KAFRELSHEIKH UNIVERSITY
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GRAIN QUALITY, NUTRITIONAL VALUE AND YIELD OF SOME PROMISING RICE GENOTYPES AFFECTED BY SOME FERTILIZER TREATMENTS

By

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Abstract

Two field experiments were conducted at Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during 2015 and 2016 rice growing seasons, to study the performance of some rice genotypes under different NPK levels. the effect of NPK-fertilizer level in permanent field on plant growth, yield and yield components of four rice genotypes namely GZ.9461-4-2-3-1, GZ.10101-5-1-1-1, GZ.10147-1-2-1-1 and GZ.10154-3-1-1-1.

The experiments were carried out in a split plot design with four replications. In the permanent field, growth characters such as number of tiller, plant height, dry matter production, leaf area index, chlorophyll content at (40 DAT) after transplanting, days to heading, yield and its attributes were also estimated at harvest time, grain quality characters and determination of NPK and Z in milled grains. GZ.9461-4-2-3-1 as *Indica/Japonica* variety and GZ.10147-1-2-1-1 as *Japonica* variety responded more and produced the highest grain yield and grain quality .

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To

The Spirit of

my

Father

Whom Never Be Forgot
Forever

إهداء

إلى الدكتور

تامر فاروق متولى

عظيم الشكر والتقدير والعرفان لمجهوداتكم الرائعة معى طوال فترة البحث

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INTRODUCTION

Rice (*Oryza sativa, L*) is one of the most important cereal crops of the world, grown in wide range of climatic zones, to nourish the mankind. It is the stable food for more than three billion peoples that is over half of the world's, contributes over 20% of the cereal consumption **(FAO, 2004)**. Increasing productivity per unit area is the native goal to meet the consistent demands from this crop. Rice occupies a conspicuous position in the predominately agricultural economy of Egypt; the attention is required to improve its yield, quality characters and quality of elements nutrition.

Nitrogen is one of the essential macronutrients for rice plant growth and yield. So, mineral nitrogen fertilizers are wildly used in agriculture all over the world, and also in Egypt. Urea is the most common nitrogen source used in crop production particularly for rice production. This fertilizer is, widely available and has a large percentage of nitrogen but relatively expensive compare to the organic fertilizers and has some negative environmental impacts. Despite this, many farmers still insist on practicing this habit.

Phosphorus deficiency symptoms appear in the lower part of the plant and sequently decreased leaf number, decreased leaf blade length, reduced panicles/plant, reduced grains/panicle and reduced filled grains panicle^{-1} (**Aide et al., 1999)**. Phosphorus not only enhances the yield of rice. But the main problem concerning phosphatic fertilizers is its fixation with soil complex within a very short period of application rendering more than two thirds unavailable. So, it is necessary to know the optimum dose of phosphorus fertilizer for maximum yield and to reduce spikelet sterility of rice **(Sahrawat et al. 2001).**

Potassium is linked with all phenomena of plant photosynthesis, respiration, metabolism of fats, carbohydrates and nitrogenous compounds, enzyme activation, cell elongation and water efficiency, so it is considered the key element in rice nutrition for improving root growth and plant vigor, helping prevent lodging and enhancing rice resistance to pests and diseases **(Krishnakumar et al. 2005).**

The grain yield of Egyptian rice (*Oryza sativa*, *L.*) is affected by drought, salinity and low soil fertility. Genetic selection and plant breeding techniques helped to develop rice varieties that are resistant to pests, diseases, and adverse environmental conditions such as drought, nutrient deficiencies, toxicities, and salinity. However, genetic selection to improve the rice crop's NPK-use efficiency needs more research. The need for developing and identifying superior NPK efficient genotypes is evident from the shortage of NPK fertilizers and associated economic and environmental concerns. Moreover, use of nutrient efficient genotypes is an important complementary strategy in improving rice yield and reducing cost of production in intensive farming system. This research work was done to assess the differences in grain yield and NPK utilization of four promising Egyptian rice genotypes.

Therefore, the main objective of this study is to test the performance and productivity of four promising rice genotypes under different levels of nitrogen, phosphorus and potassium fertilizers.

REVIEW OF LITERATURE

A: Effect of nitrogen, phosphour and potassium management:

Chopra and Chopra (2000) studied the effect of row spacing and nitrogen level on growth, yield and seed quality of rice under transplanted conditions. Results showed that increased levels of nitrogen from 0 to 80 kg N ha^{-1} significantly increased plant height, grain weight $panicle^{-1}$, number of panicles/plant and grain yield. Further increased in nitrogen rate up to 120 kg N ha^{-1} could not show significant increase in the above-mentioned characters while, panicle length and 1000-grain weight remained unaffected by nitrogen application.

Das and Borah (2000) showed that dry matter productions of rice was increased with application of NPK fertilizer, while addition of zinc along with NPK did not improve superior over NPK alone.

Ebaid and Ghanem (2000) studied the productivity of Giza177 rice variety grown after different winter crops and fertilized with different nitrogen level. They found that increasing nitrogen level from 0 and 96 to 144 kg N ha^{-1} significantly increased plant height, panicle length, plant biomass production, number of panicle m^{-2}, panicle weight, number of grain $panicle^{-1}$, 1000-grain weight, grain yield and harvest index of Giza 177 rice cultivar. Nitrogen content in rice grain and straw were increased with increasing nitrogen rates from 0 and 96 to 144 kg N ha^{-1}.

Gracia and Azevedo (2000) evaluated five dosages of nitrogen (0,50,100,150 and 200 kg N ha^{-1}) on yield components of irrigated rice. Number of panicles and weight of 1000-grain increased with the increase of nitrogen fertilizer up to 150 kg N ha^{-1}. yield components, number of grains panicle^{-1}, quadratic ally responded to nitrogen. the greatest returns in relation to costs, were obtained with 150 kg N ha^{-1}.

Neelam and Chapra (2000) studied the effect of four nitrogen levels of 0, 40, 80 and 120 kg N ha^{-1} on yield and yield attributing characters of rice. They found that the highest values of plant height, number of panicles m^{-2}, seed weight panicle^{-1}, panicle length, grain and straw yields were obtained when the nitrogen fertilizer rate increased up to 80 kg N ha^{-1}.

Sengar et al. (2000) indicated that the application of nitrogen fertilizer significantly increased the yield, agronomic efficiency compared with the control and PK treatment. The application of nitrogen fertilizer significantly increased nitrogen, phosphorus, potassium uptake by rice compared with the control and PK treatment.

Suriya-Arunroj et al. (2000) suggested that the low supply of phosphorus decreased plant height and leaf area development during early growth. The omission of phosphorus had a larger detrimental effect on growth when water supply was limited.

Channadasavanna et al. (2001) conducted filed experiment to study the effect of N levels (50,75and 100 % of recommended dose of N-150 kg N ha^{-1}) on yield of rice. Data revealed that application of 100% N (150 kg N ha^{-1}) resulted in significant higher grain yield (4704 kg N ha^{-1}) over 75% N (3999 kg N ha^{-1}) and 50% N (3798 kg N ha^{-1}) yield attributes (panicle hill^{-1} and seed panicle^{-1}) followed as similar trend.

