Advances in Bioresearch
Adv. Biores., Vol 9 (1) January 2018: 74-79
©2018 Society of Education, India
Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
DOI: 10.15515/abr.0976-4585.9.1.7479

Advances in Bioresearch

ORIGINAL ARTICLE

Wheat Response to Tillage practices and Nitrogen Fertilization

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ABSTRACT

Wheat (Triticum aestivum L.) is a main agricultural products in Iran, and wheat cultivated lands has the highest area among the crop plants. Annually considerable fertilizers, especially Nitrogen fertilizer is used in wheat cultivated lands and It costs a lot to plow the these lands. Therefore, finding the best fertilizer recommendation and seed bed preparation methods(tillage operation) were evaluated in this study. Effects of different rates of nitrogen fertilizer application (0, 90, 135 and 180 kg N/ ha) in three tillage system, mainly no tillage (No-till), conventional-till (Con-till), minimum tillage (min-till) on wheat were evaluated in field condition. The results indicated that the tillage system and nitrogen fertilization significantly affected grain yield, grain Nitrogen and protein content and harvest index. Increasing nitrogen fertilizer rates increased above mentioned indices compared to control, while there was no significant differences among 90, 135 and 180 kg/ha nitrogen fertilizers. Conventional tillage system had the highest measured parameters compared to both min-till and no-till operations.

Key words: *Tillage operation, Nitrogen fertilization, Wheat, No-till, conventional till*

Received 10.08.2017 Revised 28.08.2017 Accepted 06.12.2017

How to cite this article:
M J Asgari, M Hossein Gharineh, A Hossein Ziaiyan, M Amin Asoudar. Wheat Response to Tillage practices and Nitrogen Fertilization. Adv. Biores., Vol 9 [1] January 2018.74-79.

INTRODUCTION

Soil nutrients mineralization such as C and N were enhanced in conventional tillage system by incorporating crop residues, disrupting soil aggregates, and increasing aeration [19], while in conservation tillage the mineralization rate is low. N is one of the major reasons to support the food for increasing human population [15].

Nitrogen is the most limiting nutrient in crop production so, nitrogen fertilization is a common practice in wheat production systems. Nitrogen fertilizer application, improved crop production and some soil quality but it may increase the loses, [13]. Nitrogen application in excess of the crop requirements along with frequent tillage, not only reduces the crop productivity but also accelerates soil erosion, and water pollution [5,7].Therefore, proper use of N is critical to optimize crop yield and minimize environmental damage. It has been estimated that 40% - 60% of N-applied is taken up by wheat, which decreases as the N-input increases, resulting in higher residual soil N that can be readily leached [3].

Conservation agriculture involves zero or minimum soil disturbance through tillage (no-tillage, reduced tillage, mulch tillage and strip-tillage), a balanced use of fertilizers and herbicides, a permanent soil biomass cover enhancing water and soil conservation, crop rotation and integrated pest management, reduced production costs and increased farming efficiency [1, 2, 9, 10].

The conservation tillage has received attention; however, uncertainty exists concerning the impact of conservation tillage and nitrogen fertilizer application on the total agricultural environment [6, 13]. Zero tillage is an alternative to address the problems associated with conventional agriculture. Unlike CT, ZT may facilitate wheat planting at optimum time and re- duce cost of production. Zero tillage improve

water- and nutrient-use efficiencies, and increase crop productivity and carbon sequestration, ameliorate soil properties and mitigate green house gases emission [8].

Due to its advantages, conservation agriculture has become a common practice on about 100 million ha in South and North America, Europe, Asia and Africa. No tillage farming has become a current practice in countries such as: USA, Brazil, Argentina, Australia, Canada, Mexico [16].The combined effects of N fertilizer application and tillage practices on wheat production are not well-known. In this study, the effects of tillage practices and rate of nitrogen fertilization on wheat yield were evaluated.

MATERIALS AND METHODS

Field experiments were conducted at agricultural and natural resources research center ofFars province, Shiraz, Iran. The experiment was laid out in a randomized complete block design with split plot arrangement replicated three times. Three tillage systems namely Zero Tillage, Minimum Tillage, and Conventional Tillage were assigned to main plots, while five N (0, 90, 135 and 180 kg·N·ha^{-1} as Urea) were applied to subplots. The four subplots treated with different concentrations of N were isolated from each other by making bunds around them so that N could not be transported between these subplots. After corn harvest, the land was prepared for wheat.

