



P-ISSN: 2349-8528

E-ISSN: 2321-4902

[www.chemijournal.com](http://www.chemijournal.com)

IJCS 2020; 8(2): 293-296

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Received: 01-01-2019

Accepted: 05-02-2019

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## Response of wheat (*Triticum aestivum* L.) to nitrogen levels and seed rate under different tillage conditions

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DOI: <https://doi.org/10.22271/chemi.2020.v8.i2e.8782>

**Abstract**

A field experiment entitled "Response of wheat (*Triticum aestivum* L.) to nitrogen levels and seed rate under different tillage conditions" was conducted on loamy sand soil at Agronomy Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *rabi* seasons of 2015-16 and 2016-17. The results of experiment showed that conventional tillage significantly increased the growth attributes *viz.*, yield attributes (effective tillers per meter row length, spike length and grains per spike), grain, straw and biological yields, over zero and minimum tillage. The highest net returns (₹40118 ha<sup>-1</sup>) with B:C ratio of 2.51 were also obtained in conventional tillage over zero and minimum tillage. Seed rate of 125 kg ha<sup>-1</sup> significantly increased the grain, straw and biological yields of wheat, as compared to seed rate of 100 kg ha<sup>-1</sup>. The highest net returns (₹39902 ha<sup>-1</sup>) with B:C ratio of 1.60 were also obtained in seed rate of 125 kg ha<sup>-1</sup> over seed rate of 100 kg ha<sup>-1</sup>. Application of 120 kg N ha<sup>-1</sup> significantly increased the growth attributes *viz.*, yield attributes (effective tillers per meter row length, spike length and grains per spike), grain, straw and biological yields over 80 and 100 kg N ha<sup>-1</sup>. The highest net returns (₹41835 ha<sup>-1</sup>) with B:C ratio of 1.70 were also obtained in 120 kg N ha<sup>-1</sup>. The combined application of 120 kg N ha<sup>-1</sup> in combination with conventional tillage proved as good as 140 kg N ha<sup>-1</sup> with conventional tillage in respect of effective tillers per metre row length, number of grains per spike, grain, straw and biological yield.

**Keywords:** Conventional tillage, minimum tillage, zero tillage grain yield

**Introduction**

India stands in second position next to China in the world with regard to area and production of wheat. In India wheat is grown on 31.5 m ha with total production of 86.5 MT with average productivity of 2750 kg ha<sup>-1</sup> (Anonymous, 2015a). In Rajasthan, it is cultivated on 3.3 m ha with total production of 9.8 MT and average productivity of 2961 kg ha<sup>-1</sup>. The productivity of wheat in the Western Rajasthan is lower (858 kg ha<sup>-1</sup>) than the potential yield (Anonymous, 2015b) [1]. Large numbers of factors are responsible for stagnation in wheat yields in North Western India such as late planting, inappropriate crop establishment, inadequate and imbalanced nutrient management and degrading soil health. Growing labour and water shortages, increasing cost of fuel, changing climatic conditions are likely to further affect the productivity of wheat adversely (Saharawat *et al.*, 2010) [11]. Traditionally, farmers typically perform multiple tillage operations after *Kharif* crop harvest to prepare field for wheat planting. The intensive tillage contributes to increased cost of cultivation leading to decreased profitability (Chhokar *et al.*, 2007; Ladha *et al.*, 2009) [2, 6]. Increased use of machinery and repeated tillage operations also emit large amount of greenhouse gases (GHGs) into the atmosphere. Recently, alternative tillage options such as minimum and zero tillage has emerged as an important management strategy to address many of the pressing challenges confronting intensified wheat systems in NW India. No-tillage has been widely adopted by farmers in wheat production, particularly in North Western India, primarily to facilitate early planting of wheat, to lower production cost and increase yield so as to increase profitability (Chhokar *et al.*, 2007) [2].

## 2. Material and Methods

The experiment was conducted at the Instructional farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *rabi* seasons of 2015-16 and 2016-17. College of Agriculture is situated on Sriganganagar road at 28.01°N latitude and 73.22°E longitude at an altitude of 234.7 m above mean sea level. According to “Agro-ecological region map” brought out by National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), Bikaner falls under Agro-ecological region No. 2 (M9E1) under Arid ecosystem (Hot Arid Eco-region), which is characterized by deep, sandy and coarse loamy, desert soils with low water holding capacity and hot and arid climate. Annual PET in this region ranges between 1500-2000 mm. As per NARP classification of agro-climatic zones, Bikaner falls in Agro-climatic zone Ic (Hyper Arid Partially Irrigated Western Plain Zone). According to National Planning Commission, Bikaner falls under Agro-climatic zone XIV (Western Dry Region) of India and The field experiment was laid out in a split plot design with three replications comprising 3 levels of tillage (conventional, minimum and zero tillage) and 2 levels of seed rate (100 and 125 kg ha<sup>-1</sup>) thus 6 treatment combinations of tillage and seed rate in main plots and 4 levels of nitrogen (80, 100, 120 and 140 kg N ha<sup>-1</sup>) in sub-plots and comprising a total of 24 treatment combinations.