Devasenamma et al. (2001) investigated the response of hybrid rice to nitrogen levels (0, 60, 120 and 180 kg N ha^{-1}). They found that number of tillers, panicles, yield and yield component were increased with 180 kg ha^{-1}.

Ebaid and El-Hissewy (2001) investigated the effect of nitrogen and potassium fertilizer levels on rice grain quality of Sakha 101 rice cultivar. Four nitrogen levels were used *i.e.* (0, 55, 110 and 165 kg N ha^{-1} as urea. They indicated that hulling (%), amylose content, gel consistency and grain protein (%) were significantly increased as nitrogen levels increased up to 165 kg N ha^{-1}.

Ebaid and Ghanem (2001) studied the effect of four nitrogen levels (0, 55, 110 and 165kg. N ha^{-1}) on the productivity of rice. They found that number of panicle per hill, panicle length, and number of filled grains per panicle, grain yield and straw yield significantly increased with increasing nitrogen and potassium fertilizer in both seasons of study.

Figeria and Baligar (2001) found that nitrogen fertilizer application significantly increased dry matter and grain yield of low land rice. Ninety percent of the maximum grain yield (6400 kg N ha^{-1}) was obtained with the application of 120 kg N ha^{-1} in the first year of experimentation. Some yield at attributes i.e., panicle length and panicle m^{-2} were the highest.

Pandey et al. (2001) studied the effects of two fertilizers levels 100:60:40 and 150:100:60 kg N: P: K ha^{-1} on growth and yield of transplanted rice rice. The results showed that plant height (cm), leaf area index and grain were higher at the second level than at the first one.

Sharma and Bali (2001) reported that grain yield of rice was significantly increased with the increase in levels of NPK up to an additional 25% over the recommended rates. Further increase in fertilizer rate decreased the grain yield. Total NPK uptake of rice increased significantly with the increase in levels of NPK up to an additional 25% over the recommended rates. The increasing NPK rates resulted in a positive balance of N and P.

Singh and Srivastava (2001) studied the response of hybrid rice to nitrogen levels under transplanted condition. They found that applied nitrogen increased the grain yield significantly up to 150 kg N ha^{-1}.

Sudhakar et al. (2001) reported that there were significantly increase in grain yield, straw yield with increasing nitrogen application up to 125 kg N ha^{-1}. Application of 125 kg N ha^{-1} recorded higher grain yield and straw yield.

Abd El-Hamed (2002) indicated that increasing nitrogen levels up to 80 kg N fed^{-1} significantly increased plant height, number of tiller $hill^{-1}$, panicle length, number of filled grains $panicle^{-1}$, 1000-grain weight, panicle weight, number of panicles $hill^{-1}$, grain yield fed^{-1} and harvest index. While hulling (%), milling (%) and head rice (%) were higher with application 60 kg N fed^{-1}.

Badawi (2002) found that increasing nitrogen rate from 0 to 144 kg N ha^{-1} recorded the largest leaf area, tallest plants and panicles, harvest index, 1000-grain weight, maximum number of panicles m^{-2} and highest percentages of filled and unfilled grains as well as produced the highest grain yield of rice

Balasubramanian (2002) studied the effect of N-levels (0, 150, 200 and Soil Test Crop Response (STCR)-based N) and time of application (3 or 4 splits) of nitrogen on 'CORH 1' hybrid rice (*Oryza sativa*, L.). Hybrid rice recorded good response to N up to 256.7 kg ha^{-1} (STCR-based N). Higher levels of N improved the growth and yield of rice. The STCR-based N applied in 4 splits (basal, active tillering, panicle initiation and panicle emergence) registered the maximum grain yield, followed by 200 kg N ha^{-1} applied in 4 splits.

Chettri et al. (2002) studied the effect of N, P and K on yield and yield component of rice under intensive cropping sequence. The highest number of effective tillers, grains per panicle, percentage of filled grains, 1000-grain weight and grain yield of rice were obtained with the application of 60 kg N, 30 kg P_2O_5 and 30 kg K_2O ha^{-1}. They reported that the addition of potassium through K_2O significantly improved the yield components and grain yield of rice compared to application of N and P only.

El-Rewainy (2002) studied the effect of different nitrogen fertilizer sources on yield and some agricultural characters in rice. He found that increasing nitrogen levels from zero up to 60 kg N fed^{-1} significantly increased number of tillers hill^{-1}, plant height, panicle length, number of panicles hill^{-1}, number of filled grains panicle^{-1}, panicle weight, grain and straw yield; While, 1000-grain weight was decreased. However, harvest index didn't show any significant increased by increasing nitrogen levels in both seasons. Also, he found that the highest percentages of brown, milled and head rice were detected by applying 40 kg N fed^{-1}. Applying 60 kg N fed^{-1} led to the highest grain protein%.

Satyanarayana et al. (2002) reported that application of 120:60:45 kg N: P_2O_5: K_2O ha^{-1} increased rice grain yield, straw yield, tiller number and number of filled grains per panicle compared with the lower rate 80:40:30 and high rate 160:80:60 N: P_2O_5:K_2O ha^{-1}. The increased grain yield was due mainly to increased nutrient uptake and number of tillers, filled grains per panicle and 1000-grain weight.

Tang and Yu (2002) studied the effects and mechanisms of P and K nutrients on protein content of rice through pot experiment and biochemical analysis. The results showed that the increase of phosphorus and potassium nutrients enhanced the activities of PEP carboxylase (PEPC), glutamine synthase (GS) and sucrose phosphate syntheses (SPS) in leaves, sucrose synthase (SS), ADP glucose pyro phosphorylase (ADPGP) and GS in grains and the chlorophyll content in leaves, soluble sugar and starch content in grains. However, they decreased soluble sugar content in leaves and led to an increase of protein content in brown rice, biomass, grain and harvest index. Excessive phosphorus nutrients slightly reduced SPS and ADPG activity in leaves and grains, respectively.

Abd El-Salam (2003) conducted an experiment to study the effect of some cultural treatments on rice yield and its components. He concluded that panicle length, panicle weight, number of filled grains/panicle, 1000-grain weight, grain yield, harvest index, hulling%, milling% and head rice% significantly increased as nitrogen levels increased up to 69 kg N fed^{-1}. Further increase (92 kg N fed^{-1}) could not show any significantly increased in all studied characters except plant height, plant dry weight and number of tillersm^{-2}. On the contrary, light penetration and harvest index significantly decreased with increasing nitrogen levels.

El-Shayb (2003) studied the effect of hill spacing, nitrogen levels and harvest date on rice productivity and grain quality, He illustrated that increasing nitrogen levels up to 80 kg N/fed resulted in marked increases in number of tillers m^{-2}, panicle length, panicle weight, number of filled grains panicle^{-1}, 1000-grain weight, grain and straw yields fed^{-1}, harvest index as well as hulling%, milling%, head rice% and grain protein percentages in both seasons. The addition of 60 or 80 kg N fed^{-1} recorded the tallest plants and the highest number of panicles m^{-2} without significant difference.

