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EFFECT OF NITROGEN AND POTASSIUM ON YIELD AND YIELD COMPONENTS OF RICE CULTIVAR "HASHEMI"

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ABSTRACT
this study was conducted to investigate the effect of nitrogen and potassium fertilizers on yield and yield components of a rice cultivar "Hashemi" as factorial laid out randomized complete block design with three replications at eastern Guilan (Amlash) during farming season 2013. The experimental factors consisted of nitrogen (0, 30, 60, and 90 kg ha^{-1}) and potassium (0, 75, and 150 kg ha^{-1}). The results of ANOVA revealed that the effect of nitrogen on biologic yield, paddy yield, height, the number of tillers, the number of filled grain per panicle was quite significant. The effect of potassium on height and the number of tiller was quite significant and it had significant effect on the number of filled grain. The interaction of nitrogen and potassium on height and the number of tiller was quite significant. Means comparison of data based on Duncan test for nitrogen showed that the fertilizer level of 90 kg ha^{-1} possessed the highest yield (5714 kg ha^{-1}). The highest number of tiller obtained at the fertilizer level of 90 kg ha^{-1} nitrogen with 526.7 tillers per m^{-2} and 150 kg ha^{-1} potassium with 438.8 tillers per m^{-2}. The highest number of tiller obtained when 90 kg ha-1 nitrogen with 150 kg ha-1 potassium and 90 kg ha-1 with 75 kg ha^{-1} potassium were applied to gain 578.3 and 546.7 tillers per m^{-2}, respectively.

Keywords: *Duncan Test, Factorial, Randomized Complete Blocks, Rice Yield*

INTRODUCTION

Rice is one the most important agricultural crops in the world and is ranked the second in the view of annual production after wheat and it constitutes half of world population main meal (Chabra *et al.*, 2006). Among small cereal crops, rice, after wheat, is the main human's food stuff and therefore it is ranked the second for its demand. To respond this demand which is from population growth and economic development, it is required to raise average yield of 3.5 ton ha-1 by 1.7% annually (Rosegrant *et al.*, 2008). It is estimated that, by 2050, rice production should be increased up to 50% that this increase in production requires plant breeding and apt agronomic management applications (Netanos and Kotrobas, 2002). Rice is the main food stuff for majority of world's population and is a state strategic crop as well as a dominant crop in Mazandaran province with a cultivation area of 237,000 ha. 136,000 ha of lands have been assigned to local varieties and the remained to improved ones. Average rice yield amounts to 4500 kg ha^{-1} in these lands. It is possible to increase rice yield through fertilizer and improved varieties with effective technology and correct irrigation as well (De Data and Mikelson, 1985). Within the last two decades, state rice consumption per capita and consumption pattern and people's nutrition has been changed and rice consuming has been introduced into family's basket as a fundamental and necessary meal for daily use so that annual rice consumption has grown up from 15-20 to 38-40 kg. Rice cultivation is mainly located in Guilan and Mazandaran provinces which comprise about 75% of total rice production. Guilan, Fars, Khuzestan, Esfahan, Kohkilouye and Boyer Ahmad, Chaharmahal and Bakhtiari, Ilam, Sistan and Balouchestan, Gazvin, Zanjan, Azerbaijan Gharbi and Shargi, Lorestan, Khorasan, Kordestan, Kermanshah, and Ardabil provinces are on the next ranks (Zamani, 2009). Due to urbanism and industrialism, such an increase in yield, instead of increase in cultivation area, is provided through yield increase per area unit (Tiagi and Mohanti, 2000). Fertilizer is one of the most important factors in rice production. It causes yield to increase but this yield increase is a function of parameters such as fertilizer application, application rate, climate and ecological condition. However, fertilizer makes yield increase, over recommended application and also cultivating varieties that do not respond positively to fertilizer introduction will result in yield reduction up to 20-50 and 20-40%, respectively (Okhovat and

