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Effect of seed rate and irrigation level on the performance of wheat cv. Gourab

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Abstract

The effect of seed rate and irrigation level on the performance of wheat cv. Gourab was studied. The experiment comprises of two factors namely (1) four seed rate viz. 100, 120, 140 and 160 kg ha⁻¹ and (2) four levels of irrigation namely (i) no irrigation i.e. control, (ii) one irrigation given at Crown root initiation (CRI) stage, (iii) two irrigations given at CRI and Panicle initiation stages and (iv) three irrigation given at CRI, panicle initiation and grain filling stages. All of the yields contributing characters were significantly affected by seed rate except 1000-grain weight. The highest plant height (82.36 cm), total tillers plant⁻¹(8.99), effective tillers plant⁻¹(3.49) , spike length (8.05 cm), spikelets spike⁻¹ (15.50), filled grain spike⁻¹ (31.05), grain yield (2.82 t ha⁻¹), straw yield (3.73 t ha⁻¹), biological yield (6.55 t ha⁻¹) and harvest index (42.43%) were recorded from the seed rate of 140 kg ha⁻¹. Most of the yields contributing characters were significant due to effect of irrigation level. The highest plant height (82.33 cm), spike length (8.37 cm), filled grain spike⁻¹ (31.90), effective tillers plant⁻¹ (3.31), grain yield (3.30 t ha⁻¹), straw yield (4.09 t ha⁻¹), biological yield(7.39 t ha⁻¹) and harvest index (44.47%) were recorded when one irrigation given at CRI stage . The interaction between seed rate and irrigation level influenced significantly all the plant characters except plant height, spikelets spike⁻¹ and 1000-grains weight. The highest spike length (8.63 cm), grain yield (3.70 t ha⁻¹), biological yield (8.06 t ha⁻¹) and harvest index (45.91%) were found from the seed rate of 140 kg ha⁻¹ combined with one irrigation applied at CRI stage. So it may be stated that the seed rate of 140 kg ha⁻¹ with one irrigation given at CRI stage may be practiced for better performance of wheat cv. Gourab.

Keyword: Seed rate, Irrigation level, Gourab

Introduction

Wheat is grown in *rabi* season in Bangladesh when maximum land is occupied by *boro* rice. The water requirement for *boro* rice is much higher than that of wheat. The water requirement of wheat is only 25-33% of *boro* rice (BARI, 1990). The production cost of wheat is also less than that of *boro* rice. Therefore, wheat has much potentiality to replace *boro* rice in Bangladesh in terms of its economic production and nutritional quality. In *rabi* season, most of the land, especially in North-Western part of the country remains fallow due to lack of irrigation facilities which could easily be brought under wheat cultivation. The climate and soil of Bangladesh are quite favorable for the cultivation of wheat during this period .Wheat yield in farmers field is very low i.e. only 2 t ha⁻¹ but in the research stations it is about 4 t ha⁻¹ (BARI, 1990). This might be due to the use of improper production technology by the farmers. To get maximum yield it is necessary to use quality seed and improved agronomic techniques such as optimum seed rate, time of seeding, irrigation, fertilizer application, weeding, water management, time of harvest etc. There is a need to increase the yield of wheat per unit area in Bangladesh to provide the ever-increasing food requirement of the country, as the cultivable area is very limited and there is little scope to expand the area for production of wheat.

Seed rate plays a vital role for optimum plant densities which is a pre-requisite for increased seed yield. It influences the yield and yield attributes of wheat (Singh and Singh, 1987). Seed rate depends on seeding method. The broadcasting method requires more seeds than line sowing. Higher seed rate produces more plants in unit area resulting in less intra-crop competition hereby affecting the yield and production cost. On the other hand, lower seed rate may reduce the yield drastically.

