelet density

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW Whole	Heavy	Light	Mean of seed rate
200	5.99	5.68	5.23	5.63
250	5.56	5.71	5.61	5.63
300	6.04	5.56	5.86	5.82
Mean of seed grade	5.86	5.65	5.57	
Target rate seed.m^{-2}	**Season 2020-2021 Seed grade based on TKW Whole**	**Heavy**	**Light**	**Mean of seed rate**
200	2.78	3.33	2.71	2.94
250	3.06	3.09	3.33	3.16
300	3.07	2.87	2.79	2.91
Mean of seed grade	2.97	3.09	2.94	

Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

Grain density.spike^{-1}

Table (8) shows no significant effect of seeding rate and seed grade sizes on this trait, whereas it was significantly affected by their interaction for both seasons. The interaction of whole grain with seeding rate 200 and 250 recorded the highest values (5.52 and 1.28) respectively. Whereas the lowest was for the target seeding rate of 200 with light seed size for both seasons, which were (4.54 and 0.36), respectively. Great differences between the two seasons were obvious, which was attributed to shortage in rainfall in the second season (407.1 and 165.4) for seasons 2019-2020 and 2020-2021, respectively. The effect of rainfall was in accordance with that reported by Kalbarczyk's (42), who illustrated that the triticale yields is delivered by the course of climate conditions amid the periods from the heading to the dough stage and from the complete ripeness to harvest.

Table 8. Effect of seeding rate, seed size and their interaction on grain density per spike

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW Whole	Heavy	Light	Mean of seed rate
200	5.52 a	4.92 ab	4.54 b	4.99
250	4.94 ab	5.00 ab	4.94 ab	4.96
300	5.17 ab	4.95 ab	5.22 ab	5.11
Mean of seed grade	5.21	4.96	4.90	
Target rate seed.m^{-2}	**Season 2020-2021 Seed grade based on TKW Whole**	**Heavy**	**Light**	**Mean of seed rate**
200	0.79 ab	1.18 ab	0.36 b	0.78
250	1.28 a	0.91 ab	0.81 ab	1.00
300	0.80 ab	0.66 ab	1.01 ab	0.82
Mean of seed grade	0.96	0.92	0.73	

Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

Number of grains. spike^{-1}

The values showed in Table (9) revealed to significant effect of seeding rates and seed grade weight on this trait, while the only significant differences was detected for the seeding rate 200 and 250 interaction with whole ungraded and heavy seeds for both seasons, which was (70.23 and 9.0) 2019-2020 and 2020-2021 respectively. Whereas the lowest value was recorded for the seeding rate 200 with the light grade. These accord those of Biberdžić et al (15) and Bokan and Malesevic (17), whom referred to reduction of the sowing rate, resulted in increase in number of grains per spike. Results resemble to Habibullah et al (38) who also referred target seed rate have such effect to number of grain per spike. The results inverse the data of Chaudhry and

Hussain, (25), who found that seed size showed non-significant results while seed rates showed significant influenced.

Table 9. Effect of seeding rate and seed size and their interaction on number of grains.spike^{-1}

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW Whole	Heavy	Light	Mean of seed rate
200	70.23 a	55.56 b	55.46 b	60.42
250	59.03 b	60.96 b	60.50 b	60.16
300	59.36 b	59.70 b	60.93 b	60.00
Mean of seed grade	62.87	58.74	58.96	
Target rate seed.m^{-2}	**Season 2020-2021 Seed grade based on TKW Whole**	**Heavy**	**Light**	**Mean of seed rate**
200	5.50 ab	8.93 a	2.13 b	5.52
250	9.00 a	6.66 ab	5,16 ab	6.94
300	5.30 ab	5.56 ab	6.06 ab	5.64
Mean of seed grade	6.60	7.05	4.45	

Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

Weight of grains, g spike^{-1}

Number of grain per spike reflected on weight of grains per spike (g) as similar trend was observed for this trait, it was not significantly affected by seeding rates and seed grade size. Table (10), while the interaction was significant, and the highest value was for the seed rate 200 with whole non-graded seed size with whole ungraded and heavy grade for both seasons, respectively which were (3.39 and 0.18) for 2019-2020 and 2020-2021, respectively, but the inferior was for the same rate but with the light seed grade (2.55 and 0.02) for both seasons, respectively. These results concurred with Noori (64) who also demonstrated that increasing plant density resulted in reduction of weight of grains. However; Kernel weights was reported to be unaffected Jennifer et al (41) and Bryan (18).

