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Effect of levels of nitrogen and seed rate on yield and yield attributes of durum wheat under restricted irrigation in rainfed condition of Bhal Region of Gujarat

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Abstract
A field experiment was conducted at Agricultural Research station, Anand Agricultural University, Dhandhuka, Bhal region of Gujarat under conserved soil moisture condition in the rabi season of 2018-19- to 2020-21 to determine the effect of levels of nitrogen and seed rate on production of durum wheat with the objective of to find out suitable nitrogen level and seed rate of durum wheat (GADW- 3) for Bhal region of Gujarat under conserved soil moisture condition. Moisture received during the rainy season and conserved as such. The experiment was laid out in randomized block design (Factorial) with three replication with twelve (3 levels of seed rate & 4 levels of nitrogen) treatments combination comprising of three treatments of seed rate *viz*; S_1: 90 kg ha, S_2: 100 kg ha and S_3: 110 kg and four levels of nitrogen *viz*; N_1: 40 kg N/ha (20 kg N basal + 20 kg N at CRI), N_2: 40 kg N/ha (8 kg N basal + 16 kg N at CRI + 16 kg N at 45 DAS), N_3: 60 kg N/ha (30kg N at basal + 30 kg n at CRI) and N_4: 60 kg N/ha (12 kg N at basal + 24 kg N at CRI + 24 kg N at 45 DAS) and apply two restricted irrigation at 21 and 45 days after sowing. Result of three year pooled analysis of experiment recorded significantly higher growth and yield parameters with 90 kg seed rate per hector *viz*; plant height (cm) at harvest (114.98), tiller conversion index (%) (92.63), ear length (cm) at harvest (10.13), no. of grain per ear (54.84) and test weight (56.33). The same treatment produced significantly higher grain kg per hector (3419) whereas, straw yield was found non-significant but statically higher straw yield kg per hector was reported with S_3 treatment (4682). In case of nitrogen levels, 60 kg nitrogen per hector were recorded significantly higher data of plant height (cm) at harvest (116.53), ear length (cm) at harvest (10.51), grain per ear at harvest (56.23), test weight (57.01), tiller conversion index (%) (94.42), grain yield () (3514 kg/ha) & straw yield (4857 kg/ha). As far as economics was concerned, higher net return and BCR were realized with 90 kg seed rate per hector and 60 kg nitrogen per hector under conserved moisture condition with two restricted irrigation.

Keywords: Durum wheat, seed rate, levels of nitrogen

Introduction

Durum wheat (*Triticum durum*) is the second most important species globally as well as nationally grown after bread wheat (*Triticum aestivum* L.). In fact durum wheat was the predominantly grown in Central India, particularly in the Malwa region in Madhya Pradesh, *Bhal* and coastal agro-climatic zone in Gujarat, Southern Rajasthan and Bundelkhand region of Uttar Pradesh. Total durum wheat production in India is sharing about 4 to 10 percent of total wheat production. In Gujarat State the major growing areas of durum wheat are Dholka, Dhandhuka, Bavla and Dholera Talukas of Ahmedabad district. In *Bhal* and coastal zone of Gujarat area, rainfed durum wheat is sown across 2 lakh hectares. (Anonymous, 2017) [1]. Nitrogen plays noticeable role in plant metabolism and all the vital physiological and metabolic processes in plant are associated with protein of which nitrogen is an essential constituent (Adnan *et al.* 2016) [2]. Ames *et al.* 2003 [6] observed that nitrogen is the key nutrient element and plays an inevitable role to increase the tillering capacity which leads to higher potential yield. Nitrogen is an important nutrient for plants in agricultural ecosystems, plants take nitrogen from the soil through the roots in the form of nitrate and ammonium, it is important for most of the vital processes in plants, its presence in the soil has an important and positive role in increasing the availability of many elements in the soil, including phosphorous and potassium (Qin *et al*., 2017) [18]. Nitrogen is the major nutrient affecting the various physiological processes in the plants. It is indispensable in metabolic roles, such as the synthesis of proteins, nucleotides, nucleic acids, and chlorophyll. Nitrogen influences growth and development and promotes photosynthetic activities. Nitrogen is a limiting factor in crop production, and adequate and timely application is necessary for optimum crop production (Dobermann *et al*., 2003) [8]. 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 under conserved soil moisture conditions. Seed rate is important factor especially in ranfed areas where wheat crop grown under conserved soil moisture and apply limited irrigation to the crop. Adequate seed rate for the availability of nutrients, an effective combination of sunlight for photosynthesis, and the efficiency of soil moisture, which is important for the viability of crops, thereby raising the production and yield of crops (Alemayehu *et al*., 2015) [4]. Among the factors responsible for low wheat yield, delay in sowing, traditional sowing methods, low seed rate and improper row spacing are very important (Iqba *et al*., 2010) [11]. Limited irrigation an impotent tool of crop grown under conserved soil moisture condition due to limited irrigation yield increase up to 20 to 25% of in Bhal region of Gujarat and it also vary from crop to crop. Limited irrigation improves soil health because high number of irrigation in Bhal area of Gujarat damage soil heath. Hence, seed rate and nitrogen levels an important factor with limited or restricted irrigation at critical stages of crop in Bhal region of Gujarat for higher crop production.

