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Effect of Seed Rate in Different Sowing Dates on Grain Yield and Yield Components of Wheat in Iran

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Abstract: In order to determination of effect of seed rate in different sowing dates on yield and yield components of wheat, an experiment was carried out at Sari region in 2014-2015. This experiment was carried out at split plot in randomized complete blocks design with three replications. Three planting dates November 1, November 20 and December 10 was the main plots and three seed rates 150, 250, 350 and 450 kg ha^{-1} was the sub plots. Results showed that with delay in planting date plant height was decreased but with delay in planting date panicle length, spike length had increased. The most number of spikelet per spike and number of grain per spike had obtained in November 20 that causes to increase yield and harvest index. With seed rate increasing tiller per plant was increased. But, with increasing in seed use plant height, spike length, number of spikelet per spike and number of grain per spike increased that is cause to increase in grain yield. The most grain yield equal to 4020 kg ha^{-1} was obtained at interaction of November 20 planting date and application of 350 kg seed per hectare. Therefore use of 350 kg seed per hectare in November 20 planting date cause to optimum result.

Key words: Planting date, grain yield, sari, seed rate, Iran

INTRODUCTION

Wheat (*Triticum aestivum L.*) is a major cereal crop in many parts of the world and it is commonly known as the king of cereals. It belongs to Poaceae family and globally, after maize and rice is the most cultivated cereal. Wheat crops, being grown in a wide range of environments that affect overall performance, particularly grain yield and end-use quality. Wheat yield and end-use quality depend upon the environment, genotype and their interaction. Grain yield and quality of winter wheat are affected by several factors and crop management has a very important role among them. For achieving high yields and grain quality of wheat it is important to apply all the cultural practices completely and on time and adapt them to cultivars. The correct fertilizer application, particularly N is very important to achieve high yields and good grain quality of wheat. Besides regular nutrition of plants for achieving high yields and good quality, sowing time and planting density play an important role. Optimum plant densities vary greatly between areas, climatic conditions, soil, sowing time and varieties. Since, cultivars genetically differ for yield components, individual cultivars need to be tested at a wide range of seeding rates to determine their optimum seeding rate (Wiersma, 2002). Management practices play an important role in determining yield and end-use quality of wheat. Numerous studies have documented how N fertilization (Nikolic *et al*., 2012), seeding rate, planting date, row spacing and seeding depth affect yield and yield components of wheat (Valerio *et al*., 2009). Seeding rates for winter wheat can vary widely due to differences in seed quality, planting conditions, planting dates and planting equipment (Lloveras *et al*., 2004). New wheat varieties are more productive and some of them are of higher quality than the old ones. Therefore, their total technological requirements, planting density being one of them, are diverse, due to which they need to be continuously examined for determining their requirements in specific conditions (Caglar *et al*., 2011). Donovan *et al*. (2008) observed that increasing seeding rate for barley reduced time to maturity and wild oat fecundity but did not affect barley yield. Yield benefits from high seeding rates were also observed for canola in the eastern prairies (Hanson *et al*., 2008), western prairies (Harker *et al*., 2003).

Wheat yield is low in Iran on account of many biotic and a biotic factors. Among these the time of sowing and planting density are of great significance which determine the proper stand establishment of the growing crop through balancing the plant to plant competition and ultimately affect the yield (Nakano and Morita, 2009). Generally wheat like other cool season crop is seeded early to take maximum period for growth and development toward maturity before the (possible) heat stress. However, mid-season seeding of winter wheat for any

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locality is usually most favourable whereas late sown wheat suffers more winter injury which produces fewer tillers and may ripen in lower grain weight and number of grains per plant. Similarly, cultivars matured earlier when planted late, indicating the forced maturity due to high temperature. Kristo *et al*. (2001) showed that winter wheat grown under more favourable conditions (October sowing with 600 seeds m^{-2}) responded to the treatments more even compared to those grown under unfavourable conditions (November sowing with 300 seeds m^{-2}). It has also been noted that the increase of seeding rate at early and optimal sowing time is unfavourable but the negative effect of late sowing could be compensated by the increase of seed quantity. Hiltbrunner *et al*. (2007, 2005) advocated that a rationale increase of the seeding density with that of sowing time is an effective mean to increase the grain yield. Therefore, this study was planned to examine effect of sowing dates and seeding density on yield and yield component of wheat in wheat production farms at Sari region in Iran.