Table 10. Effect of seeding rate, seed ize and their interaction on weight of grains, g.spike^{-1}

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW Whole	Heavy	Light	Mean of seed rate
200	3.39 a	2.83 ab	2.55 b	2.92
250	2.79 b	3.01 ab	2.89 ab	2.89
300	2.77 b	2.71 b	2.89 ab	2.79
Mean of seed grade	2.98	2.85	2.77	
Target rate seed.m^{-2}	**Season 2020-2021 Seed grade based on TKW Whole**	**Heavy**	**Light**	**Mean of seed rate**
200	0.09 ab	0.18 a	0.02 b	0.09
250	0.13 ab	0.10 ab	0.11 ab	0.11
300	0.11 ab	0.10 ab	0.12 ab	0.11
Mean of seed grade	0.11	0.12	0.08	

Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

Biological yield, kg.ha^{-1}

The biological yield refers to the total dry matter accumulation of a plant system and biological yield is also referred to as gross biomass yield obtained before any losses occur during and after harvest. The results concerning the biological yield kg.ha^{-1} displayed in (Table 11). It is apparent that either seeding rates or seed grade sizes has no significant effect on this trait. The interaction of seeding rate 200 with heavy size seeds resulted in maximum biological yield (6233 kg ha^{-1}); while the interaction of seeding rate 300 with light size seeds resulted in minimum biological yield (3473 kg ha^{-1}) for season 2019-2020. Such increment in seedlings and

plant weight which reflect on biological yield was refereed by Zareian et al (85) in wheat. Whereas, these results inverse the finding of Akhter et al (6) as the biological yield was influenced by different seed rate and the highest was at 140 kg seed ha^{-1} which was statistically similar with 120 kg seed ha^{-1}.

Table 11. Effect of seeding rate, seed size and their interaction on biological yield, $kg.ha^{-1}$

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW Whole	Heavy	Light	Mean of seed rate
200	4607 ab	6233 a	4513 ab	5117.80
250	4600 ab	5373 ab	5920 ab	5297.80
300	5367 ab	4467 ab	3473 b	4435.60
Mean of seed grade	4857.80	5357.80	4635.60	
Target rate seed.m^{-2}	**Season 2020-2021 Seed grade based on TKW Whole**	**Heavy**	**Light**	**Mean of seed rate**
200	926.70	1146.70	753.30	942.20
250	1013.30	1066.70	1126.70	1068.90
300	860.00	1100.00	1140.00	1033.30
Mean of seed grade	933.30	1104.40	1006.70	

Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

Grain yield, $kg.ha^{-1}$

The results regarding grain yield $kg.ha^{-1}$ was not influenced by seeding rate or seed grade size for both seasons, while their interaction was significant (Table 12). The interaction of target seed rate 200 with heavy seeds resulted in maximum grain yield kg ha^{-1} (2895), while the interaction of target rate 300 with light seeds resulted in lowest grain yield kg ha^{-1} (57.87); for both seasons respectively. However, the interaction of seeding rates 200 with light size seeds resulted in minimum grain yield (2035.8 kg ha^{-1}) and the interaction of seeding rates 200 with light size seeds resulted in minimum grain yield (5.73 kg ha^{-1}), for both seasons respectively. Shortage of rainfall in the second season resulted in producing small atrophic seeds of light weigh, unlike large plumped seeds with adequate rainfall in the first season. The results concerning the effect of rainfall was coincided those of Pecio (66) and Biberdzic et al (14) whom referred to significant variation depending on the conditions and sowing rates. However, in comparative study reported that utilize of larger seed sizes improved grain yields by 18% and utilize of small seeds decreased yield by 16% in wheat Stougaard and Xue (78) and Anonymous (9). These results contradict the finding of Kumar et al (49) who illustrated that grain yield have no significant effected by seed size when spring oats were attained with the seed fraction of 2.8 mm have the highest value and the seed fraction of 2.2 mm have lowest value of grain yield. Also, Douglas et al (31) and Chaudhry and Hussain (25) reported that seed rates, seed sizes and their interaction had non-significant effect on the economic yield. Although, Chastain et al (23) and Chastain et al (24) demonstrated in winter wheat and barley, to no impact on yield or grain quality advantages obtained from large seed. In contrast to this McKenzie and Pauly (56), stated that the average grain yield was 10 percent greater at 500 seeds. m^{-2} than at 100 seeds.m^{-2}**.**