Materials and Methods

The experiment carried out in *Rabi* season 2018-19 to 2020-21 for three years at Agricultural Research station, Anand Agricultural University, Dhandhuka, Bhal region of Gujarat under conserved soil moisture condition. Experiment was laid out in randomized block design (Factorial) with three replication with twelve treatments combination comprising of three treatments of seed rate *viz*; S_1: 90 kg ha, S_2: 100 kg ha and S_3: 110 kg and four levels of nitrogen *viz*; N_1: 40 kg N/ha (20 kg N basal + 20 kg N at CRI), N_2: 40 kg N/ha (8 kg N basal + 16 kg N at CRI + 16 kg N at 45 DAS), N_3: 60 kg N/ha (30kg N at basal + 30 kg n at CRI) and N_4: 60 kg N/ha (12 kg N at basal + 24 kg N at CRI + 24 kg N at 45 DAS) under conserved soil moisture condition. The variety durum wheat was use GADW 3 which is sown spacing of 30 cm. Nitrogen doses and seed rate were applied as per treatment. Two restricted irrigation were apply to the crop at CRI (21 DAS) stage and 45 days after sowing of crop. Soil analysis also done before sowing of crop and after harvesting of crop. The observation like, plant height (cm), plant population, tiller conversion index, length of ear at harvest (cm), no of grains/ear at harvest, test weight (g), grain and straw yield was recorded as per schedule. Tiller conversion Index (%) was calculated by counting the number of tillers having fully developed ear from the randomly selected square meter in each plot by following formula

$$\text{Tiller conversion index calculated by} = \frac{\text{No of effective tillers}}{\text{Total no tillers}} \times 100$$

Results & Discussion

1. Plant height (cm) at harvest

The data presented in table no 1 indicated that significantly higher plant height (cm) at harvest were found with S_1 treatment in individual years 111.42, 112.55, 114.98 respectively, and pooled analysis (112.38) but found at par with S_3 in treatment individual years. 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). In case of nitrogen levels, significantly higher data was recorded with N_4 treatment in individual years 118.0, 114.47, 117.11 respectively, whereas, in pooled analysis N_4 treatment (116.53) also found significant over rest of the treatments. Nitrogen promotes cell division and differentiation, so the application of nitrogen helps to increase the height of wheat. A similar result is observed by (Singh, 2001) [23]. Interaction was found no significant in seed rate and levels of nitrogen.

Table 1: Effect of seed rate and levels of nitrogen on plant height (cm) at harvest.

