INFLUENCE OF TARGET SEEDING RATES BASED ON THOUSAND KERNEL WEIGHT ON VEGETATIVE GROWTH TRAITS OF TRITICALE, VARIETY ADMIRAL- Part I.

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ABSTRACT:
A field experiment was conducted during two seasons 2019-2020 and 2020-2021 at the Grdarasha Research Station of the Agricultural Engineering Sciences College-Salahaddin University-Erbil. The experiment was designed as factorial within randomized complete block design (RCBD), with three replicates. The first factor included three target seeding rates of Triticale (×*Triticosecale wittmack*, variety Admiral (200,250,and300seeds.m^{-2}), while the second factor was three grain size grades whole, thousand kernels weight (TKW) 47.32 g, heavy seeds, TKW 54.04 and light seeds TKW 40.18 g. The results revealed to no significant influence of seeds weight or seeding rates and their interaction on this trait excluding whole sample seed (ungraded) at the rate target of 300 seeds.m^{-2}, which was significantly reduced flag leaf area. Leaf area index was significantly varied among seed weight and target seeding rates or by their interactions. The plant height of triticale although it was higher for heavy seeds and higher target seeding rates, but it was not reached significant level, either by seed grade or target seed rate and their interactions in both. Plant height ranges from 88.00 for heavy seeds at rate 300 seeds.m^{-2} to 83.00 for light seeds at rate 200 seeds.m^{-2} for the season 2019-2020. The highest tillers number was recorded for seed rate 300.m^{-2} with whole ungraded seeds (176.00).

Keywords: Seeding rates, kernel weight, vegetative growth, triticale, admiral

تأثير معدلات البذار المحددة على أساس وزن ألف حبة في صفات النمو الخضري للقمح الشيلمي صنف ادمرال (الجزء الأول)

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المستخلص
نفذت التجربة في الموسمين 2019–2020 و2020–2021 في محطة أبحاث كرده رش لكلية علوم الهندسية الزراعية – أربيل, صممت تجربة عاملية بتصميم القطاعات الكاملة المعشاة وبثلاث مكررات، تضمن العامل الأول ثلاثة معدلات بذار صنف ادمرال (200 ، 250 ، 300 بذرة.م$^{-2}$) بينما تضمن العامل الثاني ثلاثة تدريجات حجمية للبذور– حبوب كاملة (غير مدرجة)، وزن ألف حبة 47.32(TKW)غم ، وبذور ثقيلة ، TKW 54.04غم وبذور خفيفة TKW 40.18غم. أظهرت النتائج عدم وجود تأثير معنوي لوزن البذور أو معدلات البذر وتداخلها على معظم الصفات، باستثناء البذور الكاملة للعينة غير المدرجة وبمعدل بذار 300 بذرة. م$^{-2}$، والذي أدى إلى انخفاض كبير في مساحة ورقة العلم وكان دليل مساحة الورقة متباينًا بشكل كبير بين وزن البذور ومعدلات البذار وبحسب الظروف. رغم ان معدل ارتفاع النبات للبذور الثقيلة ومعدلات البذر العالية كانت متفوقة، إلا أنها لم تصل إلى مستوى المعنوية ، سواء من حيث درجة حجم الحبوب أو معدل البذار وتداخلاتها. تم تسجيل أعلى عدد للتفرعات عند معدل البذار 300 م$^{-2}$ مع البذور الكاملة غير المدرجة (176.00).