Maiti et al. (2003) found that application of nitrogen fertilizer up to 140kg ha^{-1} caused an increase in grains yield, number of panicles, number of filled grains per panicle and 1000-grain weight by rice.

Mauad et al. (2003) investigated the effect of nitrogen and silicon fertilization on rice, and reported that nitrogen fertilization increased the number of stems and panicles m^{-2}. Excessive tillering caused by inadequate nitrogen fertilization recorded the percentage of spikes fertility and grain mass.

Meena et al (2003) studied in a field experiment the productivity and economics of rice (*Oryza sativa, L.*) as influenced by nitrogen and potassium application. The experiment was laid out in split-plot design with 2 levels of nitrogen, viz 100 and 200 kg/ha, in main plots and 2 levels of potassium, viz 62.5 and 125 kg K/ha, applied full dose at transplanting, half at transplanting + half at maximum tillering and one-third at transplanting + one-third at maximum tillering + one-third at panicle emergence in subplots. One absolute control was kept with main plot as well as in subplot treatments along with 3 replications. An application of 200 kg N ha^{-1} significantly increased the plant height, total number of tillers, dry-matter accumulation, grain and straw yields, while 100 kg N ha^{-1} resulted in highest benefit: cost ratio of the crop. Significantly higher total number of tillers, dry-matter accumulation and grain yield, straw yield and benefit cost ratio of the crop were recorded with the application of 62.5 kg K ha^{-1} when applied in 2 equal splits (halt at transplanting + half at maximum tillering).

Raghuwanshi et al. (2003) studied the effect of different nitrogen levels (0, 40, 60, 80 and 100 kg N ha^{-1}) on grain yield and yield attributes of rice. The seedlings supplied with 80 kg N ha^{-1} recorded the maximum values for all the yield attributes (number of effective tillers $hill^{-1}$, panicle length, panicle weight and number of fertile grains $panicle^{-1}$), which resulted in the highest grain yield during both years.

Shivay and Singh (2003) studied the effect of nitrogen levels on growth, yield attributes, yield and nitrogen-use efficiencies of rice. Each unit increase in N level led to significantly increase in growth, yield attributing characters and yield of rice. The maximum grain yield was recorded with highest level of nitrogen. The maximum response was observed at 75 kg N ha^{-1} and thereafter it decreased with the increase in nitrogen level. The nitrogen use efficiency (NUE), apparent recovery (%), nitrogen efficiency ratio (NER) and physiological efficiency index of absorbed nitrogen (PEIN) were significantly higher at lower level of nitrogen and decreased significantly with increasing nitrogen levels.

Hu and Huo (2004) observed that potassium fertilizer application improved transfer of nitrogen and phosphorus from stems and leaves to panicles in rice plants. Nitrogen and phosphorus use efficiencies of rice were not strongly responsive to potassium application, but potassium use efficiency decreased significantly despite the fact that the amount of total potassium uptake increased.

Pariyani and Naik (2004) showed that increasing level of nitrogen (90-150 kg N ha^{-1}) significantly increased tiller $hill^{-1}$, leaf area index (LAI) panicle length and grain yield up to 150 kg N ha^{-1} in hybrid rice.

Upendra et al. (2004) showed that panicle length, grain yield, straw yield and harvest index were significantly increased with increasing fertilizer levels up to 150 kg N ha^{-1} and 80kg K ha^{-1}.

Ali et al. (2005) reported that the increase in rice grain and straw yield by potassium application might be attributed to more N utilization in the system resulting in more chlorophyll synthesis and efficient translocation of assimilates to reproductive parts.

Ebaid (2005) reported that increasing nitrogen level up to 220 kg ha^{-1} significantly increased number of days to heading, number of panicles m^{-2}, panicle length, grain and straw yields of Giza 182 rice cultivar. Applying 165 kg N ha^{-1} was adequate for plant height, number of grains $panicle^{-1}$, panicle weight, grain yield, harvest index and 1000-grain weight.

Jean and Matelle (2005) found that N_1 (80 kg N ha^{-1}) and N_2 (160 kg N ha^{-1}) amendments produced a significant higher rice yields than untreated plants. Application of N_1 led to increased straw dry weight. All the yield component increases due to N_2 nitrogen. The N_2 application induced spikelets sterility and grain filling disturbance due to excessive nitrogen availability increase of grain weight increase in nitrogen uptake ratio.

Mahtalat et al. (2005) studied the effect of nitrogen on different characteristics of transplanted local aman rice variety, Tatai. The levels of nitrogen used in this study were 0, 20, 40, 60 and 80 kg ha^{-1}. They observed that different agronomic characteristics varied significantly among the treatments, higher N dose produced higher plant height. The highest effective tiller hill^{-1}, panicle length, filled grains panicle^{-1}, 1000-grain weight and grain yield was obtained with 40 kg N ha^{-1}. The highest and lowest biological yield was produced with 40 kg N ha^{-1}and 0-kg N ha^{-1}, respectively.

Mingsheng et al. (2005) found that rice grain yield showed an increase trend with increasing N rate. However, there was no significant difference in rice yields between N_2 (150 kg N ha^{-1}) and N_3 (225 kg N ha^{-1}) levels.

Salama (2005) conducted a field experiment to study the effect of some cultural practices on rice crop. Number of panicles m^{-2}, number of unfilled grains ha^{-1}, number of filled grains panicle^{-1}, panicle weight and 1000-grain weight were significantly increased with raising nitrogen fertilizer from 72 to 120 kg ha^{-1}.

Singh and Singh (2005) find out the effect of nitrogen and silicon levels on growth, yield attributes and yield of rice in Alifisols, They found that increasing five nitrogen levels from 60 up to 180 kg N ha^{-1} significantly increased number of productive tillers hill^{-1} and straw yield hill in both seasons. While, number of grains panicle^{-1} and grain yield hill^{-1} were significantly increased as nitrogen levels increased from 60 up to 150 kg N ha^{-1} only, further, increase didn't show any significant during both seasons. Moreover, test weight didn't show any significantly effect during both seasons.

Bharat (2006) investigated the effect of phosphorus application on rice grain yield. He recognized that phosphorus application increased leaf area, grain and straw yields.

Dwivedi et al. (2006) evaluated the effect of nitrogen, phosphorous and potassium levels on yield and yield component of hybrid rice. The results showed that application of nitrogen and potassium increased grain yield and its attributes.

Manzoor et al. (2006) studied the appropriate level of nitrogen to get maximum paddy yield of rice variety (Super Basmati). They found that maximum paddy yield was obtained from 175 kg ha^{-1} nitrogen application treatment which also produced highest values of number of grains per panicle along with a maximum 1000- grain weight The plant height along with number of productive tillers per hill and panicle length was maximum at 225 kg N ha^{-1} level.