Treatment	2018-19	2019-20	2020-21	Pooled
(A) Seed rate				
S_1	111.42	112.55	114.98	112.98
S_2	103.82	106.38	110.13	106.78
S_3	109.29	110.02	113.35	110.89
Sem±	2.24	1.61	1.42	0.99
CD at5%	6.57	4.73	4.17	2.78
(B) Nitrogen level				
N_1	105.03	106.96	109.87	107.29
N_2	104.23	108.00	110.56	107.60
N_3	105.43	109.18	113.76	109.46
N_4	118.00	114.47	117.11	116.53
Sem±	1.94	1.40	1.23	1.14
CD at5%	5.69	4.10	3.61	3.21
CV %	6.22	4.42	3.78	5.37
SxN				NS
YxS				NS
YxN				NS

2. Ear length (cm) at harvest

A critical examination of data (Table 2) indicated that among the seed rates treatments S_1 (90 kg ha.) gave significantly higher data of ear length at harvest in all the three years 11.21, 9.16, 10.01 respectively, and in pooled data also recorded significantly with S_1 (90 kg ha.) treatment (10.13). Similar results were reported by Tigabu Rahel & Asfaw Fekadu at Ethiopia (2016). Significantly higher ear length were recorded in case of nitrogen levels with N_4 treatment (60 kg N/ha (12 kg N at basal + 24 kg N at CRI + 24 kg N at 45) which is 11.36, 9.42, 10.37 in individual years respectively, and in pooled (10.51) analysis in conserved soil moisture. Ali *et al.* (2011) reported that spike length was significantly increased by increasing the nitrogen level over the control.

Table 2: Effect of seed rate and levels of nitrogen on ear length (cm) at harvest

Treatment	2018-19	2019-20	2020-21	Pooled
(A) Seed rate				
S_1	11.21	9.16	10.01	10.13
S_2	10.47	8.57	9.20	9.41
S_3	10.27	8.69	9.23	9.40
Sem±	0.26	0.18	0.23	0.13
CD at5%	0.76	0.53	0.67	0.36
(B) Nitrogen level				
N_1	10.35	8.72	9.04	9.37
N_2	10.50	8.41	9.00	9.30
N_3	10.39	8.68	9.12	9.39
N_4	11.36	9.42	10.77	10.51
Sem±	0.23	0.16	0.20	0.15
CD at5%	0.66	0.46	0.58	0.42
CV %	7.33	6.11	7.20	8.01
SxN				NS
YxS				NS
YxN				NS

3. No. of grain/year

The perusal of data for no of grains per ear presented in table no 3 indicated that significantly higher values of no of grains associated with S_1 treatment in individual years 59.38, 54.15 and 50.98 respectively and pooled analysis of three years (54.84) in case of seed rate. The potential of wheat spike is determined by the number of grains spike^{-1} which is an important yield component of grain yield (Wajid Ali, *at. el.* 2016) [25] whereas, in case of nitrogen levels, treatment N_4 (60 kg N/ha (12 kg N at basal + 24 kg N at CRI + 24 kg N at 45 DAS) recorded significantly higher data in individual years 59.70, 55.29, 53.71 respectively. Whereas, on pooled analysis of three years significant data found with N_4 (56.23). These findings are in conformity with the results (Attarde *et al.*, 1989) [5] of who also found that the indication of seed rate and nitrogen levels had significant effect on grains spike-^{1}. Seed rate in rainfed area an impotent aspect because under conserved soil moisture condition with limited irrigation optimum seed produce effective germination and ultimately good crop growth increase spike length and produced higher no of grain per spike. Consequently, there is value in defining relationships between density and wheat yield to establish optimum seeding rates for various regions. (Ejaz H *et al.*, 2002) [9]

Table 3: Effect of seed rate and levels of nitrogen on no. of grain per ear at harvest

Treatment	2018-19	2019-20	2020-21	Pooled
(A) Seed rate				
S_1	59.38	54.18	50.98	54.84
S_2	57.29	51.97	47.23	52.16
S_3	56.58	51.88	46.53	51.67
Sem±	0.63	0.78	1.19	0.55
CD at5%	1.85	2.29	3.48	1.56
(B) Nitrogen level				
N_1	56.12	52.27	46.47	51.62
N_2	58.37	51.24	45.61	51.74
N_3	56.81	51.91	47.19	51.97
N_4	59.70	55.29	53.71	56.23
Sem±	0.55	0.68	1.03	0.64
CD at5%	1.61	1.99	3.02	1.80
CV %	3.29	4.46	7.39	6.26
SxN				NS
YxS				NS
YxN				NS
				NS