In Zero tillage treatments, no tillage was performed before planting, and only with one-time movement of the direct sowing machine in the field, the wheat seed sowing was carried out in corn plant residues. Sufficient corn residues remains to cover at least 30% of the soil surface after seeding (about 1200 kg ha^{-1}). The direct slicing machine was a type of disk pair with a working width of three meters. The tractor used would have at least 100 hp and the tractor's speed was 10 to 12 km h -1.

In minimum tillage system, the compound soil tillage machines was used, without any plowing and maintaining sufficient amount of residues on the surface (about 30%). The mentioned machine did the surface disc and leveling simultaneously. The depth of the plow was about 15 cm. and the tractor used was at least 100 hp with 10 to 12 km / h speed.

In conventional tillage system, a plow of three plowshare with a depth of 25 to 30 cm for primary tillage, two-way offset disk for secondary tillage and finally for leveling the ground an ordinary leveler were used. The speed of the tractor in the initial tillage was 3 km / h. In this system, after the use of the moldboard, disk, and leveling, carried out by one of the regular operations in the region.

After tillage operation and before the experiment was laid out, composite soil samples were taken from plots and were analyzed for soil texture [4], calcium carbonate equivalent [12], Electrical conductivity of saturated extract [14], available phosphorous [21] soil reaction of saturated paste [20], available micronutrients [11] and cation exchange capacity [18]. Also Organic matter was determined through wet oxidation based upon the Walkley and Black method [10]. Total N in soil was determined by the Kjeldhal method.Based on the results of soil test, the type and amount of fertilizers were determined and, except for nitrogen, other fertilizers were applied before cultivation and simultaneously with cultivation. Nitrogen were also applied based on the design. Different amounts of nitrogen were applied in three steps (one third before cultivation, one third in the tillering stage and one third in the spike stage) from the source of urea as soil application. Wheat (cv. Sirvan) was planted in plots.

Data were recorded on harvest index (HI), grains yield, Nitrogen, Phosphorous and Potassium uptake on grain and shoot. For biological yield, each sub- plot was harvested, sun dried, and weighed into kg·ha^{-1}. For grain yield, the biomass of each subplot was sun dried, threshed, cleaned, and grains were weighed into kg·ha^{-1}. Grain nitrogen uptake was obtained from multiplying grain yield and grain nitrogen concentration. Data for each parameter was subjected to analysis of variance using a randomized complete block design with split plot arrangement according to MSTATC [17]. Treatment means were compared using least significant difference (LSD) test at $P \leq 0.05$.

RESULTS AND DISCUSSION

Analysis variance of tillage, N-fertilizer and their interactions on some indices of wheat such as Grain protein content, grain and shoot Nitrogen, phosphorous, potassium, grain yield and harvest index (HI) were illustrated in Table 1.

Table 1- Analysis variance of tillage, N-fertilizer and their interactions on some indices of wheat

	Grain Protein	Grain N content	Grain P content	Grain k content	Grain Yield	shoot N content	shoot p content	shoot k content	Harvest index
				Mean Square (MS)					
Tillage(T)	6.5**	1791*	4.980	73.641	5819808*	1032.584	36.209	6578*	99.7**
Nitrogen fertilizer(N)	2.4**	5532**	123**	358.8**	8876056**	8514**	145.7**	13857**	25.5*
T*N	0.8*	247.429	5.339	20.917	574434*	454.066	145.7**	2947**	21.9**

The results indicated that tillage operation, nitrogen fertilization and also their interaction had significant effect on wheat grain protein content (Table 1). Wheat grain had the highest protein in conventional tillage operation, while it was lowest in minimum tillage system (Fig. 1)