الكلمات المفتاحية: معدلات البذار, وزن الحبوب، نمو خضري, تريتكالى, ادمرال

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INTRODUCTION

Triticale (×Triticosecale wittmack) is a human-made crop developed by crossbreeding wheat (Triticum spp.) and rye (Secale cereale L.), where favorable alleles from both progenitor species are incorporated; high yield potential and good grain quality of wheat with disease and environment tolerance of rye (24). Triticale has huge potential for both grain and forage production, in spite of the fact that research to move forward the crop for way better adjustment and grain quality is slacking behind that of other little grains (6). Triticale gives better fodder when intercropped with legumes, in quantity and quality, compared to monoculture (25) and gave high yield of forage green than barley. Despite important grain composition but low breadmaking value, triticale is still considered to be non-bread cereal and simultaneously thought little of from the dietary point of view. Triticale has lowest gluten content; effective viscoelasticity then the prepared bread has low quality compared towards wheat bread (17). The target for triticale utilization depends since the characteristics of the variety, which is higher protein varieties can be used such as concentrated feed used for poultry, ruminants and non-ruminants, and varieties through high biomass can be used for grazing, silage or hay (22). The average total protein content of triticale grains varies from 10.2% to 15.6% of the dry matter.Triticale has a high nutritional value, contains considerable quantity of protein, fiber, vitamins and minerals (29). Triticale possess larger grain size in comparison to durum wheat, therefore at the same plant populations it has to set the seeder to 25–40% above the setting recommended for wheat, and the recommended seeding rates different from purpose and growing conditions (9). Seed size and seeding rates effect on triticale growth have been investigated by many researchers; that reduction in root and shoot length of variety (26). The 75 $kg.ha^{-1}$ (approx. 175 $seeds.m^{-2}$) was an optimum seeding rate for longer growing seasons of winter triticale (10); The seeding rate for spring triticale range from 180 to 250 $seeds.m^{-2}$ (80 to 110 $kg.ha^{-1}$) (42). Lower seeding rates significantly increased the number of grains and vice versa and reported that increased tillers with increase in seed rate (13). The main stem and primary tillers contribution differed in the number of spiklet, grain number and 1000 grain weight with different seeding rates (4, 31, 32). Increasing seeding rates caused early flowering, increased plant height, biological yield and harvest index (7, 40). Comparing different seed rates, found that plant height was not affected significantly (1).

Seeds with large food conserves became more food vigor which happened in large seed (3). Seed size plays a vital role in physical indicator of seed qualities that affects vegetative growth and has a positive relationship to yield, market grade factors and harvest capability (36). Furthermore, by increasing seed size the potential of germination and emergence were higher in triticale (26). Seed size had significant influenced on all traits in laboratory and field with the exception of germination percentage and harvest index, most traits significantly increased by increasing seed size (46). Seeding rate along with varying seed size is the most important agronomic practice which significantly influenced the grain yield of wheat (38). Seeding rates and seed sizes had significant effect on the number of fertile tillers per unit area in wheat (14). On the base of researches overview, the present study was suggested to study the effect of seeding rates based on seed weight on vegetative growth attributes of triticale variety Admiral in part one of the research work.

MATERIALS AND METHODS

A field trial was conducted 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, having annual rainfall range (250- 600 mm) during two successive growing seasons 2019-2020 and 2020-2021. The experiment was designed as a factorial within randomized complete block design (RCBD), with three replicates. The first factor was three levels of target seeding rates (200, 250, and 300 $seeds.m^{-2}$) adjusted on germination % and establishment % (10), the second factor was three 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.

Land preparation

The representative soil samples were taken as two kilograms from various locations at depth of (0-30 cm) before plowing, samples were air dried, then packed in polyethylene bags reserved at laboratory for analysis (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 five 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 by with soil by tine hand rake.

Seeds source and preparation

Seeds of Triticale (X *Triticosecale wittmack*) variety Admiral was supplied by Agriculture Research Development (ARD) company at Erbil.

Table 1. Some chemo- physical 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

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

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

The target seeding rates for all seed size grades were adjusted on the base of germintion% and field establishment %, which was considered as 80% (Table 3) (12), according to the formula: seed rate kg/ha =

$$\frac{\text{target seed number per m2 X 1000 seed weight,g X 100}}{\text{germination\% x establshment \% (80)}}$$

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	25.18
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

Table 4. Monthly rainfall, minimum, maximum and average temperature were recorded