4. Test weight (g)

A perusal of data indicated that different treatments of seed rates presented in table no 4 indicated that significantly higher values of test weight was recorded S_1 treatment (90 kg ha^{-1}) in all three years 2018-19, 2019-20, and 2020-21 and values are 56.88, 55.83 and 56.28 respectively. These results are in conformity with (Marwat *et al.*, 1989 & Sheikh *et al.*, 1985) [16, 20] who also reported that 1000 grains weight decreased with increasing in seeding densities. Changes in seed rates are of particular importance in cereal crops, especially wheat, as they have a direct effect on the yield of grains and their components (Lithourgidis *et al.*, 2006; Intsar and Wahid 2017) [15, 10]. In this study, the weight of 1000 grains decreased with an increase in the seeding rate in all cultivars, which is consistent with the findings of Baloch *et al.* (2010) and Laghari *et al.* (2011) [14]. In case if nitrogen levels treatment N_4 (60 kg N/ha (12 kg N at basal + 24 kg N at CRI + 24 kg N at 45 DAS) was found significantly in test weight over the rest of treatment in individual years and pooled analysis and values are 57.37, 56.44, 57.21 and 57.01 respectively. The

Seed rate and nitrogen levels interaction was found significant. Higher vigour and growth attained by the plants due to sufficient absorption of nutrients might have resulted in higher test weight (Noonari *et al*. 2016) [17].

Table 4: Effect of seed rate and levels of nitrogen on test weight (g)

Treatment	2018-19	2019-20	2020-21	Pooled
(A) Seed rate				
S_1	56.88	55.83	56.28	56.33
S_2	55.57	54.25	54.83	54.88
S_3	55.25	52.67	53.08	53.67
Sem±	0.43	0.59	0.74	0.35
CD at5%	1.26	1.74	2.16	1.00
(B) Nitrogen level				
N_1	54.11	53.78	52.67	53.52
N_2	56.53	54.11	54.78	55.14
N_3	55.59	52.67	54.28	54.18
N_4	57.37	56.44	57.21	57.01
Sem±	0.37	0.51	0.64	0.41
CD at5%	1.09	1.50	1.87	1.15
CV %	2.30	3.28	4.03	3.27
SxN				NS
YxS				NS
YxN				NS
				NS

5. Tiller conversion index (%)

The data of tiller conversation index for seed rate (table no 5) indicated that significantly superior tiller conversion index data were recorded with S_1 (90 kg seed ha^{-1}) treatment in individual years (92.65, 91.36 and 93.89) and in pooled (92.63) analysis. Additionally Kabir *et al. (*2009) [3] 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. Data further indicate that in nitrogen levels tiller conversion index was found significantly superior with N_4 treatment (60 kg N/ha (12 kg N at basal + 24 kg N at CRI + 24 kg N at 45 DAS) in individual years (95.0, 93.02, 95.24) and in pooled analysis (94.42) respectively. The S_1N_4 treatment interaction was found significant in in individual years and pooled analysis of three years. Similarly result indicated that the number of tillers were increased due to the greater availability of nutrients in soil due to increasing application of Nitrogen doses might have enhanced multiplication and elongation of cells leading to increased number of tillers as reported by Sharma *et al.* (2011) [21]. Nitrogen is the key nutrient element and plays an inevitable role to increase the tillering capacity which leads to higher potential yields (Ames *at el*. 2003) [6].

Table 5: Effect of seed rate and levels of nitrogen on tiller conversion index (%)

Treatment	2018-19	2019-20	2020-21	Pooled
(A) Seed rate				
S_1	92.65	91.36	93.89	92.63
S_2	88.75	86.01	89.03	87.93
S_3	89.18	88.42	89.93	89.18
Sem±	1.32	1.58	1.51	0.78
CD at5%	3.87	4.63	4.42	2.21
(B) Nitrogen level				
N_1	89.52	86.79	89.68	88.67
N_2	88.60	88.11	90.31	89.01
N_3	87.66	86.45	88.56	87.56
N_4	95.00	93.02	95.24	94.42
Sem±	1.14	1.37	1.30	0.91
CD at5%	3.35	4.01	3.83	2.56
CV %	4.39	5.34	4.97	5.23
SxN				NS
YxS				NS
YxN				NS
				NS