Rehman et al. (2006) studied the response of wheat and rice to different combinations of fertilizers and farmers practice in a farmer's field. Five treatments viz. farmers practice (FP), N alone, NP, NPK and 1/2 NP were studied in a permanent layout arranged in a randomized complete block design. The results showed a significant improvement in wheat grain (4.2 - 4.67 t/ha) and paddy (3.30-4.35 t/ha) yields during both the years with the application of recommended dose of NP. The response to K was also significant. Plant height and yield components like number of tillers and 1000-grain weight also increased with balanced fertilization (NPK). Significant higher phosphorus concentration was observed in wheat grain (0.34-0.45 percent), straw (0.16-0.20 percent), paddy (0.28-0.30 percent) and rice straw (0.16-0.17 percent). A significantly higher phosphorus uptake was also observed by wheat (24.11-34.89 kg/ha) and rice (17.44-24.56 kg/ha) with the recommended rate of NPK. Olsen extractable P built-up was observed in the soil after each crop where P was applied. The order of response was NP > NPK > FP > 1/2 NP > N alone.

Bahmaniar and Ranjbar (2007) indicated that nitrogen and potassium are the yield-limiting nutrients in rice production regions in Iran. Using of N and K efficient cultivars is an important complementary strategy in improving rice yield, increasing the quality properties of rice grains and reducing cost of production. They studied the effects of different amounts of N and K application on rice yield and yield components in pot and field conditions. Grain yield, number of grain per panicle, number of tiller, plant height, length of flag leaf, total and shoot dry matter, 1000-grain weight and harvest index have been increased by N application in field conditions. However, in pot conditions grain yield, number of grain per panicle, number of tiller, plant height, width of flag leaf, total and shoot dry matter, leaf nitrogen contents and harvest index have significantly been increased ($p <$ or $= 0.05$). Potassium application in field conditions has significantly affected on all characteristics except 1000-grain weight and leaf N and K contents. Simultaneous application of N and K have increasingly affected on grain yield, plant height, shoot dry matter and harvest index in field conditions and on plant height, length of flag leaf and shoot dry matter in pot conditions ($p <$ or $= 0.05$).

Hao et al. (2007) studied the effects of N fertilizer application on the concentrations of Fe, Mn, Cu and Zn in shoot of rice and the quality of brown rice. Results showed that the concentrations of those microelements in brown rice increased at first and then decreased with increasing N fertilizer application, reaching the highest at 160 kg ha^{-1}. N fertilizer promoted the accumulation of protein, decreased the accumulation of amylose in grain, and enhanced gel consistency of brown rice. These results indicate that appropriate N fertilizer management could increase micronutrient contents in grain and improve nutrition quality of rice.

Howlader et al. (2007) conducted an experiment at farmers' field to determine the response and to find out the optimum rate of nutrients (NPK) for Mungbean - rice cropping pattern. Different three levels of NPK with control were assigned. Average of three years study reveals that a considerable response of rice to N, P and K was observed. The response was more evident in rice compared to Mungbean. The results indicated that fertilizer nutrient dose that maximized yield of rice was 48-13-13 kg ha^{-1}.

Metwally (2007) studied the effect of N, P, K and Zn fertilizer rates on the productivity of rice cultivar Sakha 104. The phosphorus rates were 0, 18, 36 and 54 kg P_2O_5 ha^{-1}. He found application N, P and Zn gave the highest values for all studied characters i.e. plant height (cm), leaf area index, dry matter (g m^{-2}), number of panicles m^{-2}, number of grains $panicle^{-1}$, 1000 grain weight (g), filled grain percentage, panicle weight (g), grain yield (t ha^{-1}), straw yield (t ha^{-1}). Harvest index, hulling percentage, milling percentage, broken rice, protein content, nitrogen content in grain, nitrogen content in straw, phosphorus content in grain, phosphorus content in straw, potassium content in grain and potassium content in straw.

Mohammed (2007) in field trials studied the response of rice cultivar Sakha 104 to varying potassium levels, 0 and 48 K_2O fed^{-1}. He stated that 48 K_2O gave the highest values of dry matter accumulation (25.410 and 23.401 g $hill^{-1}$), leaf area index (3.555 and 3.302), plant height (96.18 and 94.2 cm), tiller number $hill^{-1}$ (19.329 and 16.631), number of panicles $hill^{-1}$ (20.036 and 17.886), filled grains $panicle^{-1}$ (135.7 and 134), unfilled grains% (5.434 and 5.835), 1000-grain weight (26.905 and 25.717 g), grain yield (9.059 and 8.654 t ha^{-1}), straw yield (11.459 and 11.057 t ha^{-1}), hulling % (83.050 and 83.226), milling % (71.497 and 71.634), head rice % (64.919 and 63.851) as compared to 0 K_2O, respectively.

Islam et al. (2008a) determined the response and the optimum rate of nutrients (NPK) for chili- rice cropping pattern under different levels of NPK with control. Average of three years' study reveals that a considerable response of chili and rice to N, P and K was observed. The results indicated that fertilizer nutrient dose that maximized yield of chili and rice were 119-97-92 kg/ha and 63-20-37 kg ha^{-1} NPK, respectively while 117-93-89 kg ha^{-1} NPK for chili and 60-19-36 kg ha^{-1} NPK for rice were in respect of yield and economics.

Islam et al. (2008b) find out the effect of nitrogen levels and transplanting dates on yield and yield components of rice. Four levels of nitrogen (0, 50, 100, and 150 kg N ha^{-1}) and three transplanting dates (10 August, 22 August and 04 September, 2007) were used They found that that most of the yield and yield contributing characters were significantly influenced by nitrogen levels and transplanting dates. They had significant positive effect on tillers $hill^{-1}$, grains $panicle^{-1}$ and straw yield. The highest grain yield was observed in 100 kg N $ha^{-1}$with 10 August transplanting treatment and straw yield was found highest in 150 kg N ha^{-1} with same date of transplanting and the lowest grain and straw yields were found in N control treatment with transplanting date of 4 September.

RRTC (2008) studied the grain yield of rice as affected by the application of phosphorus and potassium fertilizers. The phosphorus rates were 0, 23, 45 and 68 kg P_2O_5 ha^{-1}. The grain yield was significantly increased with increasing phosphorus rate up to 45 kg P_2O_5 ha^{-1}. The potassium fertilizer was tested in six different treatments i.e. T_1 (control "zero" K), basal all amount (50 kg k ha^{-1}), ½ basal + ½ top dressing at 25 days after transplanting, ½ basal + 2% spray at panicle initiation stage, 2% spray at panicle initiation stage and 2% spray at 15 days after transplanting + 20% spray at panicle initiation. The highest value of grain yield (11.45 t ha^{-1}) was found with ½ of recommended dose as a basal + spray with K_2SO_4 at the concentration of 2% at panicle initiation.

Artacho et al. (2009) carried out a field experiments in the major rice growing area of Chile to evaluate the effects of nitrogen fertilization rate from 0 to 300 kg N ha^{-1} and two experiments sites on grain yield and some yield components, dry matter production, N uptake and N use efficiency in rice cultivar "Diamante". They found that nitrogen fertilization increased rice grain yield, panicle density, spikelet sterility and dry matter production, and about 90% of maximum yield was obtained with 200 kg N ha^{-1}. The observed variation in N use efficiency indices between both sites would reflect the site, specific differences in temperature and solar radiation, which in turn, determined yield potentials of each site. On the basis of these results, rice cultivar "Diamante" would correspond to a high-N use efficiency genotype for grain yield.