MATERIALS AND METHODS

The study was conducted in the Sari region, Mazandaran province, Iran. The region is located along the south coast of the Caspian Sea in north of Iran. The climate is temperate sub-humid. Sari has mild winters and wheat is sown in the autumn during the months of November and December. Averages of maximum and minimum temperatures and rainfall during wheat growing season, December-June are 17.2 and 7.3°C and 340 mm, respectively. The crop is harvested during June, after which a soybean crop is usually sown as the second crop in a double cropping system.

This experiment was carried out at split plot in randomized complete blocks design with three replications. Three planting dates November 1, November 20 and December 10 was the main plots and three seed rates 150, 250, 350 and 450 kg ha^{-1} was the sub plots. The experiment was replicated four times having sub plot size of 3×5 m^2.

In case of fertilizer application, a basal dose of 60 kg P_2O_5 $ha^{\times1}$ was applied in the form of Triple Super Phosphate while N was applied in the form of Urea. Nitrogen application (urea) was split; half at planting, 25% top-dressed at the early tillering stage and 25% at the Jointing. Phosphorus and potassium were applied as basal dressing. The wheat rows were planted in 15 cm rows at a seed rate of approximately 300 seeds m^2. Standard agronomic practices were followed throughout the growing season. Data were recorded tillers m^{-2}, plant height, 1000 grain weight and grain yield. Tillers m^{-2} was reordered by counting the number of tillers in one meter length area of the three central rows in each subplot and their mean was then calculated. Plant height was recorded by measuring height of five representative plants in each treatment at maturity from base to the tip of the spike. After threshing 1000 grains in each subplot were randomly picked and then weighed by electronic balance. Grain yield in each subplot was determined and then converted into kg ha^{-1}. The data from Exp was analyzed using a split-plot, unbalanced ANOVA for data. Main plots were wheat cultivars and subplots were irrigation in plant growth stage at irrigation. Experiment was analyzed as a randomized complete block design. The data collected during the experiment was analyzed according to RCB design and upon obtaining significant differences Least Significant Differences (LSD) test was applied. Analyses used procedure of the SAS statistical software package.

RESULTS AND DISCUSSION

Plant height: Data concerning to plant height is presented in Table 1. Statistical analysis of the data revealed that plant height were significantly ($p\leq0.01$) affected by different sowing dates and seed rates ($p\leq0.05$) while their interaction were non significant. Mean comparison showed that planting date and plant height decreased with delay in sowing date. The highest plant height (112.92 cm) on 10 October and the lowest plant height in two planting dates of November 1 and 20, respectively, 103.67 and 102.17 cm December 10, respectively. Mean comparison showed that the highest plant height 109.22 cm simple seed rate by consuming 400 kg of seeds per hectare and the lowest plant height 102.89 cm 300 kg of seeds per hectare, respectively. Plant height with 250 and 350 kg of seed per hectare 107.67 and 105.22 cm, respectively (Table 2).