Vakili, 1997). Nitrogen is the most applied nutritive element so that its application has been estimated an increase from 1.3 million ton in 1930 to more than 85 million ton for recent years. Since nitrogen is a principle and constructing element of protein and plant needs a great amount of it, one of the resources for chemical fertilizers is urea ($CO(NH_2)_2$) (Behdani, 2011). High yield could be achieved providing that enough nitrogen aggregation was accessible to rice plant during growth season (Bofogol *et al.*, 1997). There have been many studies about the effect of nitrogen on rice and the results have emphasized that increasing nitrogen to a specified limit would raise grain yield remarkably (Kazemi Poshtmasari *et al.*, 2008; Rezaei *et al.*, 2009; Nahvi, 2006; Lin *et al.*, 2009; Lampin *et al.*, 2010). In rice, nitrogen fertilizer (50-70%) is inaccessible from ambient as gaseous which causes irrigation systems pollution (Chadhari, 2000). Some remains in soil and it are just 1.3 out of applied fertilizer that is absorbed by plant. Nitrogen fertilizer is an expensive input and applying less or more than optimum will affect rice quantity and quality (Manzor *et al.*, 2006; Sheifoul *et al.*, 2009). A suitable economic approach should be employed for increasing yield quantitatively and qualitatively (Manzor *et al.*, 2006). Potassium is the seventh element in the view of abundance and is the fourth mineral element in lithosphere in the view of nutrion (Alghi, 1993). Potassium has an outstanding role in the physiology of rice yield increase. For instance, it causes rise in size, kernel weight, stress tolerance including orifice opening and closing, resistance to unfavorable weather conditions, improvement of tillering, stems strengthening, and reduction of lodging, higher resistance to diseases such as blast, leaf taint, stem putrefaction (De Data and Mikelson, 1985). Water absorption and balance in elements absorption need potassium in cells adequately. Potassium accounts for crop quality improvement and it is necessary for a strong stem formation in cereal crops (Haghparast, 1992). Within the last two decades, there has been remarkable reduction in applicable potassium in soils in which there was no deficiency observed. The main reasons could be intensive and continuous exploitation of paddy fields, application of improved varieties, utilizing ground water instead of surface water that decrease potassium supply in fields, increased application of nitrogen and phosphate fertilizers, limited application of potassium fertilizers, and redundant potassium run-off (Malakooti, 1999). In reports, increase in rice yield has been observed as a result of increased potassium application (Bocharnikova and Matichenko, 2008; Bao, 1985; Navaro, 1989). This study was conducted due to positive impacts of nitrogen and potassium on yield and yield components of rice and necessity for authentic application of fertilizer in fields in order to achieve higher yield aiming at determination of optimum fertilizer application.

MATERIALS AND METHODS

The experiments accomplished as factorial with two factors laid out randomized complete blocks design with three replications in Amlash, in 2013. The experimental factors included nitrogen levels (0, 30, 60, and 90 kg ha^{-1}) and potassium (0, 75, 150 kg ha^{-1}) that two treatments of N_1 (0 kg ha^{-1}) and K_1 (0 kg ha^{-1}) were selected as control. Treatment N_2 (30 kg ha^{-1}) was wholly applied one day before transplanting, treatment N3 (60 kg ha^{-1}) half of that one day before transplanting and the other 3o days after transplanting, treatment N_4 (90 kg ha^{-1}) half of that one day before transplanting and the rest 45 days after transplanting based on map were given to land and two treatments K_2 and K_3 (75 and 150 kg ha^{-1}) were applied three days after transplanting based on map to land. To perform experiment, firstly land preparation, winter plowing, spring supplementary tillage, leveling operations took place before plots formation and transplanting. Map conducted on May, 16, and 12 plots of 9 m^{-2} with three replications (totally 36 plots) were formed. Seeding in nursery was done within first half of may and seedlings transferred to main land after being 3-4 leaves. Seedlings were planted in 20 cm × 20 cm intervals and the remained fertilizers were applied based on their proportional amounts. Soil analysis showed that in this clay field, electrical conductivity, pH, total nitrogen, absorbable potassium and phosphor were 0.62 ds m^{-1}, 6.78, 0.19%, 81.6 and 3.45 mg kg^{-1}. Manual weeding was done in two stages, namely 15 and 30 days after transplanting. In two phases of 25 and 45 days after transplanting, drought was accomplished by water cutoff and herbicide and irrigation was performed as common procedure. To determine biologic yield and paddy yield, harvesting was performed over an area of 2 m^2. Then, paddy was dried in an oven