Baba et al. (2010) reported that application of N to rice significantly increased plant height, number of tillers $hill^{-1}$, leaf area index, dry matter accumulation, number of panicles m^{-2}, number of grains $panicle^{-1}$ and grain and straw yield up to 120 kg N ha^{-1}. While, harvest index increased up to 90 kg N ha^{-1}.

Bahmanyar and Mashaee (2010) investigated the effects of different nitrogen rates (N) and potassium (K) top dressing on grain yield and yield components of rice. Nitrogen in the form of urea (46% N) at the rates of 0, 23 and 46 kg N ha^{-1} and potassium in the form of potassium chloride (60% K_2O) at the rates of 0, 30 and 60 kg K_2O ha^{-1} were used. Results indicated that panicle length, plant height, number of tiller, number of grain per panicle, grain and biological yield were significantly affected by N and K fertilization. Maximum grain yield (75.46 g pot^{-1}) occurred at 23 kg N ha^{-1} and 30 kg K_2O ha^{-1}.

Kandil et al. (2010) tested the mineral nitrogen fertilizer at different levels, 0, 48, 96,144 and 192 kg ha^{-1} to rice plants. There were marked increases in panicle length, panicle weight, number of filled grain $panicle^{-1}$,1000-grain weight and grain yield ha^{-1} associated with increasing nitrogen levels up to 192 kg N ha^{-1}.

Liao et al. (2010) studied the long-term effect of fertilizer application (NK, NPK, NP and CK (no fertilizer applied) on rice yield and potassium uptake. The negative yield change trends were observed in CK and NP and NK treatments of balanced nutrient application in case of omitted K and P. The positive yield change trends were observed in balanced application of NPK.

Chakraborty (2011) estimated the response of rice growth and yield to inorganic N fertilizer 20,40,60,80,100,120,140 kg ha^{-1}. Yield attributing characters differed considerably among treatments. Maximum panicle, effective tiller number hill^{-1}, filled grain number panicle^{-1}, tiller number hill^{-1}, leaf number hill^{-1}, leaf width was noted when the field was fertilized with 100 Kg N. No significant improvements of yield attributing characters, except the number of filled grains panicle^{-1}, were noted when the dose was over 100 Kg N ha^{-1}.

Fukushima et al. (2011) revealed that application of 160 kg N ha^{-1} produced the highest values of leaf area index, dry matter production at heading, number of panicles m^{-2}, number of spikelet panicle^{-1}, 1000- grain weight and grain yield m^{-2} of large grain type rice variety Bekouba.

Gorgy et al. (2011) reported that increasing of nitrogen levels to rice plant raised the main yield components, panicle number hill^{-1}, panicle weight, number of grain panicle^{-1}, 1000- grain weight, grain and straw yields as well as harvest index.

Hirzel et al. (2011) conducted a field experiment to determine the effect of N rates and split N fertilization on rice grain yield and its components in two locations. The rice grain yield increased with N rates higher than 120 and 140 kg N ha^{-1} for the two locations. Higher N rates increased the percentage of both stained and sterile grain per panicle.

Islam et al. (2011) showed that NPK briquettes gave higher rice grain yield than N control. There was no significant difference between N control and absolute control plots. NPK briquettes showed higher agronomic efficiency also there was no residual effect of NPK briquettes on soil chemical prosperities.

Javaid (2011) studied the effect of NPK fertilizer on rice growth and yield. Shoot length, number of tillers per plant and shoot biomass increased by adding NPK fertilizer it also effected on 1000- grain (g) weight and harvest index (%).

Metwally et al. (2011) evaluated the response of Egyptian Hybrid Rice 1 'H1' to nitrogen fertilizer beside the determination of N use efficiency and N uptake by rice grain and straw. Nitrogen levels were 0, 50, 100, 150, 200, 250, 300, 350, and 400 kg N ha^{-1}. They observed that nitrogen fertilization significantly increased grain yield. The maximum grain yield was obtained with the application of 200 kg N ha^{-1}. Yield components were also significantly affected by N treatments. Increasing N level up to 200 kg N ha^{-1} increased N use efficiency. Further, increasing the N levels decreased nitrogen use efficiencies.

Petroudi et al. (2011) determined the effect of nitrogen fertilizer application on agronomic rice yield indices at different dates. Three levels of N (0, 35 and 70 kg ha^{-1}) were used. The application of 70 kg N ha^{-1} yielded the highest rice grain, days to 50% heading and harvest index. Qualitative traits such as gelatinization temperature (GT) and protein content (PC) increased with large amount of N. But amylose content (AC) and gel consistency (GC) were not affected.

Bagayoko et al. (2012) determined the effect of different levels of organic fertilizer on growth, yield and yield components of rice. Good yield can be obtained using addition of mineral fertilizer still increase rice yield.

Bera and Pramanik (2012) reported that application of nitrogen at 150 kg ha^{-1} resulted in a significant panicle weight, grain yield and harvest index, whereas 200 kg ha^{-1} showed maximum plant height, number of tillers $hill^{-1}$, number of effective tillers $hill^{-1}$ a straw yield of rice.

Devi et al. (2012) studied the different nitrogen managements to improve nutrient uptake, yield and quality parameters of scented rice. The results concluded that yield attributes of scented rice responded up to 150 N kg ha^{-1} with four equal splits. Grain and straw yields obtained higher values with highest level of nitrogen *i.e.* 175 kg ha^{-1} comparable with 150 kg ha^{-1}. Grain quality parameters milling percent, head rice recovery, kernel length, breadth, amylose content and protein content of rice registered significantly highest values with 150 kg N ha^{-1}.

El-Refaee (2012) found that dry matter, LAI, plant height and grain yield of rice and most of its attributes, as well as protein content were significantly enhanced by the application of 100% NPK, along with rice straw compost at 2 t ha^{-1}, which was at per with 100% NPK and 75% NPK+2 t ha^{-1} rice straw compost. Under all irrigation regimes, application of NPK fertilizer, either alone or with rice straw compost, recorded high grain yield. It was concluded that addition of 75% NPK, along with rice straw compost at 2 t ha^{-1} for reasonable grain yield and high water productivity (WP), could decrease chemical fertilizer input by 25% from the present recommended application without decreasing rice grain.

Hasanuzzaman et al. (2012) conducted a field experiment at Sher-e-Bangla Agricultural University, Dhaka to study the response of rice to different levels of nitrogen and phosphorus. At harvest, maximum effective tillers $hill^{-1}$ (13.63), filled grains $panicle^{-1}$ (154.67), 1000-grain weight (29.35 g), grain yield (9.42 t ha^{-1}) and straw yield (13.33 t ha^{-1}) were obtained by application of 160 kg N fed^{-1} of urea super granules. About 10% more grain yield was measured from urea super granules than prilled urea. Phosphorus at the rate of 50 kg P_2O_5 gave the highest grain yield (7.85 t ha^{-1}). The interaction effect showed that the application of N-fertilization rate of 160 kg N ha^{-1} along with P-fertilization rate of 50 kg P_2O_5 gave the highest grain yield of (9.83 t ha^{-1}).