Spike length: Analysis of the data showed that only seeding density had a significant ($p\leq0.05$) effect on spike length while sowing dates and other interactions had a non significant effect (Table 1). Compare the average effect of planting date showed that the maximum spike length in two planting dates of November 20 and December 10 (9.75 and 9.33 cm, respectively) and lowest during September (8.17 cm) on the culture of November 1 was obtained. Although, this trait was not statistically affected by the treatment. The mean effect it showed that highest spike length obtained in September 10 with 350 and 450 kg of seeds per hectare against 9.56 and 8.22 cm

Table 1: Mean square of agronomical traits and grain yield of wheat under different planting date and seed rate in sari region

SOV	df	Plant height	Spike length	Tiller per plant	Spikelet per spike	Grain per spike	Grain yield
Replication	2	104.25*	31.58**	1.03	8.18**	15.72*	278374.25
Planting Date (D)	2	406.75**	8.08*	0.19	21.47**	80.23**	1621256.32**
Error	4	64.00	6.92	2.03	4.80	10.54	160454.05
Seed rate (S)	3	69.58*	4.62	4.40**	5.15**	5.10	71915.16
D×S	6	16.97	11.45	0.12	1.24	3.98	82642.76
Error	18	29.34	2.73	0.66	0.90	3.08	111044.53
CV (%)	-	5.10	18.20	13.21	5.79	5.63	9.60

**,* respectively significant in 1 and 5% level

Table 2: Mean comparison of agronomical traits and grain yield of wheat under different planting date and seed rate in sari region

Reatments	Plant height (cm)	Spike length (cm)	Tiller per plant	Spikelet per spike	Grain per spike	Grain yield (kg.ha^{-1})
Planting date						
Nov. 1	112.92^{a}	8.17^{b}	6.17^{a}	14.88^{b}	28.42^{b}	3137.3^{b}
Nov. 20	103.67^{b}	9.75^{a}	6.00^{a}	17.43^{a}	33.53^{a}	3864.8^{a}
Dec. 10	102.17^{b}	9.33^{a}	6.25^{a}	16.86^{ab}	31.63^{ab}	3409.6^{ab}
LSD 0.05	9.07	2.98	1.61	2.48	3.68	454.03
Seed rate						
150 kg ha^{-1}	107.67^{ab}	8.22^{b}	6.67^{a}	16.20^{b}	31.70^{a}	3427.7^{a}
250 kg ha^{-1}	102.89^{b}	8.78^{ab}	6.78^{a}	15.64^{b}	30.98^{a}	3578.4^{a}
350 kg ha^{-1}	105.22^{ab}	9.56^{a}	5.78^{b}	16.28^{b}	31.87^{a}	3503.0^{a}
450 kg ha^{-1}	109.22^{a}	9.78^{a}	5.33^{b}	17.44^{a}	30.22^{a}	3373.3^{a}
LSD 0.05	5.36	1.64	0.80	0.94	1.74	330.03

Values within each column followed by same letter are not significantly different at LSD ($p \le 0.05$)

to 9.78 cm and the shortest spike was observed with the consumption of 150 kg of seeds per hectare (Table 2).

Flag leaf length: This trait also statistically only under the effect of planting date showed significantdifferences in the level of 5% (Table 1). The mean effect of planting date it was observed that the maximum flag leaf length 30.17 and 30.08 cm November 1 and Novembe r 20 and the lowest flag leaf length of 27.83 cm on December 10, respectively. Compare the average effect of the seed also showed that flag leaf length with the use of the seeds 150, 250, 350 and 450 kg of seeds per hectare, 29.44, 28.78, 29.78 and 29.44 cm, respectively (Table 2).

Number of tiller per plant: Tillers per plant under the effect of seed probability level showed a significant statistical difference in ($p \le 0.01$) significantly level (Table 1). Compare the average effect of planting date showed that the number of tillers per plant, number of tillers per plant on Tuesday 10th of November 1, November 20 and December 10 respectively, 6.17 and 6.25 tiller. The highest number of tillers per plant with the use of 150 and 250 kg (6.67 and 6.78 tiller). The use of 350 and 450 kg of seeds per hectare against 5.78 and 5.33 tiller, respectively (Table 2).

