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Response of Wheat on Seed Rate and Irrigation Levels

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Abstract
This paper was prepared by reviewing documents and research findings from studies conducted focusing on interaction effect of seed rate and irrigation level on wheat crops. The temporal and spatial coverage of the research findings was between 2009 and 2016. Approaches followed on the response of crops to irrigation level and seed rates were through reviewing journals from websites and research output reports. In this review, achievements of different seed rates for different irrigation levels on crops under diverse agro-ecologies are highlighted based on the current knowledge from available sources. Research findings revealed that interactive effect of seed rates and amount of irrigation water had significantly improved yield of crops. Therefore, based on the current findings, application of seed rate increased for irrigated crops the yield also increased and be combined with the required amount of irrigation water and seed rate.
Keywords: seed rate, Wheat, irrigation level
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Introduction

There is an increasing need to produce more food in order to feed the ever increasing population in the world. This is also true for cereal production. As it is not possible to increase the land cultivated, the only solution and option are to increase the grain yield and productivity**.** Ethiopia's agriculture system constitutes 46% of gross national production, employs 85% of its population, and creates 75% of export commodity value (FDRE, 2013). Despite its large scale, the agricultural sector is largely formed by smallholder subsistence farms burdened by dependence on erratic rain-fed systems. In all, smallholders account for 96% of total area cultivated (Taffesse et al., 2011). Ethiopia's rain dependent agricultural system is particularly vulnerable to shifts in climate and weather, with less than 3% of households having access to irrigation (or less than 1% of cereal acreage) (Mann and Warner, 2015, Taffesse et al., 2011). These vulnerabilities are further exaggerated by extensive use, land degradation, and household poverty.

Now a day's irrigation development is increasingly implemented in Ethiopia more than ever to supplement the rain-fed agriculture. It aims to increase agricultural productivity and diversify the production of food and raw materials for agro-industry as well as to ensure that the agriculture to play a pivotal for driving the economic development of the country.The major crop category that included cereals**,** pulses and oil seeds, which not only constituted the major food crops for the majority of the country's population but also served as a source of income at household level and a contribute for the country's foreign currency earnings, among others.

Within the category of Grain crops**,** Cereals are the major food crops both in terms of the area they are planted and volume of production obtained. They are produced in larger volume compared with other crops because they are the principal staple crops. Cereals are grown in all the regions with varying quantity (CSA, 2017/18). Out of the total grain crop area, 80.71% the area was under cereals. Tef, maize, sorghum and wheat took up of the grain crop area, respectively. Cereals contributed 87.48%) of the grain production. Maize, teff, wheat and sorghum made up 27.43%, 17.26%, 15.17% and 16.89% of the grain production, respectively (CSA, 2017/18).

Ethiopia is the second largest producer of wheat in Sub-Saharan Africa. In Ethiopia, wheat is one of the major cereal crops grown between 6 and 14o N latitudes; and between 35 and 42oE longitude ranging in altitude from 1500 m to 3200 m. The most suitable regions, however, fall between 1900 m and 2700 m. The current total area of production of both durum (Triticum turgidum var. durum) and bread wheat (Triticum aestivum) is more than about 861,100 hectares (CSA, 1988)). Other sources, however, estimate the total area to be 1.2 to 1.5 million hectares. This area is limited to the intermediate altitudes and the highlands despite a potential for irrigated wheat production in the lowlands. In area coverage, durum and bread wheat types hold equal proportions according to a recent survey by a group of wheat researchers. Bread wheat production, nevertheless, is on the increase. Other Ethiopian wheat species are also cultivated, but to a lesser extent. An example is emmer wheat (Triticum dicoccum). Ethiopia is one of the very few countries where Triticum dicoccum is still under cultivation. Other species like Triticum polonicum and Triticumaethiopicum are also grown in mixtures with other wheat species.

Seed rate is the most important agronomic aspect. Seed rate is playing a vital role for optimum cereal plant densities which is a pre-requisite for increased seed yield. It influences the yield and yield attributes of cereals.