### 2.1 Varietal characters

Raj-4120: It is a dwarf variety of wheat suitable for western plains zone under irrigated conditions. The grains are amber medium bold semi-hard having around 38 g average 1000 grain weight with good chapatti making quality. It is about 80-90 cm in height and takes 115-118 days in maturity. Its yield potential is about 40-45 q ha<sup>-1</sup>.

Grain yield: The grain yield of each net plot (inclusive of tagged plants) was recorded in kg per plot after cleaning the threshed produce was converted as kg ha<sup>-1</sup>.

Harvest index (%): The harvest index was calculated by using following formula and expressed as percentage (Singh and Stoskopf, 1971).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (kg/ha)}}{\text{Biological yield (kg/ha)}} \times 100$$

### 2.2 Benefit: cost ratio

Treatment wise benefit: cost ratio was calculated to ascertain economic viability of the treatment using following formula:

$$\text{B: C ratio} = \frac{\text{Gross returns ( ₹ ha}^{-1}\text{)}}{\text{Cost of cultivation ( ₹ ha}^{-1}\text{)}}$$

### 2.3 Statistical analysis

In order to test the significance of variance in experiments, the data obtained for various treatment effects were statistically analysed as per procedure described by Panse and Sukhatme (1985) [10]. The critical differences were calculated to assess the significance of treatment means wherever, the “F” test was found significant at 5 per cent and 1 per cent level of significance. The analysis of variance for all the data presented and discussed has been given in appendices at the end.

## 3. Results and Discussion

The ultimate effect of experimental variables is reflected in the final yield of crop and thus, it is a major criterion to identify the efficiency of various treatments in a given situation. The per cent increase in grain yield with the conventional tillage was 9.01 and 4.19 per cent in pooled mean over zero and minimum tillage, respectively. Seed rate of 125 kg ha<sup>-1</sup> increased the stover yield by 4.69 per cent in pooled mean over 100 kg ha<sup>-1</sup> seed rate. Straw yield is also an important parameter of the biological yield to evaluate the harvest index and makes some contribution to the crop value. CT was able to produce significantly higher grain and straw yields compared ZT and MT but the difference between ZT and MT were only marginal (Table 1). The increase in grain yield of wheat under CT could be attributed to higher yield attributes whereas the increase in biological yield was due to higher dry matter production. To some extent it could also attributed to better soil environment (Idnani & Kumar 2012) [3]. This was probably due to better rooting induced by reduced soil strength in the upper 10-15 cm layer. The per cent improvement in mean number of grains per spike with conventional tillage was 10.48 and 4.50 per cent in pooled mean over zero and minimum tillage, respectively. The increase in spike length under pooled mean due to application of 120 kg N ha<sup>-1</sup> was to the extent of 29.27 and 8.58 per cent over 80 and 100 kg N ha<sup>-1</sup>, respectively. revealed that different tillage practices, seed rate and increasing levels of nitrogen did not show any significant effect on test weight of wheat during both the years of experimentation as well as in pooled analysis. Yield of any crop depends on the source-sink relationship and is the cumulative function of various growth parameters and yield attributing components *viz.*, number of effective tillers, number of grains per spike, spike length and 1000-grain weight. Yield of wheat often had a positive correlation with LAI and RGR (Watson *et al.*, 1963) [15] and any effect on these parameters by any treatment ultimately affects the biological and economic yields of crop.

Different seed rates affect the yield attributes and yield of wheat crop at harvest stage in terms of number of effective tillers, number of grains per spike, spike length, grain yield, straw yield, biological yield. Seed rate of 125 kg ha<sup>-1</sup> caused significant difference in number of effective tillers than at 100 kg ha<sup>-1</sup> seed rate. While number of grains per spike and spike length increased significantly with decrease in seed rate. With the decrease in seed rate from 125 to 100 kg ha<sup>-1</sup>, all yield attributes except effective tillers and yields significantly decreased due to lower number of plants and less number of tillers per meter row length which in turn decreased the LAI. Decreased LAI led to lower photosynthetic efficiency which unfavourably affects the yield contributing parameters. The similar response of decrease in yield and yield attributes with decreasing seed rates have been reported by Iqbal *et al.* (2010) [4] and Laghari *et al.* (2011) [7].