Month	Season 2019-2020				Season 2020-2021			
	Rainfall mm	Temp. C^0min	Temp. C^0max	Average C^0	Rainfall mm	Temp. C^0min	Temp. C^0max	Average C^0
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 vegetative growth traits were recorded during heading, complete spike emergence stage (ZGS-5) according to (45) growth stage scale; for each plot ten representative flag leaf area for the main tiller of the middle row was measured by the formula used by Singh and Singh, 1992: leaf blade length cm x mid leaf blade width cm x factor 0.70. Leaf area index (LAI) was measured according to (44) and modified formula of (11).

$$\text{LAI}=\frac{\text{specific leaf area (leaves area of harvested sample cm2}}{\text{leaves weight of harvested sample,g}}\times\frac{\text{leaves weight of harvested segments,g}}{\text{area of harvested land segment,cm2}}\quad(44)$$

$$\text{LAI}=\frac{\text{dry weight sampling area,g}}{\text{sampling area cm2}}\times\frac{\text{leaf area cm2}}{\text{leaf dry weight g}}\quad(11)$$

Accordingly the fresh weight (g) of the ten leaves and the sum of their area was measured, known the fresh weight of total leaves of 20 cm length of middle row; the area of the leaves of 20 cm row length can be estimated by simple mathematical proportional. Then the LAI equation was applied (modified as we used fresh weight, since (30) reported that the correlation between leaf area index with both fresh and dry weight was, 0.98.

$$\text{Leaf area index} = \frac{\text{total leaf area cm2 of 20 cm row length}}{\text{land area (20 cm row length x 20 cm row space)}}$$

Means of ten main tillers height (cm) from ground level to the spike peduncle or neck, total number of tillers.m^{-2} (number of tillers in one middle row 2.5 m length x 0.2m row space x2 =1m^{-2}), similarly the number of reproductive tillers (bearing spike), and non-reproductive tillers (with no spike) were calculated.

Data analysis: The collected data were subjected to analysis of variance utilizing SAS version 9.1 (39), Duncan's Multiple Range Test (18) was used for means comparison at 0.05 level of significant.

RESULTS AND DISCUSSION

The vegetative traits of triticale as affected by seeding rate and thousand kernel weight (TKW) included:

Flag leaf area: The results of flag leaf for seasons 2019-2020 and 2020-2021, displays in Table (5) reveal to non-significant influences of seed weight or seeding rates and their interaction on this trait excluding the interaction for the season 2019-2020 was significant, whole sample seed (ungraded) at the rate target of 200 seeds.m^{-2} gave the highest value (12.37), whereas the lowest was for the 300 seed rate with the same grade size (8.96). Generally the results refers to a severe reduction in leaf area for the season 2020-2021, which was certainly affected by drought stress due to shortage in rainfall of this season (165.40 mm) (Table 4) which correspondent by (16).

Table 5. Effect of seeding rate and seed weight and their interaction on triticale flag leaf area, cm^{-2} season, 2019-2020 and 2020-2021

Season 2019-2020				
Target rate seed.m^{-2}	Seed grade based on TKW*			Mean of seed rate
	Whole	Heavy	Light	
200	12.37 a	11.12 ab	9.96 ab	11.15
250	10.30 ab	10.77 ab	11.59 ab	10.88
300	8.96 b	11.77 ab	10.88 ab	10.54
Mean of seed grade	10.54	11.22	10.81	
Season 2020-2021				
Target rate seeed.m^{-2}	Seed grade based on TKW			Mean of seed rate
	Whole	Heavy	Light	
200	3.72	4.11	2.90	3.58
250	3.60	3.07	3.89	3.52
300	4.65	4.19	3.95	4.26
Mean of seed grade	3.99	3.79	3.58	

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%.
*** TKW (thousand kernels weight).**

Leaf Area Index (LAI)