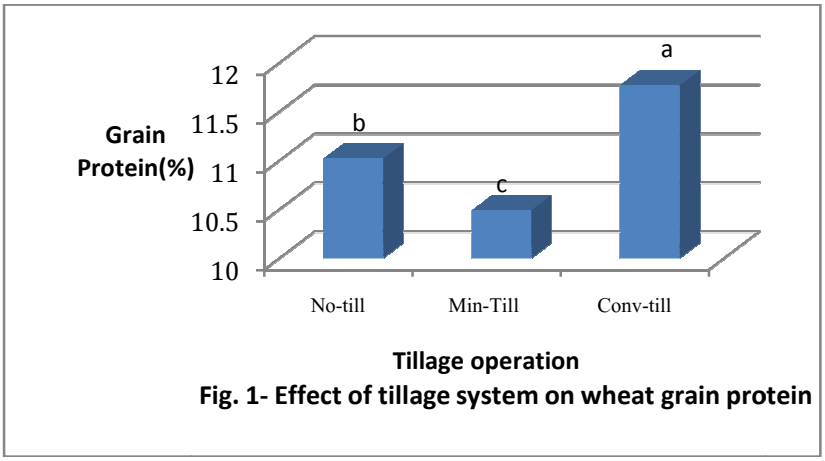

Fig. 1- Effect of tillage system on wheat grain protein

The results of nitrogen fertilization and tillage operation on wheat grain protein revealed that

Wheat grain protein content in conventional tillage system along with 90 kg nitrogen application was the highest and more nitrogen fertilizer application (135 and 180 kg/ha) could not increase grain protein significantly. While in minimum tillage operation grain protein was the lowest and application of nitrogen fertilizer did not increase grain protein compared to the control (Fig. 2).

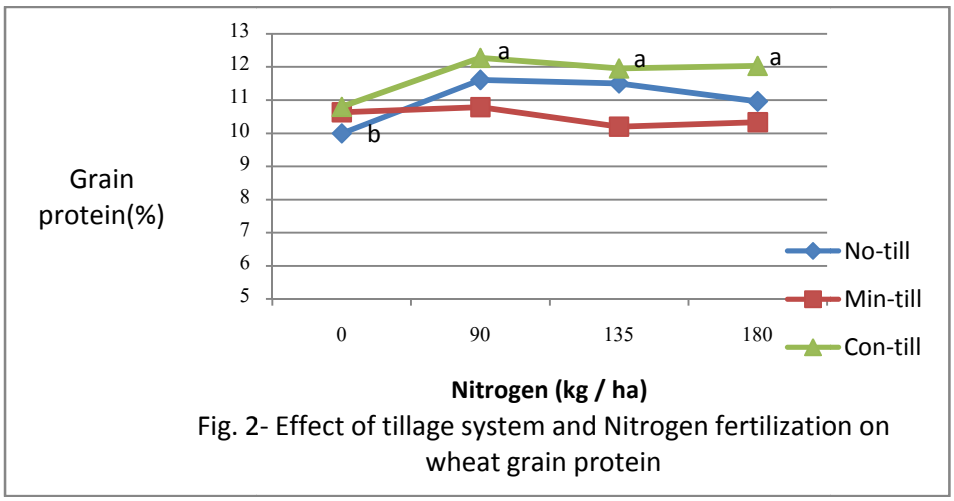

Fig. 2- Effect of tillage system and Nitrogen fertilization on wheat grain protein

The results revealed that Nitrogen fertilizer application significantly affected grain yield in all three tillage system, compared to the control(no Nitrogen application). As Fig. 3 shows, only in conventional tillage, application of 180 kg Nitrogen produced the highest grain yield and in both no-till and min-till, application of 180 kg N /ha had no significant difference with 90 and 135 kg/ha rates (fig. 3).

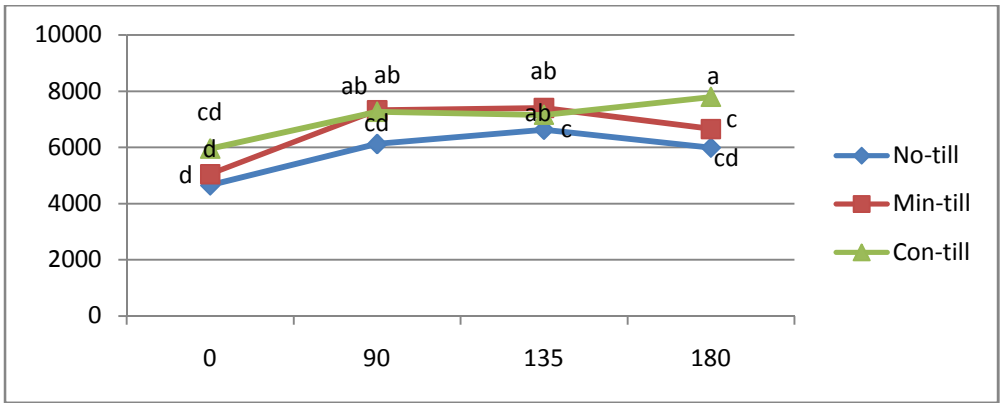

Fig. 3- Effect of tillage system and N fertilizer application on wheat grain yield