Maximum grain yield was produced from 125 kg ha<sup>-1</sup> seeding rates as compared to 100 kg ha<sup>-1</sup> seeding rates which produced minimum grain yield. This might be due to the fact that more number of plants emerged m<sup>-2</sup> with more branches, more well filled spikes and plump seed, which in return yielded more grain yield. Our results supported by Mahboob *et al.* (2005) [8] who reported that planting dates and seeding rates had significant effect on the grain yield. Sharma and Singh, 2011 [13] also reported that seed rate of 125 kg ha<sup>-1</sup> gave 4.0% more wheat grain yield than 100 kg seed/ha which

in turn recorded 20.0% and 26.0% more grain yield than 75 and 150 kg seeds ha<sup>-1</sup>, respectively. However, Sandhu *et al.* (2010) [12] observed that increasing trend in grain yield of wheat with increasing in seed rates. Selection of appropriate plant density for higher productivity depends mainly on tillering and lodging. High plant density beyond optimum leads to mutual competition among plants due to which it fails to exploit the inputs fully. Economic yield is the ultimate goal of all crop production pursuits. The data showed that minimum straw yield was found in the plots where seed rate of 100 kg ha<sup>-1</sup> was used and there was increased as the seed rate increased and highest straw yield was recorded from the plots where seed rate of 125 kg ha<sup>-1</sup> was applied. This might be due to the fact that higher seed rates might result in more plant population which resulted in higher straw yield. The trend of result was almost the same during both the experimental years and pooled data also reflected the same results. Since, biological yield is a function of seed and straw yield representing vegetative and reproduction growth of crop (Table 2). The increase in straw and biological yield with

increase in seed rate was also reported by earlier researchers (Sharma and Singh, 2011 [13] and Tigabu and Asfaw (2016) [14]).

The highest pooled mean net returns (₹40118/ha) with B:C ratio of 1.51 were obtained in conventional tillage over zero and minimum tillage. The pooled mean net return was higher by ₹ 2274 and 859 under conventional tillage as compared to zero and minimum tillage, respectively. The highest significant pooled mean net returns (₹41835 ha<sup>-1</sup>) and B:C ratio (1.70) were obtained in 120 kg N ha<sup>-1</sup> over 80 and 100 kg N ha<sup>-1</sup>. The pooled mean net return was higher by ₹ 8950 and 3504 under 120 kg N ha<sup>-1</sup> as compared to 80 and 100 kg N ha<sup>-1</sup>, respectively. Each successive increment in nitrogen levels exhibited higher net return as well as B:C ratio. Each incremental dose of nitrogen resulted in proportionate increase in grain yield surplusing the extra cost incurred towards nitrogen fertilizers. These results are also in the line with the findings of Kumar and Yadav (2005) [5], Mitra *et al.*, (2014) [9].

**Table 1:** Effect of tillage, seed rate and nitrogen levels on yields of wheat

Treatments	Yield (kg ha <sup>-1</sup> )									Harvest index (%)		
	Grain			Stover			Biological			2015-16	2016-17	Pooled
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled			
<b>Tillage</b>												
ZT	2953	2843	2898	4091	4038	4064	7044	6881	6962	41.9	41.3	41.6
MT	3075	2990	3032	4458	4278	4368	7533	7268	7401	40.8	41.2	41.0
CT	3212	3106	3159	4767	4447	4607	7979	7552	7766	40.2	41.2	40.7
S.Em±	37	35	25	50	49	35	85	84	60	0.12	0.03	0.06
CD (P=0.05)	111	106	73	153	149	102	257	254	173	NS	NS	NS
<b>Seed rate (kg ha<sup>-1</sup>)</b>												
100	3033	2927	2980	4352	4142	4247	7385	7069	7227	41.1	41.5	41.3
125	3127	3032	3079	4526	4366	4446	7652	7398	7525	40.9	41.0	40.9
S.Em±	30	29	21	41	40	29	69	68	49	0.09	0.03	0.05
CD (P=0.05)	91	87	60	125	121	83	210	208	141	NS	NS	NS
<b>Nitrogen levels (kg ha<sup>-1</sup>)</b>												
80	2707	2713	2710	3948	3908	3928	6656	6620	6638	40.8	40.9	40.9
100	3048	2925	2987	4401	4186	4294	7449	7112	7280	41.0	41.2	41.1
120	3238	3104	3171	4636	4417	4527	7874	7521	7698	41.1	41.3	41.2
140	3326	3176	3251	4770	4505	4638	8096	7681	7889	41.1	41.4	41.2
S.Em±	48	37	30	65	47	40	111	82	69	0.14	0.13	0.10
CD (P=0.05)	138	105	86	186	135	113	317	233	194	NS	NS	NS