In Bangladesh, wheat ranks second position in respect of total area of land having an annual production of 0.976 million tons and total area of 0.56 million hectares (BBS, 2005). Irrigation at optimum level is one of the most important tools for boosting up the yield of wheat (Razzaque *et al.*, 1992). It influences dry matter production, plant height, leaf area, duration of grain filling and grain protein content of wheat (Thomson and chase 1992). In Bangladesh, the rainfall during *rabi* season is

characteristically scanty and uncertain. As such, wheat gives poor yield under non-irrigated condition. Moreover irrigation facilities are not so extensive to ensure abundant irrigation water throughout the country. Insufficient water affects the germination of seed and uptake of nutrients from soil. Nutrients from soil reach the root surface by mass flow and diffusion process which are related to moisture content of the soil. Moreover movement of nutrients through the plant body by physiological activities is also associated with soil water (Tisdale *et al.*, 1985). But as a matter of fact, irrigation water in Bangladesh is a limited resources and hence irrigation practices must be rationalized if irrigation is provided at critical growth stages of wheat. Because the yield of wheat is influenced by the level of irrigation as well as stages of crop growth and development at which irrigation are given. Therefore, when water supply is limited, it is necessary to take of the critical stages of crop growth into account with respect to soil moisture level. In view of the above circumstances, the present study was undertaken to find out the optimum seed rate and irrigation level for wheat cv. Gourab; and to study the interaction effect between seed rate and irrigation level on the yield of wheat cv. Gourab.

Materials and Methods

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from November 2005 to April 2006. The experimental land was medium high belonging to the non-calcareous dark grey flood soil having silty loam texture. It belongs to the agro-ecological zone of Old Brahmaputra Flood Plain (AEZ-9). Wheat variety Gourab (BARI GAM 20) was used as planting material. It is a high yielding variety and suits better as a late variety. Sowing time and plant height range from 15 November to 7 December and 90 to 102 cm producing 5-6 tillers per plant. The spike length varieties between 9-10 cm and seeds spike⁻¹ are 45-50 containing white seed color. Gourab matures within 100-108 days and yield varies between 3.6-4.5 ton ha⁻¹. The cultivar is claimed to be restraint to leaf rust and leaf spot (BARI, 2000). Treatments included in the experiment were as follows: Seed rate (kg ha⁻¹) viz. 100 (S₁), 120 (S₂), 140 (S₃), 160 (S₄) and irrigation level viz. no irrigation i.e. control (I₀), one irrigation given at Crown Root Initiation (CRI) stage (I₁), two irrigation given at CRI and panicle initiation stages (I₂), three irrigation given at CRI panicle initiation and grain filling stages (I₃). The experiment was laid out in a split-plot design with three replication in which level of irrigation was assigned in the main plot and seed rate in the sub plot at random. The experimental field was finally prepared by a country plough followed by laddering for breaking clods and leveling the land. All weeds, stubbles and crop residues of the field were removed prior to sowing of seeds and whole experimental area was divided into unit plots maintaining the desired spacing. The field was fertilized with urea, triple super phosphate, muriate of potash, gypsum @ 220, 180, 50, 120 kg ha⁻¹ respectively. Two-third of urea, the whole amount of triple super phosphate, muriate of potash, gypsum was applied at the time of final land preparation. The rest urea was top dressed at CRI stage. Seeds were sown by hand at depth of 4-5 cm a part furrows with a tine made of iron. After sowing, the seeds were covered with soil. Care was taken to avoid damage of the seeds and emerging seedlings by birds. Intercultural operations such as weeding(two weeding one at 25 days after sowing (DAS) and the other at 50 DAS were done by the help of a nirani), Irritation was given as per experimental specification. The crop was harvested at full maturity. Ten plants (excluding border plants) were selected randomly from each unit plot and uprooted before harvesting for recording data .The harvested crop of each plot was bundled separately, tagged properly and brought to the clean threshing floor. The bundles were dried sun, threshed and then grains were cleaned. The seed and straw weight for each plot were recorded after sun drying to constant weight. The dry weight of grains of sample plants was added to the respective unit plot to record the final yield plot⁻¹. The grain and straw yield was finally converted in to t ha⁻¹. All the collected and calculated data were analyzed following the ANOVA-technique. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984), using a computer operated program named MSTAT-C.