6. Grain yield (kg/ha)

The perusal of data presented in table no 6 indicated that significantly higher grain yield recorded with S_1 (90 kg/seed rate per ha) treatment in all individual years 3472, 3437, and 3348 respectively, and found at par with S_2 & S_3 treatment in the year 2018- and 2019-20 where as in year S_1 treatment found at par with S_2 treatment. Significantly higher grain yield also recorded with S_1 treatment in pooled analysis (3419 kg/ha). In case of nitrogen levels, N_4 treatment (60 kg N/ha (12 kg N at basal + 24 kg N at CRI + 24 kg N at 45 DAS) fetched significantly higher grain yield in all three years 3553, 3565 and 3423 kg/ha respectively, in conserved soil moisture condition with two limited irrigation at CRI (21 DAS) stage and 45 days after sowing of crop. Grain yield if wheat also found significant with N4 treatment in pooled analysis of three years. The increase in grain yield due to the optimum seed rate 90 kg/ha application is attributed to better crop stand and decreased competition. It appears that greater translocation of photosynthates from source to sink might have increased seed yield. Increased nitrogen fertilizer and its availability to the plants and favourable environments in the rhizosphere. The results were in according with Sandana and Pinochet (2014) [19]. Grain yield of wheat is the function of its unique yield component in response to nitrogen leve and seeding rate for the yield of the crop (Javaid *at el.*, 2012) [12]

Table 6: Effect of seed rate and levels of nitrogen on grain yield (kg/ha)

Treatment	2018-19	2019-20	2020-21	Pooled
(A) Seed rate				
S_1	3472	3437	3348	3419
S_2	3197	3114	3169	3160
S_3	3115	3271	3047	3144
Sem±	113	77	92	48
CD at5%	330	226	270	134
(B) Nitrogen level				
N_1	2931	3213	3053	3066
N_2	3302	3106	3081	3163
N_3	3259	3213	3195	3223
N_4	3553	3565	3423	3514
Sem±	98	67	80	54
CD at5%	286	196	234	115
CV %	10.36	7.07	8.67	8.80
SxN				NS
YxS				NS
YxN				NS
				NS

7. Straw yield (kg/ha)

The data reported in table no 7 indicated that data of wheat straw yield was found significant with S_1 (5410 kg/ha) and N_4 (5604) treatment in the year 2020-21 and rest of the year's was found no significant. In case of seed rate pooled analysis of three years also found no significant. Whereas, pooled analysis of nitrogen levels, N_4 (4953 kg/ha) treatment was found significant. The interaction of SxN, YxS and YxN was found non-significant in individual years and pooled analysis.

Table 7: Effect of seed rate and levels of nitrogen on straw yield (kg/ha)

Treatment	2018-19	2019-20	2020-21	Pooled
Seed rate				
S_1	4662	3898	5410	4657
S_2	4875	3998	4708	4527
S_3	4958	4130	4958	4682
Sem±	241	140	221	122
CD at5%	NS	NS	647	NS
(B) Nitrogen level				
N_1	4620	3898	4496	4338
N_2	4889	4099	4722	4570
N_3	4744	3855	5279	4626
N_4	5074	4183	5604	4953
Sem±	208	121	191	118
CD at5%	NS	NS	560	334
CV %	14.93	10.50	13.17	13.31
SxN				NS
YxS				NS
YxN				NS
				NS

Conclusion

In light of the above results and It can be concluded from the three year pooled analysis data that durum wheat variety GADW 3 grown under 90 kg seed/ha (S_1 Treatment) and apply 60 kg nitrogen/ha in three split (N_4 Treatment) (12 kg N at basal + 24 kg N at CRI + 24 kg N at 45 DAS) recorded significantly higher data of plant height (cm), ear length (cm), no. of grain per ear, test weight (g), tiller conversion index (%) and grain yield over rest treatments. The S_1 and N_4 treatment gave higher net realization (110419 ₹/ha) & (119114 ₹/ha) individually.

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