The results of harvest index indicated(HI) that, this parameter varied from 34.65 to 44.13 and the highest HI was recorded in min-till and application of 135 kg/ha Nitrogen fertilizer treatment, while the lowest rate observed in no-till without Nitrogen application(Table 2). Generally in No-till and min-till system increasing Nitrogen fertilizer application increased HI significantly, while in conventional tillage this increase was not significant.

Table 2- Effect of tillage operation and Nitrogen fertilization on wheat harvest index

	N0	N90	N135	N180
NO-till	34.65 c	38.03 b	39.81 b	37.73 bc
Min-till	36.47 c	42.99 ab	44.13 a	41.28 ab
Con-till	44.10 a	41.6 ab	41.69 ab	41.93 ab

Grain nitrogen content in three tillage system increased with increasing nitrogen compared to control. As shown in Figure 4, Min-till system had the highest grain nitrogen content in 90 kg N /ha, application more nitrogen fertilizer in this tillage system, decreased grain Nitrogen content, while in No-till and conventional tillage this decreasing were not significant (Fig. 4).

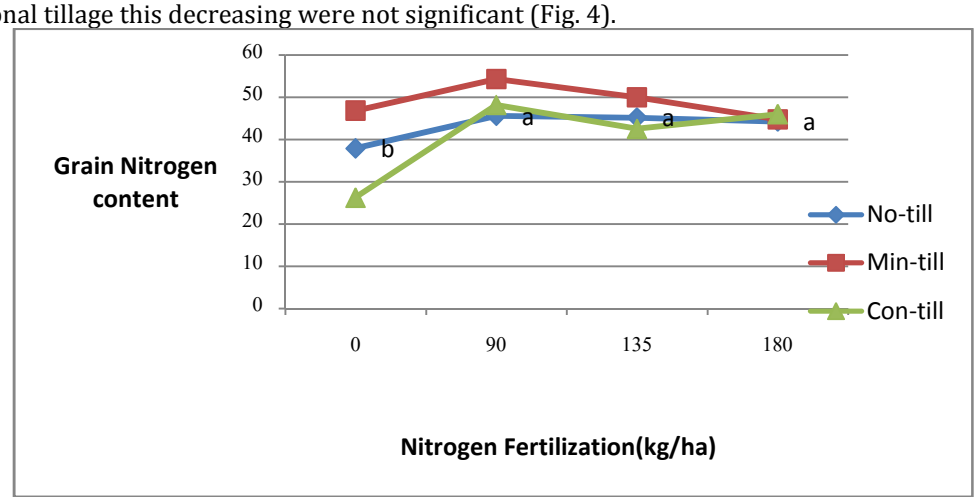

Fig. 4- Effect of tillage system and N fertilizer application on wheat grain Nitrogen content

Grain yield was significantly affected by N, Tillage operation and also T and N interactions (Table 1). Grain yield increased with increase in N rate and maximum grain yield could be achieved at 180 kg·N·ha−1 in conventional tillage system, while minimum grain yield was recorded from control in No-till system. The increase in grain yield at higher N rate is mainly due to increased radiation interception driven by a rise in growth rate, leaf area and leaf area index, which ultimately increased grain yield [22]. Moreover, the highest grain yield is the result of increased spikes m−2, grains spike−1 and 1000-grain weight (data not shown). The results further revealed that tillage systems produced statistically similar grain yield which is quite encouraging regarding No-Till because of lower inputs cost. All the three tillage systems performed better at higher N rates compared to lower or no N.

The results indicate that No-till without N fertilizer would have adverse effect on wheat grain yield compared to Min-till and Con-till probably due to lower N availability at the commencement of crop growth [23].

The influence of the agriculture system on wheat production revealed that for all the fertilization levels conservation agriculture system has determined a lower production. This was due to the fact that sowing directly into the ground required by conservation agriculture has led to a higher apparent soil density than in the classical tillage system. As a consequence, soil porosity and its capacity of mineralization of the applied fertilizer has been diminished [24].

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