Results and Discussion

Effect of seed rate: All of the yields contributing characters were significantly affect due to seed rate except 1000-grain weight. The tallest plant (82.36 cm) was found from the seed rate of 140 kg ha⁻¹ and the shortest plant (77.80 cm) was found for the seed rate of 100 kg ha⁻¹. The highest number of total tillers plant⁻¹ (8.99), effective tillers plant⁻¹ (3.49) was recorded from the seed rate of 140 kg ha⁻¹

and the lowest number of total tillers plant⁻¹ (8.27), effective tillers plant⁻¹ (2.48) was found from the seed rate of 100 kg ha⁻¹. On the other hand the highest number of non-effective tillers plant⁻¹ (1.17) was found from the seed rate of 100 kg ha⁻¹ and the lowest (0.95) was recorded for the seed rate of 140 kg ha⁻¹ which is statistically similar to the seed rate of 120 kg ha⁻¹. The result is in agreement with the findings of Azimzadeh and Koocheki (1999). The longest spike (8.05 cm), highest number of spikelets spike⁻¹ (15.50) was produced by the seed rate of 140 kg ha⁻¹ and the shortest spike (7.10 cm), shortest number of spikelets spike⁻¹ (13.85) was found from the seed rate of 100 kg ha⁻¹. Talukder et al., (2004) obtained similar results. The highest number of filled grains spike⁻¹ (31.05) was recorded from the seed rate of 140 kg ha⁻¹ and the lowest (26.55) was recorded from the seed rate of 100 kg ha⁻¹. The highest number of unfilled grains spike⁻¹ (3.51) was found for the seed rate of 100 kg ha⁻¹ which was statistically similar the seed rate 160 kg ha⁻¹ and the lowest (2.82) was found from the seed rate of 140 kg ha⁻¹. Numerically the highest 1000-grain weight (33.48g) was obtained from the seed rate of 140 kg ha⁻¹. The results showed that the highest grain yield (2.82 t ha⁻¹) was obtained by the seed rate of 140 kg ha⁻¹, because of higher total tillers plant⁻¹, effective tillers plant⁻¹, lower non-effective tillers plant⁻¹, longest spike, highest number of spikelets spike⁻¹. The lowest grain yield (2.15 t ha⁻¹) was produced by the seed rate of 100 kg ha⁻¹. The result is in agreement with the findings of Talukder et al., (2004). The highest straw yield (3.73 t ha⁻¹) was found from the seed rate of 140 kg ha⁻¹ and the lowest (3.26 t ha⁻¹) was found for the use seed rate of 100 kg ha⁻¹ which was identical with the seed rate of 160 kg ha⁻¹. The highest harvest index (42.43%) was obtained from the seed rate of 140 kg ha⁻¹ and the lowest harvest index (39.12%) was obtained from the seed rate of 100 kg ha⁻¹. It was observed that by using low amount of seed rate harvest decreased harvest index.