YosefTabar (2012) investigated the effect of nitrogen and phosphorus fertilizer on growth and yield in rice cultivar Tarom Hashemi. Nitrogen fertilizer at 50,100 and 150 kg N ha^{-1} was main plot and phosphorus fertilizer at four levels 0 (control), 30, 60 and 90 P_2O_5 kg ha^{-1} as sub plot. The results showed that tiller number, fertile tiller, total grain, 1000-grain weight and yield increased significantly with nitrogen and phosphorus fertilizer. Interesting in comparison to 50 and 100 kg ha^{-1} level application of higher N-fertilizer 150 kg ha^{-1} showed a positive respond to application of high nitrogen for Taroom Hashemi cultivar.

Debnath et al. (2013) carried out an experiment at the field to assess the comparative advantages of using Urea Super Granule (USG) and NPK briquette over normal urea, Triple super phosphate and Muriate of Potash. The effect of different levels of fertilizer was studied on growth, yield and yield attributing character of T. aman. Six fertilizer Treatments (F0= Control (No urea), F1 = Total urea (150 kg ha^{-1}) during land preparation at available tide free time, F2 = Urea (75 kg ha^{-1}) at 2 split, F3 = Urea (50 kg ha^{-1}) at 3 split, F4= Urea Super Granule (54 kg N ha^{-1}) at 10 days after transplanting and F5 = NPK briquette (42Kg N ha^{-1} 9 Kg P ha^{-1} 12 Kg K ha^{-1}) at 10 days after transplanting of T. aman rice). Besides, TSP, MOP, zinc sulphate and gypsum were applied at 100, 70, 50 and 12 kg ha^{-1} respectively as basal dose. The analysis revealed that different fertilizer management practices with a few exceptions significantly influenced the growth، yield and yield attributes of the T. aman rice. Plant height, number of effective tillers $hill^{-1}$, number of non-effective tillers hill^{-1}, panicle length (cm), number of grains panicle^{-1}, number of sterile spikelets panicle^{-1}, nitrogen use efficiency،(%) straw yield (t ha^{-1}) and grain yield (t ha^{-1}) were found highest when NPK briquette was applied and all the characters showed lowest value when control.

Hatamifar et al. (2013) performed an experiment to study the effects of irrigation techniques and application of nitrogen and potassium on rice cultivar (Nitrogen in three concentrations (control, 60 and 90 kg N ha^{-1}) from urea source). Results indicated that the influence of nitrogen on grain yield, straw yield, plant height, fertile tiller number m^{-2} and Panicle length was significant. Maximum yield and yield components were achieved by applying 90 kg ha^{-1}.

Kamruzzaman et al. (2013) studied the response of rice to nitrogen fertilizer (0, 40, 80 and 120 kg N ha^{-1}). They found that the highest values of tillers hill^{-1}, effective tillers hill^{-1}, panicle length, no. of grains panicle^{-1}, grain yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest index were obtained with the application of 120 kg N ha^{-1}.

Maqsood et al. (2013) found that transplanted rice gave a significantly higher paddy yield of 19.18 % versus direct-seeded crop. The rice kernel characteristics were also affected by culture methods and nitrogen levels. In addition, return variable cost in the transplanted rice increased by 22.27% over direct-seeded rice. Regarding quality, the amylose (24.35%) and protein (8.56%) contents were also higher in transplanted rice as compared to direct seeding at 100 kg N ha^{-1} application. The nitrogen rate and culture method also affect the chlorophyll contents positively in transplant rice at higher level of nitrogen relative to direct seeded rice.

Pramanik and Bera (2013) investigated the optimization of nitrogen levels under different age of transplanted seedlings on growth, chlorophyll content, yield and economics of rice. Fifteen treatment combinations consisted of three levels of seedlings age (10, 20 and 30 days) and five levels of nitrogen viz. N_0, N_{50}, N_{100}, N_{150} and N_{200} kg ha^{-1} were used. Nitrogen fertilizer had marked effect on all the growth, chlorophyll content and yield attributing traits. Among of the nitrogen levels N200 kg ha^{-1} gave significant higher plant height, Number of tillers $hill^{-1}$, total chlorophyll content, panicle length and straw yield and nitrogen levels N_{150} kg ha^{-1} gave significant higher Number of effective $tillers^{-1}$, effective tiller index, panicle weight, filled grain $panicle^{-1}$, 1000 grain weight, grain yield, and harvest index as compared to N_0, N_{50}, N_{100} during both years. N_{150} kg ha^{-1} produced significantly highest grain yield of 6286 and 6652 kg ha^{-1} in 2010 and 2011, respectively. The percentage of grain yields an increase of 72.5, 44.4, 23.8 and 5.1 percent in first year and 69.9, 44.1, 22.1 and 3.5 per cent in second year over N_0, N_{50}, N_{100} and N_{200} kg ha^{-1} respectively.

Saba et al. (2013) indicated that efficient plant nutrition management enhances and sustains agricultural production and safeguards the environment. An experiment to improve synthetic fertilizer efficiency through bio-fertilizer (BF) application in rice was conducted. The treatments consist of the combinations of bio-fertilizer (0 and 500 kg ha^{-1}), nitrogen (60, 120 kg N ha^{-1}) and phosphorous (45 and 90 kg P_2O_5 ha^{-1}). The results showed that combination of bio-fertilizer, nitrogen and phosphorous (500: 120: 90 kg ha^{-1}) exceeded all other treatments in number of tillers m^{-2}, number of panicles m^{-2}, number of spikelets $panicles^{-1}$, percent normal kernels, 1000-grain weight (g) and paddy yield (t ha^{-1}).

Sarker et al. (2013) reported that the economic rate of nutrients was determined with eight different fertilizer treatment applied on T. aman rice. The treatment combinations were: T1 (N64 P14 K28 S6 Zn1), T2 (N80 P14 K28 S6 Zn1), T3 (N80 P17.5 K28 S6 Zn1), T4 (N80 P14 K35 S6 Zn1), T5 (N64 P17.5 K35 S6 Zn1), T6 (N80 P17.5 K35 S6 Zn1), T7 (N48 P10.5 K21 S4.5 Zn0.75), and T8 (control). Grain and straw yields were significantly affected by the application of fertilizers at different rates. Results revealed that the average highest grain was recorded in T6 (N80 P17.5 K35 S6 Zn1) treatment and straw yield was recorded in treatment T3 (N80 P17.5 K28 S6 Zn1) which is 132.54% and 86.06% respectively higher over control treatment. The second highest grain yield was obtained in T3 treatment and straw was recorded in T6 treatment. Average nutrient uptake (grain and straw) was the highest in T3 treatment.