Yursel, (2009) reported under irrigation condition lower number of plants m^{-2} and number of spike m^{-2} are significantly higher grain yield. In the seed rate experiment the lowest seed rate produced the highest grain yields

spike. The seed rate of the highest value was obtained with the lowest seeding rate.

The rain-fed Agriculture of our Country cereal crops of seed rate is determined by different investigation. But in irrigated Agriculture still now we used the rain fed cereals seed rate. From the experiences the use of the rain-fed packages to irrigated Agriculture is not recommended due to seed extravagance especially when the cereal crops are planted in rows.

In Ethiopia most farmers are producing cereal crops. So determinations of seed rate and fertilizer levels are useful under Irrigated Agriculture in order to increase yield and yield productivity of cereals. However, compiling the available research finding on seed rate recommendation for Wheat crops in irrigated agriculture is essential. Therefore, a review of different research outputs was conducted on Response of Wheat on seed rate and irrigation levels for efficient water and seed rate management and to make available information and technologies for user under irrigated agriculture. In this review, achievements of seed rates for Wheat crops are highlighted based on the current knowledge from available sources. Finally my recommendation was the seed rate of Wheat on irrigated Agriculture more difference from rain –fed agriculture. Still know in our Country do not conducted such experiment.

MATERIALS AND METHODS

Different research outputs on Response of Wheat on seed rate and irrigation levels were reviewed. This includes journals from online websites using www.goole.com search.

RESULTS AND DISCUSSION

Different seed rate and irrigation levels have a significant improvement on wheat yield indifferent research findings. Kabir et al. (2009) reported that 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 $ha^{-1}$and also 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}. 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 $plant^{-1}$. Based on irrigation level 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 study revealed that the maximum seed rate and application of full irrigation water obtained high yield of wheat.

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}.

Since the amount of soil moisture and seed rate have an interaction effect. The interaction between seed rate and irrigation level influenced significantly all the plant characters except plant height, spikelets $spike^{-1}$ and 1000-grains weight. Most of the time the availability of adequate amount of water at the optimum depletion level leads to higher use efficiency of seed and vice versa. Moreover, adequate moisture content of the soil could lead to sufficient seed germination and productivity in soil.

Additionally Kabir et al. (2009) reported that the combination result of irrigation level and seed rate 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.. 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 yield.

Similarly, Shah et al. (2016) reported that the irrigation levels and seed rates had significant effect on grain yield of wheat. Regarding seed rates, maximum grain yield (3160 kg ha-1) was produced when plots were seeded with 120 kg ha-1, while minimum grain yield (2437 kg ha-1) was noted with 60 kg ha-1 seed rate. The maximum grain yields (3130 kg ha-1) was recorded in plots treated with 470 mm water , while minimum grain yield (2417 kgha-1) was recorded when 120 mm water was given to the plot.

While the number of grains spike-1 of wheat significantly influenced by different irrigation levels and seed rates. Maximum grains spike-1 (64) were recorded from plots treated with 470 mm water and less grains spike-1

(51) were recorded when 120 mm water was given. The data also revealed that in seed rates, more grains spike-1 (62) were produced when plots were seeded with 120 kg ha-1 seed rate (SR4), whereas less number of grains spike-1 (54) were noted with 60 kg ha-1 seed rate (SR1). The data further showed that interaction between irrigation levels and seed rates (IL x SR) was found significant. Maximum number of grains spike-1 were noted when water was used at the rate of 470 mm and seeded with 120 kg ha-1 while minimum number of grains spike-1 were recorded from plots when 120 mm water was applied and 60 kg ha-1 seed rate used.