Leaf area index values in Table (6) reveal to significant differences among seed weight and target seeding rates or by their interactions. In general it was higher in the season 2019-2020 than the season 2020-2021; that was attributed to more annual rainfall for the season 2019-2020, which conversed on growth, amount of rainfall in both season (407.80 mm and 165.40 mm), respectively (Table 4). The maximum leaf area index was recorded 4.63 and 4.58 for targets seed rate of 250 and 300 seeds.m^{-2}, respectively; for the season 2019-2020 (Table 6). While, the minimum was (4.16) for the target seed rate of 200 seed.m^{-2}. Regarding seed weight, both grades, heavy and whole surpassed light grade for this trait (5.0, 4.82 and 3.54, respectively. Meanwhile the interaction of heavy grade with target rate 300 seeds.m^{-2} resulted in higher value (5.24), whereas the lowest was for light seed grade interaction with target seed rate 200 seeds.m^{-2} (3.24). Such role of seed size on vegetative growth and its positive relationship to yield reported by Rukavina et al (36) and Willenborg et al (43).

Table 6. Effect of seeding rate and seed weight and their interaction on triticale leaf area index (LAI).

Season 2019-2020				
Target rate seed.m^{-2}	Seed grade based on TKW			Mean of seed rate
	Whole	Heavy	Light	
200	4.55 c	4.69 bc	3.24 e	4.16 b
250	4.71 abc	5.07 abc	3.95 d	4.58 a
300	5.22 ab	5.24 a	3.44 e	4.63 a
Mean of seed grade	4.82 a	5.00 a	3.54 b	
Season 2020-2021				
Target rate seed.m^{-2}	Seed grade based on TKW			Mean of seed rate
	Whole	Heavy	Light	
200	3.21 b	2.85 bc	1.82 d	2.63 b
250	3.10 b	3.16 b	2.08 d	2.78 b
300	3.63 a	3.74 a	2.58 c	3.32 a
Mean of seed grade	3.31 a	3.25 a	2.17 b	

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%.

Plant height (cm): Tallness in wheat plants is mostly associated with the genetic makeup of the parental material of varieties; but this trait is also influenced by the quality and quantity of inputs applied. The plant height of triticale although it was higher for heavy seeds and higher target seeding rates, but it was not reached significant level, either by seed grade or target seed rate and their interactions in both successive growth seasons 2019-2020 and 2020-2021 (Table 7). Plant height ranges from 88.00 for heavy seeds at rate 300 seeds.m^{-2} to 83.00 for light seeds at rate 200 seeds.m^{-2} for the season 2019-2020. Similar trend was observed for the season 2020-2021 which was 39.76 cm and the lowest was for light grade at rate 200 seeds.m^{-2}. These results were concurred those of Jedel and Salmon (23) and Faris and De Pauw (21) who also referred that seeding rate did not significantly affect the plant height of wheat. The influence of rainfall shortage was obvious on this traits, as in the total rainfall second season was (165.40 mm) Table (4). Furthermore these results confirmed by Mut et al (35) who demonstrated drastic reduction in plant height with decreasing precipitation rainfall at growing season.

Table 7. Effect of seeding rate and seed weight and their interaction on plant height (cm).

Season 2019-2020				
Target rate seed.m^{-2}	Seed grade based on TKW			Mean of seed rate
	Whole	Heavy	Light	
200	86.53	84.86	83.00	84.80
250	84.03	87.00	85.93	85.65
300	84.40	88.00	85.80	86.06
Mean of seed grade	84.98	86.62	84.91	
Season 2020-2021				
Target rate seed.m^{-2}	Seed grade based on TKW			Mean of seed rate
	Whole	Heavy	Light	
200	35.61	34.20	29.73	33.03
250	33.63	37.06	35.10	35.26
300	35.50	39.76	35.46	36.10
Mean of seed grade	34.26	37.01	33.13	