Effect of Irrigation level: Most of the yields contributing characters were significant due to effect of irrigation level except spikelets spike⁻¹ and 1000 –grain weight. The tallest plant (82.33 cm) was obtained by one irrigation given at crown root initiation (CRI) stage and the shortest plant (77.07 cm) was obtained without irrigation. The highest number of total tillers plant⁻¹ (9.07) was recorded by two irrigations given at CRI and panicle initiation stage which was statistically identical with one irrigation given at CRI stage and the lowest (8.18) observed when no irrigation was given. The highest effective tillers plant⁻¹ (3.31) was obtained by one irrigation applied was at CRI stage which is statistically similar to two irrigations applied at CRI and panicle initiation stages, the lowest (2.43) was recorded when no irrigation was applied. The highest number of non-effective tillers plant⁻¹ (1.42) was obtained by no irrigation application and the lowest (0.61) was found in one irrigation applied at CRI stage. The longest spike length (8.37cm), highest number of filled grains spike⁻¹ (31.90) was recorded by one irrigation given at CRI stage and the shortest spike length (6.77cm), lowest number of filled grains spike⁻¹ (26.21) was recorded when no irrigation was given. On the other hand the highest number of unfilled grains spike⁻¹ (3.97) was found when no irrigation was applied and the lowest (2.67) was found from one irrigation applied at CRI stage. The result is in agreement with the findings of Singh and Uttam (1993). The highest grain yield (3.30 t ha⁻¹) was produced by one irrigation applied at CRI stage and the lowest (1.77 t ha⁻¹) was produced by control treatment which was statically similar to three irrigations applied at CRI , panicle initiation and grain filling stages. The highest straw yield (4.09 t ha⁻¹) was obtained by one irrigation applied at CRI stage and lowest (2.99 t ha⁻¹) was obtained by control treatment applied which was statically similar with applied of three irrigations application at CRI, panicle initiation and grain filling stages. The highest straw yield was observed with three irrigation. Increased straw yield with irrigation was attributed mainly due to increase in plant height and tillers plant⁻¹. The results of grain and straw yield supported by Singh and Uttam (1993). The highest harvest index (44.67%) was observed with one irrigation applied at CRI stage which was statistically similar to two irrigation applied at CRI and panicle initiation stages and harvest index (37.06%) was obtained from no irrigation treatment.

Effect of interaction: The interaction between seed rate and irrigation level influenced significantly all the plant characters except plant height, spikelets spike⁻¹ and 1000-grains weight.

Table1. Effect of Seed rate on the yield and yield performance of wheat cv. Gourab

Seed rate (kg ha ⁻¹)	Plant height (cm)	Total tillers plant ⁻¹	Effective tillers plant ⁻¹ (no.)	Non-effective tillers plant ⁻¹ (no.)	Spike length (cm)	Spikelets spike ⁻¹ (no.)	Filled grains Spike ⁻¹ (no.)	Unfilled grains Spike ⁻¹ (no.)	1000-grain weight (g)	Grain Yield (t ha ⁻¹)	Straw Yield (t ha ⁻¹)	Biological Yield (t ha ⁻¹)	Harvest Index (%)
100	77.80 ^d	8.27 ^b	2.48 ^d	1.17 ^a	7.10 ^c	13.85 ^c	26.55 ^d	3.51 ^a	32.91	2.15 ^d	3.26 ^c	5.41 ^d	39.12 ^c
120	80.42 ^b	8.84 ^a	2.98 ^b	0.99 ^c	7.85 ^{ab}	14.80 ^b	28.95 ^b	3.09 ^b	32.90	2.57 ^b	3.57 ^b	6.14 ^b	41.28 ^b
140	82.36 ^a	8.99 ^a	3.49 ^a	0.95 ^c	8.05 ^a	15.50 ^a	31.05 ^a	2.82 ^c	33.48	2.82 ^a	3.73 ^a	6.55 ^a	42.43 ^a
160	79.46 ^c	8.76 ^a	2.71 ^c	1.09 ^b	7.67 ^b	14.34 ^{bc}	27.56 ^c	3.38 ^a	33.45	2.38 ^c	3.27 ^c	5.72 ^c	40.94 ^b
Level of significance	**	**	**	**	**	**	**	**	NS	**	**	**	**
S_x	0.32	0.10	0.04	0.02	0.09	0.21	0.326	0.05	0.26	0.02	0.05	0.89	0.37
CV(%)	3.71	6.28	6.50	11.97	4.65	4.22	4.18	10.62	1.54	4.39	3.88	4.94	2.47

In a column figures having common letter(s) do not differ significant as per DMRT.** indicates 1% level of probability, NS indicates not significant

Table 2. Effect of Irrigation on the yield and yield performance of wheat cv. Gourab