Number of spikelet per spike: Statistical analysis of the data revealed that this parameter were significantly ($p \le 0.01$) affected by different sowing dates and seed rates ($p \le 0.05$) while their interaction were non significant (Table). Compare the average effect of planting date showed that the highest number of spikelet per spike (17.43 spikelet) on 30 November and the lowest number of spikelet per spike planting times in the history of culture of November 1 was 14.88 spikelet. Spikelet per spike on December 10 months against the 16.86 spikelet. Most spikelet per spike with consumption of 450 kg of seed (17.44 spikelet) and the lowest number spikelet were obtained at other levels equal to 16.2, 15.64 and 16.28 was number (Table 2).

Number of grain per spike: The number of grains per spike under the effect of planting date only statistically significant difference in the level of one percent indicated (Table 1). Compare the average effect of planting date showed that the highest number of grains per spike (33.53 numbers) on November 20 and the lowest number of grains per spike planting (number 28.42) was observed in the history of culture of November 1. The number of grains per spike in various quantities of seed of 150, 250 350 and 450 kg of seeds per hectare 31.7, 30.98, 31.87 and 30.22 number, respectively (Table 2).

Grain yield: Statistical analysis of the data revealed that grain yield were significantly ($P \le 0.01$) affected by different sowing dates while seed rate and double interaction were non significant (Table 1). Compare the average effect of planting date show that the maximum grain yield (3864.8 kg ha^{-1}) on the date of November 20 was produced that mainly due to favorable weather conditions and an increase in the yield components. The minimum yield (3137.3 kg ha^{-1}) on the culture of November 1, res pectively. Mean comparison showed that

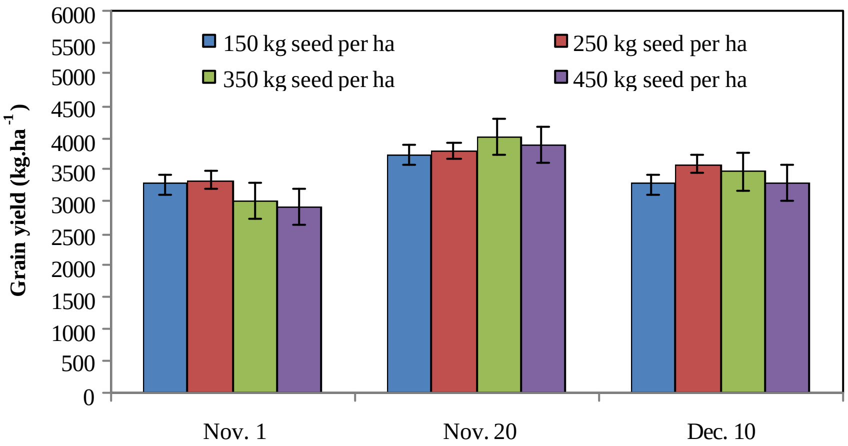

Fig. 1: Interaction of sowing date and seed rate on grain yield

the effect of the seed grain and oil yield, 150, 250, 350 and 450 kg of seeds perha 3427.7, 3578.4, 3373.3 and 3503 kg per ha, respectively (Table 2). Interaction between planting date and seeding rate on yield showed that the maximum grain yield of 4020 kg per hectare for interaction between planting date Nov. 30 with 350 kg of grain per hectare and minimum grain yield of 2920 kg per hectare in the history of interaction in November 1 with 450 kg of seeds per ha (Fig. 1).