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 total tillers.m^{-2}

Tillering is a core component of plant architecture Moeller et al (34). Varying tiller number may produce significant differences in spike morphology Kebrom et al (27), Evers et al (20), and Baktash and Naes (8). Table (8) display the total tillers number.m^{-2}; neither seed rate nor seed grade weight influence significantly on total number of tillers in both growth seasons, whereas the interaction was significant. Although Mian and Nafziger, (26), have demonstrated that higher germination percentage from larger seeds may be beneficial in establishing plants under dry soil conditions, but the effect of seed size was not evidence in the present work; the most astonishing results that all tillers were reproductive or bearing spike for the season 2019-2020. The highest tillers number was recorded for seed rate 300.m^{-2} with whole ungraded seeds (176.00), whereas the inferior value 97.33 for the interaction of seed rate 200.m^{-2} with whole ungraded seeds, for the season 2019-2020. This result is in conformity with the findings of Akhter et al (2), Sarker et al (37), Khurshid (28) and Dhahi and Baktash (15) who stated that number of tillers per m^{-2} increased with the increase in seed rate at wheat. There was inconsistency in results of this trait and inverse in the second season as the highest value was for seed rate 300.m^{-2} with the light seed grade 237.33, but the lowest was for the same seed rate with ungraded seeds (125.33 seed.m^{-2}).

Table 8. Effect of seeding rate and seed weight and their interaction on total tillers.m^{-2}.

Season 2019-2020				
Target rate seed.m^{-2}	Seed grade based on TKW			Mean of seed rate
	Whole	Heavy	Light	
200	97.33 d	171.33 ab	126.00 bcd	131.56
250	132.67 a-d	150.00 abc	157.33 abc	146.67
300	176.00 a	116.67 cd	174.00 ab	155.56
Mean of seed grade	135.34	146.00	152.45	
Season 2020-2021				
Target rate seed.m^{-2}	Seed grade based on TKW			Mean of seed rate
	Whole	Heavy	Light	
200	152.00 ab	144.67 b	128.00 b	141.56
250	136.67 b	196.00 ab	177.33 ab	170.00
300	125.33 b	153.33 ab	237.33 a	172.00
Mean of seed grade	138.00	164.67	180.89	

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 reproductive tillers.m^{-2} for the season 2020-2021

The number was varied in the second season 2020-2021 (Table 9). It was obvious that fluctuation occurs for both climatic factors precipitation and temperature during January to June of both seasons which affect crop growth Aslam et al (5). The results revealed to no significant difference between seed grade on this trait, while target seeding rate and the interaction was significantly influence on this trait. The rate of 300 seed.m^{-2} and the interaction of this rate with light seed grade recorded highest values of fertile tillers in the season 2020-2021, which were 105.33 and 136.67, respectively. Whereas the lowest value was 66.89 for the rate 200seed.m^{-2} and the interaction of this rate with the light grade seed (54.67).

Table 9. Effect of seeding rate and seed weight and their interaction on number of fertile tillers.m^{-2}.

Target rate plants/m-2	Season 2020-2021 Seed grade based on TKW			Mean of seed rate
	Whole	Heavy	Light	
200	65.33 b	80.67 ab	54.67 b	66.89 b
250	74.00 ab	90.67 ab	79.33 ab	81.33 ab
300	73.33 ab	106.00 ab	136.67 a	105.33 a
Mean of seed grade	70.89	92.44	90.22	

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 non-reproductive tillers.m^{-2} for the season 2020-2021: General climate change scenario prior sowing precipitation reveals negative influence on crop yield ENNOS (19). Then due to the drought conditions that occurred in the season 2020-2021, and shortage in the amount of rainfall (165.40 mm) (Table 4) the crop grew vegetative, but it failed to complete its life cycle and form spikes, thus the number of non-fertile tillers was recorded and displays in Table (10). The drought stress adversely influenced even on field establishment as total number of tillers much less than half of sown seed rate and the analysis indicated to no significant effect of seed rate or seed grade or their interaction on this trait.

Table 10. Effect of seeding rate and seed weight and their interaction on the number of non-fertile tillers.m^{-2}.

Season 2020-2021				
Target rate seed.m^{-2}	Seed grade based on TKW			Mean of seed rate
	Whole	Heavy	Light	
200	86.67	64.00	73.33	74.67
250	62.67	105.33	98.00	88.67
300	52.00	47.33	100.67	66.67
Mean of seed grade	67.12	72.22	90.67	

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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