Level of Irrigation	Plant height (cm)	Total tillers plant ⁻¹	Effective tillers plant ⁻¹ (no.)	Non-effective tillers plant ⁻¹ (no.)	Spike length (cm)	Spikelets spike ⁻¹ (no.)	Filled grains Spike ⁻¹ (no.)	Unfilled grains Spike ⁻¹ (no.)	1000-grain weight (g)	Grain Yield (t ha ⁻¹)	Straw Yield (t ha ⁻¹)	Biological Yield (t ha ⁻¹)	Harvest Index (%)
I ₀	77.07 ^d	8.18 ^c	2.43 ^c	1.42 ^a	6.77 ^d	13.88	26.21 ^d	3.97 ^a	32.97	1.77 ^c	2.99 ^c	4.78 ^c	37.06 ^c
I ₁	82.33 ^a	8.99 ^a	3.31 ^a	0.61 ^d	8.37 ^a	15.70	31.90 ^a	2.67 ^d	33.45	3.30 ^a	4.09 ^a	7.39 ^a	44.67 ^a
I ₂	80.93 ^b	9.07 ^a	3.22 ^a	0.97 ^c	8.10 ^b	15.14	28.54 ^b	2.87 ^c	33.17	2.94 ^b	3.74 ^b	6.76 ^b	43.37 ^a
I ₃	79.71 ^c	8.62 ^b	2.69 ^b	1.20 ^b	7.42 ^c	13.77	27.45 ^c	3.29 ^b	33.15	1.90 ^c	3.00 ^c	4.90 ^c	38.69 ^b
Level of significance	**	**	**	**	**	NS	**	**	NS	**	**	**	**
S_x	0.28	0.07	0.06	0.04	0.08	0.45	1.341	0.05	0.28	0.04	0.03	0.87	0.43
CV(%)	3.71	6.28	6.50	11.97	4.65	4.22	4.18	10.62	1.54	4.39	3.88	4.94	2.47

In a column figures having common letter(s) do not differ significant as per DMRT.** indicates 1% level of probability, NS indicates not significant

I₀ = no irrigation i.e. control

I₁ = one irrigation given at Crown Root Initiation (CRI) stage

I₂ = two irrigation given at CRI and panicle initiation stages

I₃ = three irrigation given at CRI, panicle initiation and grain filling stages.

Table 3. Interaction effect of seed rate and irrigation on the yield and yield performance of wheat cv. Gourab