Table 12. Effect of seeding rate, seed size and their interaction on grain yield, kg.ha^{-1}

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW Whole	Heavy	Light	Mean of seed rate
200	2203.50 ab	2895.70 a	2035.80 b	2378.30
250	2163.90 ab	2386.90 ab	2601.20 ab	2384.00
300	2626.40 ab	2070.50 ab	2510.10 ab	2402.30
Mean of seed grade	2331.30	2451.00	2382.40	
Target rate seed.m^{-2}	**Season 2020-2021 Seed grade based on TKW Whole**	**Heavy**	**Light**	**Mean of seed rate**
200	22.27 ab	42.80 ab	5.73 b	23.60
250	45.67 ab	22.73 ab	14.60 ab	27.67
300	15.93 ab	27.53 ab	57.87 a	33.78
Mean of seed grade	27.96	31.02	26.07	

Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

Harvest index

The data represented in Table (13) revealed to no significant effects of seeding target rate or seed grade size and their interaction on this trait with an exception of the interaction of the second season 2020-2021. The highest value of interaction of seed rate 300 with light seed size which was (4.8), while the lowest value was at seed rate 200 and 250 with light seed size were (0.8 and 1.22), respectively. The most impact of planting pattern and plant density on a crop is basically due to difference how sunlight would disperse through the canopy and expanding sunlight assimilation would cause progressing yield Naseri et al (61). Hence, dispersing of plant influenced the sum retained daylight over the canopy. Results are in general agreement with Kumar et al (49) who also demonstrated that seed size did not affect the straw yields of oats significantly. Zareian et al (85) there were no significant differences between seed size on harvest index.

Table 13. Effect of seeding rate and seed size and their interaction on harvest index

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW Whole	Heavy	Light	Mean of seed rate
200	47.86	46.43	45.17	46.48
250	46.42	44.71	43.49	44.87
300	49.51	46.34	50.75	48.86
Mean of seed grade	47.93	45.82	46.47	
Target rate seed.m^{-2}	**Season 2020-2021 Seed grade based on TKW Whole**	**Heavy**	**Light**	**Mean of seed rate**
200	2.31 abc	2.94 abc	0.86 c	2.04
250	4.41 ab	2.12 abc	1.22 c	2.58
300	1.61 bc	2.32 abc	4.80 a	2.91
Mean of seed grade	2.78	2.46	2.29	

Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

Thousand kernels weight, TKW, g

Thousand kernels weight is a quality parameter to assess the grain quality and this trait is generally influenced by genetic makeup of varieties and application of inputs to the crop. Results displays in Table (14) shows to no significant influence of seed rate and seed size for season 2019-2020 on this trait, while the interaction was significant. The superior weight was for the interaction of rate 200 seeds with heavy grade size (52.02), whereas the least was with rate of 300 with heavy grade size, (46.28) for the season 2019-2020. The second season was clearly obvious as heavy grade resulted in heavier seeds significantly (14.88) although it was very small atrophic seeds, regarding the interaction, the highest value was for heavy seeds with 200 seeds rate (15.83) but the lowest was for the same rate with light seeds (11.56). Biberdžić et al (15) and Djekic et al (29) observed that the 1000 grain weight varies considerably depending on

the weather conditions in each year. The results in line with Miric et al (58) that reported that the 1000 grain weight decreases with the increasing sowing rate, or planting density, but it is very specific to each variety, which is confirmed by our results. With enough photosynthetic matter during the grain filling stage in thicker density is possible reason to lessening 1000-grain weight due to increasing density Yu et al (83). These results are in conformity with the findings of Baloch et al (11) and Laghari et al (50), who stated that by increasing showing that higher seeding rate decreased 1000-grain weight. Also, the results accord with Chaudhry and Hussain (25) that referred of 1000-grain weight was affected significantly by seed rates as well as seed sizes especially by large seed size.