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by 70 °C for 48 hours and biologic yield and paddy yield was finally calculated. Harvest index was computed through the following formula:
Harvest index % = economic performance / biologic yield × 100
Five plants were selected from each plot to determine plant height. For determining 1000-grain weight, 1000 kernels of rice were used from each experimental plot and then their weights were measured by a digital scale (0.01 g). To determine the number of tiller, five plants were randomly selected before harvesting and counted and the average was considered as the number of tiller. To specify the number of filled grains per panicle, 10 panicles were selected from each plot. The number of filled grains in each panicle was counted. Then, the average of filled grains from these 10 plants was calculated.

RESULTS AND DISCUSSION

Biological Yield (Biomass)

According to the results, it was revealed that the effect of nitrogen on biologic yield was significant at 1% level. But, the effect of potassium and interaction of nitrogen and potassium were identical on this trait (Table 1). The maximum biologic yield was on treatment N4 (9587 kg ha^{-1}) and the minimum one was related to N1 (5348 kg ha^{-1}) (Table 2). Zhu and Wang (2003) reported that leaf biologic yield was increased by nitrogen. In a research by Lorzadeh and Gholizadeh (2009), the effect of nitrogen fertilizer levels on biologic yield has been reported. Timsina *et al.*, (2001) reported that the aggregation of total biologic yield during rice growth was affected significantly by nitrogen levels. Nitrogen fertilizer influences dry mass aggregation, nitrogen aggregation, and its allocation on different parts of plants. The difference in dry mass aggregation in response to nitrogen results in the difference in receiving photosynthesis active radiation by plant canopy and plant efficiency for using solar radiation (Dordas and Se-Olas, 2009). Nitrogen causes more dry mass and yield through affecting size and longevity of the leaf, formation and survival of the tiller, increase in size and persistence of plant overcasting (Sadrzadeh, 2002). Deficiency in plant nitrogen requirement causes reduction in growth and photosynthesis and also failure in dry mass aggregation. If plant nitrogen requirement would not supply plant would encounter reduction in growth, photosynthesis, and dry mass aggregation. In this study, rice biology yield increased significantly through nitrogen rising from N1 to N4. By increasing nitrogen level and providing the optimum nutrition conditions with rice growth and yield, biologic yield arose. Attaining the maximum biologic yield on treatment N4 could be attributed to enough nitrogen supply for passing favorably phonological stages and appropriate formation of vegetative and reproductive organs and also better filling of grains.

Table 1: Analysis of Effect of nitrogen and potassium on yield and yield components of Rice cultivar Hashemi

		MS						
SOV	**df**	**Biological yield**	**Paddy yield**	**Harvest index**	**Height**	**1000 grain weight**	**Tillering**	**The number of filled grains**
Block	2	1.808 ^{ns}	0.002 ^{ns}	57300.111^{ns}	198802.03 ^{ns}	1.203 ^{ns}	369.44 ^{ns}	10.07 ^{ns}
Nitrogen	3	520.79**	0.004^{ns}	10299029.95**	28620751.4**	4.181^{ns}	60093.52**	201.41**
potassium	2	411.19**	0.003^{ns}	346737.03^{ns}	687094.78^{ns}	4.451^{ns}	3800.69**	209.57*
Interaction	6	15.08 **	0.002^{ns}	350464.28^{ns}	821781.29^{ns}	0.807 ^{ns}	4316.43**	21.23^{ns}
Error	22	3.625	0.003	478775.59	1000807.85	1.64	370.96	37.14
CV (%)		1.46	4.97	15.47	13.52	8.08	4.6	6.67

*ns = Non significant; * and ** = Significant at 5% and 1% probability level, respectively*

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Table 2: Comparison different nitrogen levels on yield and yield components in Rice cultivar Hashemi