Interaction (Seed rate x Irrigation)	Plant height (cm)	Total tillers plant ⁻¹	Effective tillers plant ⁻¹ (no.)	Non-effective tillers plant ⁻¹ (no.)	Spike length (cm)	Spikelets spike ⁻¹ (no.)	Filled grains Spike ⁻¹ (no.)	Unfilled grains Spike ⁻¹ (no.)	1000-grain weight (g)	Grain Yield (t ha ⁻¹)	Straw Yield (t ha ⁻¹)	Biological Yield (t ha ⁻¹)	Harvest Index (%)
S ₁ I ₀	74.50	7.75 ^d	2.00 ^j	1.50 ^a	6.25 ^g	13.15	25.00 ⁱ	4.36 ^a	33.30	1.55 ^l	2.90 ^h	4.45 ^g	34.83 ^j
S ₁ I ₁	80.23	8.88 ^{ab}	3.00 ^{def}	0.77 ^{gh}	8.11 ^{abc}	15.00	29.20 ^{def}	3.00 ^{efg}	33.58	2.85 ^e	3.68 ^{def}	6.53 ^{cd}	43.64 ^{abc}
S ₁ I ₂	78.89	8.95 ^{ab}	2.60 ^{gh}	1.10 ^{de}	7.85 ^{bcd}	14.25	26.40 ^{hi}	3.12 ^{def}	32.32	2.55 ^f	3.50 ^{efg}	6.05 ^d	42.15 ^{cd}
S ₁ I ₃	77.58	7.50 ^d	2.30 ⁱ	1.30 ^c	6.20 ^g	13.00	25.60 ^{hi}	3.56 ^c	32.44	1.65 ^{kl}	2.95 ^h	4.60 ^g	35.87 ^{hi}
S ₂ I ₀	77.50	8.40 ^{bc}	2.50 ^{hi}	1.40 ^b	7.00 ^{ef}	14.00	26.55 ^{gh}	4.03 ^b	31.67	1.83 ^{ij}	2.99 ^h	4.82 ^{f,g}	37.97 ^{fgh}
S ₂ I ₁	82.58	9.03 ^{ab}	3.46 ^{bc}	0.53 ⁱ	8.50 ^{ab}	15.92	32.56 ^b	2.51 ^{ij}	33.37	3.55 ^b	4.50 ^a	8.05 ^a	44.10 ^{abc}
S ₂ I ₂	81.10	9.03 ^{ab}	3.17 ^{de}	0.93 ^f	8.10 ^{abc}	15.50	28.50 ^{ef}	2.60 ^{hi}	33.45	3.00 ^d	3.90 ^{cd}	6.90 ^c	43.48 ^{bc}
S ₂ I ₃	80.50	8.90 ^{ab}	2.80 ^{f,g}	1.10 ^e	7.80 ^{cd}	13.77	28.21 ^{ef}	3.25 ^{cde}	33.13	1.90 ^{hi}	2.90 ^h	4.80 ^{f,g}	39.58 ^{ef}
S ₃ I ₀	79.67	8.55 ^{abc}	2.95 ^{ef}	1.30 ^c	7.25 ^{de}	14.79	28.00 ^{ef}	3.25 ^{cde}	33.95	2.00 ^h	3.20 ^{gh}	5.20 ^{ef}	38.46 ^{efg}
S ₃ I ₁	85.27	9.10 ^a	3.63 ^b	0.47 ⁱ	8.63 ^a	16.47	35.36 ^a	2.25 ^j	33.22	3.70 ^a	4.36 ^{ab}	8.06 ^a	45.91 ^a
S ₃ I ₂	83.25	9.18 ^a	4.12 ^a	0.83 ^g	8.35 ^{abc}	15.90	31.33 ^{bc}	2.76 ^{ghi}	33.24	3.36 ^c	4.11 ^{bc}	7.47 ^b	44.98 ^{ab}
S ₃ I ₃	81.25	9.15 ^a	3.25 ^{cd}	1.20 ^{cd}	7.95 ^{bc}	14.83	29.50 ^{de}	3.00 ^{efg}	33.51	2.20 ^g	3.25 ^{gh}	5.45 ^e	40.37 ^{de}
S ₄ I ₀	76.60	8.03 ^{cd}	2.26 ^{ij}	1.45 ^{ab}	6.58 ^{f,g}	13.58	25.30 ^{hi}	4.25 ^{ab}	32.94	1.70 ^{jk}	2.90 ^h	4.60 ^g	36.96 ^{ghi}
S ₄ I ₁	81.25	8.93 ^{ab}	3.15 ^{de}	0.68 ^h	8.25 ^{abc}	15.40	30.50 ^{cd}	2.90 ^{fgh}	33.64	3.11 ^d	3.80 ^{cde}	6.91 ^c	45.01 ^{ab}
S ₄ I ₂	80.50	9.13 ^a	3.00 ^{def}	1.03 ^e	8.10 ^{abc}	14.90	27.92 ^{f,g}	3.00 ^{efg}	33.69	2.85 ^e	3.47 ^{f,g}	6.64 ^c	42.86 ^{bc}
S ₄ I ₃	79.50	8.93 ^{ab}	2.43 ^{hi}	1.20 ^d	7.73 ^{cd}	13.50	26.50 ^{ghi}	3.36 ^{cd}	33.53	1.85 ⁱ	2.90 ^h	4.75 ^{f,g}	38.95 ^{efg}
S ₁ I ₀	74.50	7.75 ^d	2.00 ^j	1.50 ^a	6.25 ^g	13.15	25.00 ⁱ	4.36 ^a	33.30	1.55 ^l	2.90 ^h	4.45 ^g	34.83 ^j
Level of significance	NS	*	**	*	*	NS	*	*	NS	**	*	*	**
S _x	0.66	0.20	0.09	0.03	0.19	0.42	0.654	0.11	0.53	0.04	0.11	0.18	0.73
CV (%)	3.71	6.28	6.50	11.97	4.65	4.22	4.18	10.62	1.54	4.39	3.88	4.94	2.47