Table 14. Effect of seeding rate, seed size and their interaction on thousand kernels weight, TKW, g

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW Whole	Heavy	Light	Mean of seed rate
200	51.13 ab	52.02 a	47.55 bc	50.23
250	50.68 ab	50.92 ab	49.72 abc	50.44
300	49.30 abc	46.28 c	50.54 abc	48.71
Mean of seed grade	50.37	49.74	49.27	
Target rate seed.m^{-2}	**Season 2020-2021 Seed grade based on TKW Whole**	**Heavy**	**Light**	**Mean of seed rate**
200	12.50 cd	15.83 a	11.56 d	13.30
250	13.46 bcd	13.53 bcd	12.16 d	13.05
300	14.70 abc	15.30 ab	12.83 cd	14.27
Mean of seed grade	13.55 b	14.88 a	12.18 c	

Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

Test weight, kg.hl^{-1}

Test weight was not significantly affected by seeding rates and seed size (Table 15). While the interaction of target rate and seed size was significant for test weight. The highest value at seeding rate 200 with heavy seed size was (78.00), whereas the lowest value at seeding rate 250 with light seed size which was (73.12) for the first season. While second season the seed rate was significantly effects on this trait and the highest value at rate 300 which was (55.59) but the lowest value at rate 200 was (49.47). Regarding seed size grade also significant, as heavy seeds gave highest value (55.54) whereas the light seeds gave lowest value (48.72). These results are in harmony with Biberdžić et al (15) that referred the meteorological conditions show significant influence on hectoliter weight. The influence of meteorological factors on the value of the hectoliter weight was confirmed earlier by Lalevic et al (51). Croatian spring malting barleys by increasing seed size the test weight was increased Rukavina et al (72).

Table 15. Effect of seeding rate, seed size and their interaction on test weight, kg.hl^{-1}

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW Whole	Heavy	Light	Mean of seed rate
200	76.64 ab	78.00 a	75.52 ab	76.72
250	76.54 ab	73.93 ab	73.12 b	74.53
300	76.50 ab	76.89 ab	75.92 ab	76.44
Mean of seed grade	76.56	76.27	74.85	
Target rate seed.m^{-2}	**Season 2020-2021 Seed grade based on TKW Whole**	**Heavy**	**Light**	**Mean of seed rate**
200	48.11 d	52.46 c	47.84 de	49.47 c
250	55.16 abc	56.49 ab	44.48 e	52.04 b
300	55.27 abc	57.66 a	53.84 bc	55.59 a
Mean of seed grade	52.85 b	55.54 a	48.72 c	

Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

Protein, %

Protein content as percentage was significantly affected by seeding rate, seed grade size and their interaction for the first season (Table 16). Protein % at 200 seeding rate surpassed other rates (12.04), but the inferior was with the rate 300. Seed size grade was also significant, and the whole ungraded seeds resulted in higher protein (12.25) but the lowest was for the light seed weight (11.12). With respect of the interaction the highest values was for whole ungraded seeds with target 200 (13.03). The results in agreement with Samuel and East (74) and Geleta et al (34) who stated that protein concentration declined as seeding rates increased. However it contradicts to those of Jennifer et al (41) and Bryan (18) reported that wheat quality was not reduced at higher seeding rates as protein content, kernel weight and test weight were unaffected.

Table 16. Effect of seeding rate, seed size and their interaction on protein%

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW			Mean of seed rate
	Whole	Heavy	Light	
200	13.03 a	12.16 b	10.93 c	12.04 a
250	12.70 a	11.26 c	11.16 c	11.71 b
300	11.03 c	11.13 c	11.26 c	11.14 c
Mean of seed grade	12.25 a	11.52 b	11.12 c	

Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

Protein yield, kg.ha^{-1}

Table (17) represents the values of protein yield kg per hectare, showed that seeding rates and seed grade size had negligible impact on protein yield. The interaction effect of seeding rate and seed size was significant, the highest value was recorded at seeding rate 200 with heavy seed size which was (351.84), while the lowest at seeding rate 200 or 300 rates with both light and heavy seed size which were (222.06, 229.49), respectively. Results in harmony with the reported of Chaudhry and Hussain (25) that illustrated protein content was increased by large seed size.

Table 17. Effect of seeding rate and seed size and their interaction on protein yield, kg.ha^{-1}

Target rate seed.m^{-2}	Season 2019-2020 Seed grade based on TKW			Mean of seed rate
	Whole	Heavy	Light	
200	288.07 ab	351.84 a	222.06 b	287.32
250	275.42 ab	269.33 ab	289.70 ab	278.15
300	289.83ab	229.49 b	283.00 ab	267.44
Mean of seed grade	284.44	283.55	264.92	

Note: Within the individual factor or their interaction, the values that share the alphabet do not differ significantly according to the DMRT, 1955 at α 5%.

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