Nitrogen Fertilizer	Biological yield	Paddy yield	Harvest index	Height	1000-grain weight	Tillering	The number of filled grains
0	5348 d	3196 d	0.59 a	120.8 d	14.9 b	336.1 d	85.9 b
30 kg.ha^{-1}	6815 c	4129 c	0.60 a	127.6 c	15.8 ab	381.1 c	90.1 b
60 kg.ha^{-1}	7850 b	4852 b	0.62 a	132.9 b	16.5 a	430.6 b	91.8 ab
90 kg.ha^{-1}	9587 a	5714 a	0.59 a	138.6 a	15.7 ab	526.7 a	97.4 a

Table 3: Comparison of yield and yield components in different nitrogen levels

Potassium Fertilizer	Biological yield	Paddy yield	Harvest index	Height	1000-grain weight	Tillering	The number of filled grains
0	7587 a	4587 a	0.61 a	123.8 c	15.6 a	405.0 b	88.8 b
75 kg.ha^{-1}	7130 a	4277 a	0.59 a	130.9 b	15.5 a	412.1 b	88.9 b
150 kg.ha^{-1}	7483 a	4553 a	0.71 a	135.2 a	16.6 a	438.8 a	96.2 a

Table 4: Interaction of different levels of nitrogen and potassium on yield and yield components of rice

Treatments		Biological yield	Paddy yield	Harvest index	Height	1000 grain weight	Tillering	The number of filled grains
0 kg.N.ha^{-1}	0 kg.P.ha^{-1}	5725 efg	3462 def	0.60 a	115.7 g	14.7 b	348.3efg	79.4 d
	75 kg.P.ha^{-1}	5015 g	2930 f	0.58 a	122.2 f	14.8 b	340 fg	85.4 cd
	150 kg.P.ha^{-1}	5305 fg	3194 ef	0.60 a	124.3 f	15.3 ab	320 g	93.1 abc
30 kg.N.ha^{-1}	0 kg.P.ha^{-1}	7561 cde	4541 abcd	0.59 a	123.2 f	16.2 ab	376.7cde	88.2 bcd
	75 kg.P.ha^{-1}	5903 efg	3537 def	0.60 a	127.8 e	15.1 ab	365 def	87.9 bcd
	150 kg.P.ha^{-1}	6980 def	4310 cde	0.62 a	131.8 d	16.1 ab	401.7 c	94.2 abc
60 kg.N.ha^{-1}	0 kg.P.ha^{-1}	7475 de	4502 bcd	0.60 a	124.8ef	15.6 ab	440 b	89.7 abcd
	75 kg.P.ha^{-1}	7792 bcd	4929 abc	0.63 a	135.1c	16.3 a	396.7 cd	89 abcd
	150 kg.P.ha^{-1}	8284 abcd	5125 abc	0.62 a	138.8 b	17.6 a	455 b	96.7 abc
90 kg.N.ha^{-1}	0 kg.P.ha^{-1}	9587 ab	5845 a	0.61 a	131.6 d	15.8 ab	455 b	98.1 ab
	75 kg.P.ha^{-1}	9811 a	5713 ab	0.58 a	137.2bc	15.5 ab	546.7 a	93.6 abc
	150 kg.P.ha^{-1}	9364 abc	5583 abc	0.59 a	147 a	17.2 ab	578.3 a	100.5 a

Nitrogen rise results in an increase in the number of tiller per hill and plant height and consequently straw yield through speed up vegetative growth and its longevity. Nitrogen causes more dry mass production and yield via affecting the size and longevity of the leaf, tiller formation and survival, rise of size and persistence of plant overcasting.

Paddy Yield

The results of ANOVA showed that nitrogen levels had significant effects on paddy yield at 1% level (Table 1). Also, it was observed that the effect of potassium levels and interaction of nitrogen and potassium were not significant on paddy yield (Table 1). Grain yield was the highest on treatment N4 (5714 kg ha^{-1}) and the lowest on was on treatment N1 (3196 kg ha^{-1}) (Table 2). In a research by Netanos and Kotrobas (2002), the effect of nitrogen levels on paddy yield was reported. Koaleh (1994) stated that rice grain yield had a very high correlation with nitrogen absorption. Sharafi (1377) and Erfani and Salehi