YosefTabar (2013) studied out the effect of nitrogen rates and split application on panicle structure and yield in rice. Nitrogen rates were (100, 200 and 300 kg N ha^{-1}) at three split applications. The results showed that that panicle number, panicle length, panicle dry matter, number of primary branches, total grain and grain yield, increased significantly with nitrogen fertilizer, application or 300 kg N ha^{-1} observed high rate of these parameter.

Uddin et al. (2013) studied the influence of nitrogen and potassium on the yield response of NERICA 1 rice, The experiment encompassed five levels of nitrogen viz., 0, 20, 40, 60 and 80 kg N ha^{-1} and four levels of potassium viz. 0, 20, 40 and 60 kg K_2O ha^{-1}. Results revealed that application of nitrogen at 80 kg ha^{-1} produced the highest number of total spikelets and maximum number of grains $panicle^{-1}$ resulted in the highest grain yield. In case of potassium, the highest number of total tillers and effective tillers, maximum number of total spikelets and grains panicle^{-1} resulted in the highest grain yield from 40 kg K_2O ha^{-1}.

Bi et al. (2014) investigated in a long-term (33 years) experiment the effect of chemical fertilization on rice yield, yield trends, soil properties, agronomic efficiency of applied nutrients and nutrient balance for the double rice cropping systems in subtropical China. The treatments were different combinations of N, P and K fertilizers (N, NP, NK and NPK), double dose of recommended NPK (2NPK) and no fertilizer control (control). Compared with no fertilizer control, all fertilization treatments had no significant effects on soil pH and SOC contents ($P > 0.05$), but generally increased nutrients content when corresponding elements were applied. The impact of fertilizers on grain yields was 2NPK > NPK > NP > NK > N, and application of P fertilizer not only increased the rice yield, but improved yield stability. The trend of agronomic use efficiency of applied P was significantly positive ($P < 0.05$) only for the first rice crop, suggesting that P fertilizer played a less important role in the second rice season than in the first rice season. The study indicated that the current local fertilizer recommendations should be optimized for the consideration of differences in indigenous nutrient supplies in different rice seasons.

Duan et al. (2014) reported that improving nitrogen use efficiency (NUE) and decreasing N loss are critical to sustainable agriculture. They investigated the effect of various fertilization regimes on yield, NUE, N agronomic efficiency (NAE) and N loss in long-term (16- or 24-yr) experiments carried out at three rice-wheat rotation sites subtropical China. Three treatments were examined: sole chemical N, phosphorus (NP), and NP+potassium (NPK) fertilizations. Grain yields at three sites were significantly increased by 9.3-81.6% (rice) and 54.5-93.8% (wheat) under NP compared with N alone, 1.7-9.8% (rice) and 0-17.6% (wheat) with NPK compared with NP. No changes in NUE were observed in rice between NP and NPK at all three sites. They estimated that an uptake increase of 1.0 kg N ha^{-1} would increase 40 kg rice and 30 kg wheat ha^{-1}. Nitrogen loss/input ratios were ~60, ~40 or ~30% under N, NP or NPK at three sites, indicating significant decrease of N loss by P or PK additions. They attributed part of the increase in NUE soil N accumulation which significantly increased by 25-55 kg ha^{-1} yr^{-1} under NPK at three sites.

Murthy et al. (2015) conducted a field experiment on rice for three consecutive *rabi* seasons with an objective to revise the existing fertilizer doses of major nutrients for *rabi* rice in Krishna Godavari delta regions of Andhra Pradesh, India. Grain yield was increased by 11.5% and 6.3% due to increase in recommended dose of N from 100% (120 kg ha^{-1}) to 125% and 150%. Increase in P & K doses from 100 to 125% (P from 60 to 75 and K from 40 to 50 kg ha^{-1}) also improved grain yield significantly. Agronomic efficiency of N P and K was progressively increased with incremental doses of respective nutrients. Energy use efficiency of K is remarkably high particularly with first increment (4.87) followed by P and N. Highest gross returns, net returns and rupee per rupee invested were recorded with application of NPK 210-60-40 kg ha^{-1}. Incremental doses of N, P and K over the recommended dose recorded significant improvement in uptake of respective nutrients. Grain quality, milling characters were significantly influenced by incremental doses of N P & K. While considering the economics, nutrient depletion and quality parameters, application of N 180-

90-60 kg ha^{-1} appears to be the most optimum dose for *rabi* rice in deltaic alluvial soils of Andhra Pradesh.

Hashem et al. (2016) reported the effect of growth regulators application at different nitrogen levels on lodging and productivity of rice cultivar Sakha 102. Leaf area index at 50 days after transplanting (DAT), plant height (cm) at harvest, number of panicles m^{-2}, grain yield t ha^{-1} and NPK uptake were correlated significantly and positively with lodging area percentage while 1000- grain (g) correlated significantly and negatively with lodging area percentage.

B: Genotypic variations in nitrogen, phosphour and potassium response:

Bhowmick and Nayak (2000) studied the performance of two hybrids and two high-yielding cultivars of rice at 5 levels of NPK fertilizer (0:0:0, 120:60:60, 150:75:75, 180:90:90) + 30 $ZnSO_4$ kg ha^{-1}. Grain and straw yields increased with increasing level of nutrition for hybrids up to a rate of 180:90:90 +30 ZnSO4 kg ha^{-1}, and for high-yielding cultivars up to 120:60:6.

Hari et al. (2000) studied the effect of 5 nitrogen levels (0, 50,100,150 and 200kg N ha^{-1}) on grain yield and yield components of tow rice varieties. The highest values for grain yield and its attributes were obtained with 200 kg N ha^{-1}.

Singh et al. (2000) investigated the effect of planting time and nitrogen fertilizer on production potential of Basmati rice varieties. They found that increasing nitrogen levels from 60 to 100 kg N^{-1} significantly increased number of panicles m^{-2}, number of grains $panicle^{-1}$, 1000-grain weight, grain yield and straw yield while panicle length significantly increased only up to 80 kg N ha^{-1}. The tested rice varieties showed a significant difference in their response to nitrogen fertilizer.

Ibrahim (2001) studied the effect of nitrogen and phosphorus on yield and yield components of three rice cultivars. The treatments consisted of four nitrogen levels (0, 50, 100 and 150 kg N ha^{-1}), three phosphorus levels (0, 20 and 40 kg P ha^{-1}) and three rice cultivars. The parameters assessed in the study were number of panicles per hill, number of spikelet per panicle, number of grains per panicle, 1000-grain weight and paddy yield. The results of the combined analysis for the two years showed that the 100 and 150 kg N ha^{-1} treatments were at a par and significantly better than 50 kg N ha^{-1} which was also better than the control treatment in all the parameters assessed.

Mohammed et al. (2001) investigated the influence of nitrogen on grain yield and quality traits of scented rice varieties under normal and late planting. They recorded that yield increased by 22, 46 and 49 % with 50, 100 and 150 kg N ha^{-1}, respectively, over the control however quality characters were not affected by nitrogen rates.