In a column figures having common letter(s) do not differ significant as per DMRT

** = indicates 1% level of probability, * = indicates 5% level of probability, NS = indicates not significant.

S₁ = 100 kg ha⁻¹ I₀ = no irrigation i.e. controlS₂ = 120 kg ha⁻¹ I₁ = one irrigation given at Crown Root Initiation (CRI) stageS₃ = 140 kg ha⁻¹ I₂ = two irrigation given at CRI and panicle initiation stagesS₄ = 160 kg ha⁻¹ I₃ = three irrigation given at CRI, panicle initiation and grain filling

The highest number of total tillers plant⁻¹ (9.18) was recorded from the seed rate of 140 kg ha⁻¹ combined with two irrigations applied at CRI and panicle initiation stages which was statistically similar with the seed rate of 160 kg ha⁻¹ and two irrigations applied at CRI and panicle initiation stages and for the seed rate of 140 kg ha⁻¹ and one irrigation applied at CRI stage. The lowest number of total tillers plant⁻¹ was found from the seed rate of 100 kg ha⁻¹ combined with three irrigations applied at CRI, panicle initiation and grain filling stages. The highest number of effective tillers plant⁻¹ (4.12) was found in the seed rate of 140 kg ha⁻¹ combined with two irrigation applied at CRI and panicle initiation stages and the lowest number of effective tillers plant⁻¹ (2.00) was observed from the seed rate of 100 kg ha⁻¹ and no irrigation applied. The highest number of non-effective tillers plant⁻¹ (1.50) was found from the seed rate of 100 kg ha⁻¹ and with no irrigation applied and the lowest number of non-effective tillers plant⁻¹ was counted from the seed rate of 140 kg ha⁻¹ and one irrigation applied at CRI stage. The longest spike (8.63cm) was obtained from the seed rate of 140 kg ha⁻¹ with one irrigation applied at CRI. The shortest spike was obtained from the seed rate of 100 kg ha⁻¹ with three irrigations applied at CRI, panicle initiation and grain filling stages. The highest number of filled grains spike⁻¹ (35.36) was counted from the use of seed rate of 140 kg ha⁻¹ and one irrigation applied at CRI stage and the lowest one (25.00) was counted from the seed rate of 100 kg ha⁻¹ and no irrigation applied. The highest number of unfilled grains spike⁻¹ (4.36) was produced by the seed rate of 100 kg ha⁻¹ and without irrigation and the lowest number of unfilled grains spike⁻¹ (2.25) was obtained by the seed rate of 140 kg ha⁻¹ and one irrigation applied at CRI stage. Among the treatments combination, the highest grain yield (3.70 t ha⁻¹) was found from the seed rate of 140 kg ha⁻¹ combined with one irrigation applied at CRI stage. The lowest grain yield (1.55t ha⁻¹) was found from the seed rate of 100 kg ha⁻¹ and control treatment. The highest straw yield (4.50 t ha⁻¹) was observed from the seed rate of 120 kg ha⁻¹ combined with one irrigation applied at CRI stage. The lowest straw yield (2.90 t ha⁻¹) was observed from the seed rate of 160 kg ha⁻¹ combined with three irrigation applied at CRI, panicle initiation and grain filling stages. The highest harvest index (45.91%) was observed from the seed rate of 140 kg ha⁻¹ combined with one irrigation applied at CRI stage. The lowest harvest index (34.83%) was obtained from the use of seed rate of 100 kg ha⁻¹ with no irrigation applied. From the results of the present study it may, therefore be concluded that the seed rate of 140 kg ha⁻¹ with one irrigation given at CRI stage may be practiced for better performance of wheat cv. Gourab.

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