In other studies, 1000-kernel weight was increased with increasing seeding rate in all genotypes and investigated years. Changes in seeding density have special importance in wheat crops since they have a direct effect on grain yield and its components (Ozturk *et al.*, 2006) according to the cultivation environment (Lloveras *et al.*, 2004). The seeding rate induced increase in 1000-kernel weight in all study years. On the other hand, there are results showing that higher seeding rate decreased 1000-kernel weight (Laghari *et al.*, 2011). Several authors emphasized the influence of sowing density on the number of fertile tillers per square meter and 1000-kernel weight (Dubis and Budzynski, 2006). They established that with seeding rate of 600 in compare to 480 seeds m-2 increased number of spikes m-2, number of grains per spike but 1000 grain weight and coefficient of productive tillering decreased. Valerio *et al.* (2009) established that low tillering ability genotypes showed a closer association of number of fertile tillers with grain yield. However, an inverse association was found between number of fertile tillers and weight of 1000-grains. Effects of seed rate on 1000-grain weight and grain specific weight were small and inconsistent (Gooding *et al.*, 2002). Also, the highest kernel yield was achieved with sowing rate 600 germinable seeds m^{-2}. On the other hand, various sowing rates had highly significant influence on the number of fertile tillers (Wajid *et al.*, 2004) and that sowing rate influences mainly of number of spikes per square meter which has the closest relationship to yield from all yield components (Ozturk *et al.*, 2006). Results are in accordance with the findings of Geleta *et al.* (2002). They pointed out that seeding rate is a predictable environmental factor that affects some agronomic and end-use quality traits of wheat; therefore, it should be studied carefully to obtain higher grain yields with better end-use quality. Lloveras *et al.* (2004) and Otteson *et al.* (2007) established that kernel weight was significantly affected by environment and variety but not by seeding rate.

More researchers investigated the effect of planting density on yield and yield components than on grain quality. Otteson *et al.* (2008) point out that seeding rate did not result in a significant change in grain quality or milling and baking quality. Overall, genotype was the most important factor in determining grain quality and milling and baking performance. According to Caglar *et al.* (2011) seeding rates had significant impacts on yield and quality parameters of wheat. They found out that seeding rate of 325 seeds m^{-2} was suitable for flour yield but 526-625 seeds m^{-2} like dense seeding rates had better effects over other parameters (sedimentation volume, wet gluten content, dry gluten content and flour ash content). In investigation significant differences among cultivars, years, seeding rate and their interactions were identified for sedimentation value and wet gluten content. These results agree with findings of Geleta *et al.*, (2002) who reported significant differences among environments, seeding rates, genotypes and some of their interactions. They found out that lower seeding rates decreased plant population, grain yield, kernel weight, flour yield, mixing time, caused later flowering and increased flour protein content and mixing tolerance. Similar results were obtained Hiltbrunner *et al*., (2005, 2007) who established that grain yield was not decreased by wider row spacing, 1000-kernel weight and grain protein content were increased from 42.6-43.5 g and from 11.7-12.7%, respectively, compared to the narrow row spacing. In this study, correlation coefficient between Zeleny sedimentation and wet gluten content was positive (r = 0.496) what agree with previous results established (Tayyar, 2010). Bokan and Malesevic (2004) concluded that planting density of winter wheat varieties, at an optimal planting date, should amount to 600 germinating kernels m^{-2}, thus producing a sufficient number of good-quality spikes with adequate yield structure. Plants compensated for low population densities by increasing production and survival of tillers and, to a lesser extent, increasing grain numbers per ear. Schillinger (2005) point out that grain yield in spring wheat was not affected by sowing rate because increased number of heads per unit area and kernels per head consistently compensated for reduced plant stand density. The optimal seeding rates vary from year to year and depending on growing seasons (Caglar *et al*., 2011) and grain-filling periods. Seeding rates in wheat can vary widely due to differences in seed quality, planting conditions, planting dates and planting equipment or system being used. The results suggest that lower seeding rates may be adequate under excellent growing conditions (Lloveras *et al*., 2004). Seeding rate should be considered as a factor in obtaining higher grain yield with good end-use quality (Geleta *et al*., 2002). Optimum seeding rates for grain yield of winter cereals may be higher when seeding is delayed past the optimum date of seeding. High seeding rates increase early DM accumulation and weed competitiveness but may have negligible or negative impacts on grain yield due to increased inter-plant competition (Park *et al*., 2003).

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