**Table 2:** Effect of tillage, seed rate and nitrogen levels on yield attributes of wheat

Treatments	Effective tillers (No. m <sup>-2</sup> )			Spike length (cm)			Grains per spike			Test weight (g)		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
	<b>Tillage</b>											
ZT	76.3	74.6	75.5	7.25	6.96	7.10	32.1	31.0	31.5	38.9	38.3	38.6
MT	79.1	77.3	78.2	8.07	7.80	7.94	33.7	32.8	33.3	39.3	38.7	39.0
CT	80.3	78.9	79.6	8.72	8.50	8.61	35.4	34.2	34.8	40.1	39.2	39.7
S.Em±	0.7	0.7	0.5	0.11	0.08	0.07	0.4	0.4	0.3	0.5	0.6	0.4
CD (P=0.05)	2.0	2.2	1.4	0.32	0.23	0.19	1.2	1.1	0.8	NS	NS	NS
<b>Seed rate (kg ha<sup>-1</sup>)</b>												
100	76.9	75.8	76.4	8.52	8.24	8.38	34.5	33.7	34.1	39.2	38.5	38.8
125	80.2	78.1	79.1	7.51	7.27	7.39	33.0	31.7	32.3	39.8	38.9	39.4
S.Em±	0.5	0.6	0.4	0.09	0.06	0.05	0.3	0.3	0.2	0.4	0.5	0.3
CD (P=0.05)	1.6	1.8	1.2	0.27	0.19	0.16	1.0	0.9	0.6	NS	NS	NS
<b>Nitrogen levels (kg ha<sup>-1</sup>)</b>												
80	74.5	73.3	73.9	6.63	6.48	6.56	30.8	30.0	30.4	38.5	37.8	38.2
100	77.7	76.1	76.9	7.95	7.67	7.81	33.0	32.1	32.6	39.7	38.7	39.2
120	80.5	78.4	79.5	8.61	8.35	8.48	35.1	33.9	34.5	39.7	39.0	39.4
140	81.6	80.0	80.8	8.87	8.52	8.70	36.0	34.7	35.3	40.0	39.3	39.6
S.Em±	0.8	0.8	0.6	0.11	0.13	0.09	0.4	0.4	0.3	0.6	0.6	0.4
CD (P=0.05)	2.4	2.2	1.6	0.31	0.37	0.24	1.1	1.1	0.8	NS	NS	NS

**Table 3:** Effect of tillage, seed rate and nitrogen levels on economics of wheat

Treatments	Net returns (Rs. ha <sup>-1</sup> )			B:C ratio		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
<b>Tillage</b>						
ZT	38817	36870	37844	2.70	2.62	2.66
MT	40256	38262	39259	2.64	2.56	2.60
CT	41527	38708	40118	2.56	2.46	2.51
S.Em±	747	731	522	0.03	0.03	0.02
CD (P=0.05)	2265	2217	1514	0.09	0.09	0.06
<b>Seed rate (kg ha<sup>-1</sup>)</b>						
100	39460	37030	38245	2.63	2.52	2.58
125	40940	38863	39902	2.64	2.56	2.60
S.Em±	610	597	427	0.03	0.02	0.02
CD (P=0.05)	NS	1810	1236	NS	NS	NS
<b>Nitrogen levels (kg ha<sup>-1</sup>)</b>						
80	32915	32855	32885	2.35	2.36	2.35
100	39687	36974	38331	2.63	2.51	2.57
120	43289	40382	41835	2.76	2.64	2.70
140	44910	41576	43243	2.80	2.67	2.73
S.Em±	988	743	618	0.04	0.03	0.03
CD (P=0.05)	2809	2112	1735	0.11	0.09	0.07

#### 4. Conclusion

The planting of wheat with conventional tillage and 125 kg seed rate in conjunction with 120 kg N ha<sup>-1</sup> gave significantly higher grain, straw and biological yields. The conventional tillage and 125 kg seed rate in conjunction with 120 kg N ha<sup>-1</sup> gave significantly higher net returns and B:C ratio of wheat.

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