(2000) reported the maximum yield related to 90 kg ha^{-1} pure nitrogen. Farrokh *et al.*, (2003) reported, in an investigation conducted on the effect of nitrogen and potassium fertilizers on yield and related traits of rice, that the effect of nitrogen on grain yield was significant at 1% level. Nahvi (2001) expressed, in studying rice promising lines, that the most appropriate fertilizer level for line 424 was 90 kg ha^{-1} of pure nitrogen. Mojm *et al.*, (2009) reported that increase in nitrogen application caused rise of grain yield. According to Mobser (2006), inaccessibility of nitrogen for plant caused growth and photosynthesis fall and also failure in dry mass aggregation and decreased yield per area unit as well. Hence, applying nitrogen up to 90 kg ha-1 would increase biologic yield because of rising grain yield and also straw yield. Regarding insignificance of potassium effect on yield, some researchers have pointed out such a result (Wilson *et al.*, 1996; Iqbal *et al.*, 1991). To achieve the maximum yield, vegetative and reproductive nitrogen level for plant must be provided at critical limit since aggregated nitrogen during reproductive stage has the most influence on grain yield (Hori *et al.*, 1997). Yield drop in treatment N1 might be occurred due to lack of nitrogen supply required for improvement traits led to higher yield. Traits led to higher yield ability are, in most cases, related to a reaction with respect to nitrogen. One of the reasons regarding yield increase from rising nitrogen level to level N_4 could be an increase in the number of tillers to such a fertilizer level in this study. Nitrogen application not only increases photosynthesizing area (rise of the number of tiller and developing leaf area) but also increases activity of ribolz-1 and 5-biphosphat carboxylase enzymes. This enzyme forms more than 50% of soluble proteins in leaf. So, it is expected that there would be a high correlation between absorption level and Co2 construction and nitrogen and leaf protein density (Sediq and Banaeian, 1994).

Harvest Index

The results of ANOVA indicated that the effects of nitrogen level and potassium levels and the interaction of nitrogen and potassium were not significant on harvest index (Table 1). In an investigation by Esfahani *et al.*, (2005), harvest index was not affected by any kind of fertilizer treatments. In studies by Eshghi *et al.*, (2011), Rezaei *et al.*, (2009), and Esmaeilzadeh *et al.*, (2011), it was revealed that nitrogen levels were not significant on harvest index. Abamo (1995) found out that harvest index was not affected by different levels of nitrogen fertilizer. Gilani *et al.*, (2005) suggested that local varieties with higher plant height had lower harvest index.

Height

The results of ANOVA indicated that the effects of nitrogen levels, potassium levels, and interaction of nitrogen and potassium were not significant at 1% level (Table 1). On treatment N4, the maximum (138.6 cm) and minimum (120.8 cm) height obtained (Table 2). On treatment K3, the maximum (135.5 cm) and minimum (123.8 cm) height attained (Table 3). On the interaction of nitrogen potassium, treatment N_4K_3 had the maximum height (147.0 cm) which located at A classification and the minimum height related to treatment N1K1 (115.7 cm) which was at G classification (Table 4). Zareie (2001) obtained the maximum height at pure nitrogen level of 90 kg ha^{-1}.

In a research by Bahmanyar and Soa (2010), the effect of nitrogen on height was reported. Increase in cells growth under nitrogen might be a reason for rise of plant height. Scientists have reported that nitrogen deficiency reduces cells growth and polisakarids production levels which are components of plant cells walls (Gnter and Odo, 2005). Studies show that the highest yield relates to the tallest variety and the shortest varieties, due to producing more sterile tillers and high leaf area and more overcasting, catch decreased photosynthesis and grain formation (Mahdavi, 2004); since a higher canopy has a better aeration and Co2 intensity is higher inside canopy in consequence.

Marschener (1995) stated that nitrogen, due to its role in production and emission of citoxin from root to aerial organs, increases cell division, growth, and height of plant. Nitrogen elements causes increase in cell division and consequently rise of height, the number of tiller, and leaf area in rice plant because of stimulation of biosynthesis citokinin and its emission from root to aerial parts of plant. Increase in tiller by nitrogen implies the indirect effect that nitrogen has on jiberlin hormone due to citokinin. In such a case, citokinin causes multiplication and rise of end parts of young leaves and branches which are spots for jiberlin synthesis.