Table 1.Effect of seed rate on the yield and yield performance of wheat CV

	Seed rate (kg/ha)	Plant height(cm)	Total tillers plant^{-1}	Effective tillers plant^{-1} (no)	Non-effective tillers plant^{-1}(no)	Spikelets spike^{-1} (no)	1000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
Kabir et al. (2009)	100	77.80^{d}	8.27^{b}	2.48^{d}	1.17^{a}	13.85^{c}	32.91	2.15^{d}	3.26^{c}	39.12^{c}
	120	80.42^{b}	8.84^{a}	2.98^{b}	0.99^{c}	14.80^{b}	32.90	2.57^{b}	3.57^{b}	41.28^{b}
	140	82.36^{a}	8.99^{a}	3.49^{a}	0.95^{c}	15.50^{a}	33.48	2.82^{a}	3.73^{a}	42.43^{a}
	160	79.46^{c}	8.76^{a}	2.71^{c}	1.09^{b}	14.34^{bc}	33.45	2.38^{c}	3.27^{c}	40.94^{b}
	Level of significance	**	**	**	**	**	NS	**	**	**
	SX	0.32	0.10	0.04	0.02	0.21	0.26	0.02	0.05	0.37
	CV (%)	3.71	6.28	6.50	11.97	4.22	1.54	4.39	3.88	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 yield and yield performance of wheat CV.

	Level of Irrigation	Plant height(cm)	Total tillers plant^{-1}	Effective tillers plant^{-1} (no)	Non-effective tillers plant^{-1}(no)	Spikelets spike^{-1} (no)	1000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
Kabir et al. (2009)	I0	77.07^{d}	8.18^{c}	2.43^{c}	1.42^{a}	13.88	32.97	1.77^{c}	2.99^{c}	37.06^{c}
	I1	82.33^{a}	8.99^{a}	3.31^{a}	0.61^{d}	15.70	33.17	3.30^{a}	4.09^{a}	44.67^{a}
	I2	80.93^{b}	9.07^{a}	3.22^{a}	0.97^{c}	15.14	33.15	2.94^{b}	3.74^{b}	43.37^{a}
	I3	79.71^{c}	8.62^{b}	2.69^{b}	1.20^{b}	13.77	33.15	1.90^{c}	3.00^{c}	38.69^{b}
	Level of significance	**	**	**	**	**	NS	**	**	**
	SX	0.28	0.07	0.06	0.04	0.45	0.28	0.04	0.03	0.43
	CV (%)	3.71	6.28	6.50	11.97	4.22	1.54	4.39	3.88	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