1000-grain Weight

According to the results, it was revealed that the effects of nitrogen, potassium, and their interaction on 1000-grain weight were not significant (Table 1). Increase in fertilizer application did not effect on the grain weight (Table 1). 1000-grain weight is one of the most important yield components indicating allocation of more photosynthesis substances to kernels and as genetic characteristics of varieties, is somehow influenced by maturity period. In local varieties, 1000-grain weight is lower than improved varieties because of having shorter kernel filling period and lack of adequate time for aggregation of high dry mass (Honarnejad, 2002). 1000-grain weight in a genotype, despite applying nitrogen treatments, does not have significant variations (Matsoshima, 1980). 1000-grain weight is an important yield component of rice which is a genetic trait and varies for different varieties and its value is affected by maturity conditions; since the size of rice grain is controlled by husk, therefore, the variations of this trait is not citable (Saha *et al.,* 1998). Since, rice kernel is covered by internal and external glumes and kernel growth is limited by such a tenacious external coverage in this condition, it is not unexpected that 1000-grain weight is not impacted by treatments (Wilson *et al.,* 1981; Yu, 1976). Limitation in dry mass production after flowering because of precocious senility of leaves at kernel filling period, absence of enough amount of stored substance in order to retransfer to kernel, reduction in photosynthesizing area and lowliness of sump with respect to cistern which has deterring effect on producing organs, are main reasons for reduction in yield and 1000-grain weight (Lee *et al.,* 1994). Increase in nitrogen level caused the number of tiller raised per unit area and resulted in lesser nutrition available for each panicle. 1000-grain weight is a genetic trait and varies among varieties and its value is affected by maturity conditions. One determinant components of yield is 1000-grain weight which is mainly a genetic trait but in unfavorable circumstances such as reduction and or increase in temperature, relative humidity, rise of fungal diseases and nutrition is affected completely. It can be stated, among the reasons why 1000-grain weight is not influenced by potassium treatment, that soil clay content is high (53%) which is a competitor to plant and makes potassium inaccessible to plant. Thus, due to high clay content, critical density of potassium must be considered higher.

Tillering

According to the results, it was indicated that the number of tiller was severely affected by the effect of nitrogen levels, potassium levels, and their interaction ($p<0.01$) (Table 1). Treatment N4 had the maximum number of tiller (526.7 tiller per m^{-2}) that was at A classification and the minimum one related to treatment N1 (336.1 tiller per m^{-2}) which was at D classification (Table 2). The maximum number of tiller belonged to treatment N3 (438.8 tiller per m^{-2}) that was at A classification (Table 3). The highest number of tiller for the interaction of nitrogen potassium associated to treatments N4K3 and N4K2 with 578.3 and 546.7 tillers per m^{-2}, respectively so that both were at A classification (Table 4). The results by Islam *et al.,* (2008) and Mirza *et al.,* (2010) approved the point that increasing nitrogen levels raised the number of tiller. Singh *et al.,* (2000) reported that the most sensible effect of nitrogen application on rice yield appeared as increase in the number of tiller and preservation and stimulation of its production. Lampin *et al.,* (2010) suggested that increase in the number of tiller was due to application of nitrogen fertilizer. Salehifar *et al.,* (1390) reported that nitrogen fertilizer had significant effect on the number of tiller. Taghizadeh *et al.,* (2008) found out that nitrogen affected the number of tillers. Nitrogen influenced jiberlin hormone indirectly through citoxin. Thus, it caused increase in growth of end parts of branches and plant young leaves and for rice, it made the number of tillers arise. The most sensible effect of nitrogen fertilizer on rice yield has been reported as increase in the number of tiller per m^2 (Singh and Jin, 2000). Absorbed nitrogen by plant from tillering to initial advent of panicle caused a rise in the number of tiller and panicle on plant (Mohammadian, 2002). In a report by Khabazkar *et al.,* (2010), application of cloror potassium made the number of prolific tiller increase on rice. Generally, plants respond to nitrogen deficiency through decrease in resource utilization, efficiency drop of resource utilization and or both of them. First respond would be reduction in receiving solar radiation by canopy as a result of falling development of leaves and tillering and reduction in leaf area index in consequent. Second respond is a drop in efficiency of energy utilization due to lowering of leaves nitrogen levels for area unit that impacts leaf photosynthesis negatively (Lamir *et al.*, 2008). High growth speed during initial vegetative growth causes rapid development of leaves and ultimately, more tiller is produced (Morita, 2007). The number of tiller has a positive and significant correlation with yield. Increase in yield as a result of a rise in the number of tiller could be attributed to the impact of the number of tiller on sump (the number of panicle and grain per area unit) and cistern (leaf area index).

The Number of Filled Grains

Based on the results, it was revealed that the effect of nitrogen fertilizer on the number of filled grains was significant at 1% level and the effect of potassium fertilizer on the number of filled grain was significant at 5% level. But, the interaction of nitrogen potassium on the number of filled grain was not significant (Table 1). The maximum filled grain was related to treatment N_4 with 97.39 filled grains (Table 2). Treatment K_3 with 96.15 filled grains had the highest number of filled grain (Table 3). In an investigation by Kazemi *et al.,* (2007), the effect of nitrogen levels on the number of filled grain was reported. Bahmanyar (2010) reported the effect of nitrogen and potassium on the number of filled grains on the panicle. Salem *et al.,* (2006) reported that the number of filled grain on the panicle has increased significantly due to simultaneous application of organic manure and nitrogen. In a research by Talkokdar *et al.,* (2002), the number of filled grain increased significantly by rising nitrogen application. Sashara *et al.,* (1993) noted that nitrogen application at the panicle advent and afterwards caused an increase in nitrogen level in influential organs for grain filling like flag leaf and underneath flag leaf which was an indicative for proficiency of panicle activity and organs associated to grain filling.

Peng and Senadhara (1999) stated that higher biomass production might be a reason for grain filling and lower biomass production could be an implication for weak grain filling. Nitrogen application, by increasing processed syntheses before pollination, could have an important role in raising the amount of processed syntheses for transferring to kernels after pollination. In this case, the importance of processed syntheses aggregation before pollination, scientists expressed that dry mass and aggregated nitrogen before pollination is an important photosynthesis and nitrogen-based compounds resources for kernels growth (Dordas and Sea, 2009).

In general, the relationship between filled grains percentage and nitrogen level is as a parabola (Agiu and Goru, 1990). Processed syntheses for filling grains are not merely supplied by leaves and green parts photosynthesis. They are also supplied by transferring carbohydrates from the other organs of a plant which are responsible for stability of each kernel's weight on a plant. Stem reserves in cereal crops especially in stress conditions could have significant impact on the yield through transferring these syntheses to the kernels (Manderz *et al.,* 2009).

Applying nitrogen fertilizer at the maximum tillering and gestation stages might probably increase flag leaf chlorophyll level and defer leaf senility and raise photosynthesized substances and photosynthesis speed on photosynthesizing organs and cause higher filled grains. Also, at lower levels of nitrogen, nutritive inadequacy required for filling grains would be the main reason for lower percentage of filled grains on the panicle.

Conclusion

To sum up, it could be concluded that paddy yield was affected by applying nitrogen treatments. By considering conditions for this study, the maximum paddy yield obtained for treatment N4 (5714 kg ha^{-1}). Among the reasons for yield increase in treatment N_4, supplying nitrogen required for improving traits that lead to high yield can be noted.

Traits that lead to high yield ability are, in most cases, related to a reaction with respect to nitrogen including the number of tiller and the number of further filled grain on the panicle. Thus, by supplying nitrogen for a plant, the required level of processed syntheses for growing more tillers would be provided and the number of tiller would increase ultimately. In addition to this, nitrogen fertilizer is one of the factors supplies latex adequately for plants that this causes filling of all grains and results in allocation of more latex to grain. Hence, the maximum grain yield is observed at higher levels of fertilizer application. Thus, due to nitrate pollution from excessive application of nitrogen fertilizers which are threatening regional ground water, nitrogen level of 90 kg ha^{-1} is recommended as an appropriate criterion.

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