I_o = no irrigation i.e. control

I_1 = one irrigation given at Crown Root Initiation (CRI) stage

I_2 = two irrigation given at CRI and panicle initiation stages

I_3 = 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

	Interaction (Seed rate × Irrigation)	Plant height(cm)	Total tillers plant^{-1}	Effective tillers plant^{-1} (no)	Non-effective tillers plant^{-1}(no)	Spikelets spike^{-1} (no)	1000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
Kabir et al. (2009)	$S_1 I_0$	74.50	7.75^{d}	2.00^{j}	1.50^{a}	13.15	33.30	1.55^{l}	2.90^{h}	34.83^{i}
	$S_1 I_1$	80.23	8.88^{ab}	3.00^{def}	0.77^{gh}	15.00	33.58	2.85^{e}	3.68^{def}	43.64^{abc}
	$S_1 I_2$	78.89	8.95^{ab}	2.60^{gh}	1.10^{de}	14.25	32.32	2.55^{f}	3.50^{efg}	42.15^{cd}
	$S_1 I_3$	77.58	7.50^{d}	2.30^{i}	1.30^{c}	13.00	32.44	1.65^{kl}	2.95^{h}	35.87^{hi}
	$S_2 I_0$	77.50	8.40^{bc}	2.50^{hi}	1.40^{b}	14.00	31.67	1.83^{ij}	2.99^{h}	37.97^{fgh}
	$S_2 I_1$	82.58	9.03^{ab}	3.46^{bc}	0.53^{i}	15.92	33.37	3.55^{b}	4.50^{a}	44.10^{abc}
	$S_2 I_2$	81.10	9.03^{ab}	3.17^{de}	0.93^{f}	15.50	33.45	3.00^{d}	3.90^{cd}	43.48^{bc}
	$S_2 I_3$	80.50	8.90^{ab}	2.80^{fg}	1.10^{e}	13.77	33.13	1.90^{hi}	2.90^{h}	39.58^{ef}
	$S_3 I_0$	79.67	8.55^{abc}	2.95^{ef}	1.30^{c}	14.79	33.95	2.00^{h}	3.20^{gh}	38.46^{efg}
	$S_3 I_1$	85.27	9.10^{a}	3.63^{b}	0.47^{i}	16.47	33.22	3.70^{a}	4.36^{ab}	45.91^{a}
	$S_3 I_2$	83.25	9.18^{a}	4.12^{a}	0.83^{g}	15.90	33.24	3.36^{c}	4.11^{bc}	44.98^{ab}
	$S_3 I_3$	81.25	9.15^{a}	3.25^{cd}	1.20^{cd}	14.83	33.51	2.20^{g}	3.25^{gh}	40.37^{de}
	$S_4 I_0$	76.60	8.03^{cd}	2.26^{ij}	1.45^{ab}	13.58	32.94	1.70^{jk}	2.90^{h}	36.96^{ghi}
	$S_4 I_1$	81.25	8.93^{ab}	3.15^{de}	0.68^{h}	15.40	33.64	3.11^{d}	3.80^{cde}	45.01^{ab}
	$S_4 I_2$	80.50	9.13^{a}	3.00^{def}	1.03^{e}	14.90	33.69	2.85^{e}	3.47^{fg}	42.86^{bc}
	$S_4 I_3$	79.50	8.93^{ab}	2.43^{hi}	1.20^{d}	13.50	33.53	1.85^{i}	2.90^{h}	38.95^{efg}
	$S_1 I_0$	74.50	7.75^{d}	2.00^{j}	1.50^{a}	13.15	33.30	1.55^{l}	2.90^{h}	34.83^{i}
	Level of significance	NS	*	**	*	NS	NS	**	*	**
	S*x*	0.66	0.20	0.09	0.03	0.42	0.53	0.04	0.11	0.73
	CV (%)	3.71	6.28	6.50	11.97	4.22	1.54	4.39	3.88	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 Io = no irrigation i.e. control
S2 = 120 kg ha-1 I1 = one irrigation given at Crown Root Initiation (CRI) stage
S3 = 140 kg ha-1 I2 = two irrigation given at CRI and panicle initiation stages
S4 = 160 kg ha-1 I3 = three irrigation given at CRI, panicle initiation and grain filling

Table 4. Number of Tillers Thousand grains weight and grains yield wheat as affected by seed Rates and irrigation level

	Treatments	Number of tillers	1000 grains weight (g)	Grains Yield (kg/ha)
Shah et al. (2016)	Seed rate (SR=kgha-1)			
	SR1=60	299.35d	39.30 d	2437 c
	SR2=80	312.90c	41.31c	2599bc
	SR3=100	317.65c	41.95bc	2695b
	SR4=120	346.10a	43.15a	3160a
	SR5=140	331.20b	42.35b	2821b
	LSD Value	**10.08**	**0.72**	**232.5**
	Irrigation levels(IL=mm)			
	IL1	250.30d	38.38d	2417c
	IL2	306.55c	41.43c	2650c
	IL3	332.70b	42.22b	2710b
	IL4	362.35a	43.19a	3130a
	IL5	355.30a	42.85a	2805b
	LSD Value	**8.68**	**0.51**	**254.3**
	LSD Value for interaction			
	SR X IL	*	*	*

Means in the same category followed by different letters are significantly different at P ≥0.05 levels.*=significant

Conclusions

Based on different Research findings for irrigated Wheat crop at different parts of the country, site specific and crop based seed rate recommendation should be used for different irrigation conditions like no irrigation, one irrigation two irrigation and three irrigation conditions. Research findings revealed that different seed rate of wheat crop under irrigation condition significantly produced higher yield. Various crops under different agro-ecology and soil type were significantly different in the requirement of seed rate. Therefore, application of higher seed rate for irrigated wheat should be site specific and it should be combined with the amount of irrigation water requirement of the particular area based on the current finding. Moreover, more study on effect of different irrigation water management option should be studied. The findings clearly indicated the interactive effect of the moisture content and amount of seed rate has significant yield advantage over almost all the control treatments.

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