Nagappa and Biradar (2002) determined the response of four rice cultivars to different levels of nutrient application under wet land conditions. Treatment without nitrogen, phosphorus and potassium served as the control. Application of 150:80:50 NPK kg ha^{-1} recorded the highest grain (8589 kg ha^{-1}) and straw yields (10528 kg ha^{-1}). The highest grain and straw yields were mainly attributed to the highest number of tillers per hill, number of panicles per hill and plant height. The control treatment recorded the lowest grain (2510 kg ha^{-1} and straw yields (3972 kg ha^{-1}), and related yield parameters.

Singh and Singh (2002) stated that plant height, panicles number m^{-2}, panicle length, number of grains $panicle^{-1}$, grain and straw yield of different rice cultivars significantly responded to nitrogen fertilizer application up to75kg N ha^{-1}. The heaviest weight of 1000-grain was obtained by nitrogen fertilizer rate of 50 kg N ha^{-1}.

Tunio et al. (2002) determined the performance of two rice cultivars under different nitrogen rates (0, 30, 60, 90, 120 and 150 kg N ha^{-1}). They reported that nitrogen rates of 60 and 90 kg N ha^{-1} proved to be the best among the rates evaluated in terms of productive tillers, filled grains $panicle^{-1}$, number of panicles m^{-2}, harvest index and grain yield.

El-Siginy (2004) conducted field experiments to study the effect of some agronomic practices on growth, yield and quality of some rice varieties. He found that increasing nitrogen levels up to 120 kg N fed^{-1} significantly increased number of days to heading, plant height, panicle length, number of tillers m^{-2}, number of panicles m^{-2}, and grain yield. Meantime, hulling% and milling percentage were significantly increased at 80 kg N fed^{-1}. Only one thousand grain weight was not affected by increasing nitrogen levels.

Kumar and Prasad (2004) showed that N uptake and apparent recovery (AR) of applied N was significantly higher with hybrid rice PRH3 than with high yielding variety (HYV) Pusa 834. Nitrogen uptake increased significantly with each successive level of N uptake up to 180 kg N/ha, however, AR declined with each successive level in HYV Pusa 834. With hybrid PRH3 the AR increased as the level of N was raised from 60 to 120 kg ha^{-1} and declined only when it was increased to 180 kg N ha^{-1}. Hybrid PRH3 utilized applied N more efficiently.

Salama (2004) evaluated agronomic and quality characters of rice varieties as affected by nitrogen fertilization. He indicated that increasing nitrogen levels up to 150 kg N ha^{-1} significantly affected number of ear-bearing tillers m^{-2}, panicle weight, number of filled grains $panicle^{-1}$, filled grains weight $panicle^{-1}$, 1000-grain weight, grain yield and protein content%. While, plant height, panicle length, heading date, grain shape, hilling, total milled rice%, transparency and gel consistency were not significantly affected by different nitrogen levels.

Singh et al. (2004) studied the effect of nitrogen levels (0, 60, 120 and 180 kg N ha^{-1}) on yield, nutrient accumulation and nitrogen use efficiencies (NUE) of two rice cultivars. Nitrogen levels had a significant effect on yield attributes (panicles $hill^{-1}$, panicle weight, filled grains $panicle^{-1}$, except 1000-grain weight), yield and nutrient accumulation up to 120 kg N/ha. The maximum grain yield was recorded at the highest level of nitrogen nutrition (180 kg N ha^{-1}) and was (4.2, 15.5 and 39.3%) higher than in the (120, 60 and 0) kg N/ha treatments, respectively.

Debanumaiti and Kdas (2005) observed that in a field experiment, which conducted during 2001-2002 and 2002-2003 on rice in rainy season (Kharif), the highest grain yield was recorded in the treatment where recommended levels of N, P, K, Zn and farmyard manure were applied. The fertility builds up to in soil in relation to organic C, N, P, K and Zn content were [(0.05-0.09%), (1.73-7.19), (1.2-3.5), (2.08-5.17) kg ha^{-1}] and [0.01-0.09 mg/kg] in growing rice, respectively.

Ebaid and El-Rewiny (2005) indicated that increasing nitrogen level up to 138 kg N ha^{-1} significantly increased number of days to heading, plant height, while 115 kg N ha^{-1} was adequate for yield and its components (number of productive tillers hill^{-1}, panicle weight, number of filled grains panicle^{-1}, straw and grain yields,1000- grain weight and harvest index). Giza 178, Sakha101 and Egyptian Jasmine recorded the highest values of agronomic efficiency under 115 kg N ha^{-1}. There was a significant effect due to the interaction between nitrogen levels and rice cultivars on panicle weight and grain yield.

Mhaskar et al. (2005) studied the effect of different N-levels (0 ,40, 80 and 120 kg ha^{-1}) on leaf area index and yield of four rice varieties. Results showed significantly increase leaf area with increasing the rate of N from 0 to 120 kg ha^{-1}. A similar trend was observed for LAI. Application of N at 120 kg ha^{-1} recorded the highest grain and straw yield.

Reis et al. (2005) studied the effects of N fertilizer (urea) rate (100, 200, 400 or 800 mg kg^{-1} of soil) on yield and nutrient (N, P and K) uptake by three rice cultivars (Capivari, Inca and Sapucai). The N fertilizer was applied at 10, 30 and 40 days after emergence using 30, 30 and 40% of the total rate, respectively. Capivari recorded the greatest N uptake and grain yield among the cultivars, suggesting that Capivari was the most efficient in N use. N at 800 mg N kg^{-1} of soil was not enough for Capivari to reach its maximum yield. Sapucai was inferior in terms of N use efficiency.

RRTC (2005) investigated the effect of five nitrogen levels on grain yield of five rice cultivars of rice namely; Giza 177, Giza 178, Sakha 104, Hybrid 3 and Hybrid 4. The results showed that increasing nitrogen levels up to 80 kg N fed^{-1}significantly increased grain yield of the inbred varieties; Giza 177, Giza 178, Sakha 104. While the Hybrid 3 and Hybrid 4 was significantly increased only at 100 kg N fed^{-1}.

Zayed et al. (2006) studied the response of some inbred cultivars and hybrid rice (SK2034H, SK2025H, SK2058 Giza 178 and Sakha 104) to various nitrogen levels (0, 60, 120, 180 and 240 kg N ha^{-1}). They determined growth, yield, yield attributes and nitrogen use efficiencies of the tested rice varieties under the mentioned nitrogen levels. Hybrid rice of SK2034H surpassed other tested rice cultivars, whereas SK2034H had higher nitrogen-use efficiency than inbreeds. They also found that, increasing nitrogen levels significantly improved growth, yield attributes, grain and straw yields. The maximum grain yield was produced with the addition of 240 kg N ha^{-1} recorded by SK2034H.

Abd-El-Maksoud (2008) studied the effect of different nitrogen fertilization levels and its splits on growth and yield of three rice cultivars. The tested cultivars were Giza 178, Sakha 103 and Sakha 104. Two nitrogen fertilizer levels 40 and 60 kg were splited and applied at two, three and four equal doses. The results revealed that all rice cultivars differed in their growth, grain yield components and quality characters. Sakha 103 was the superior in most characters and Sakha 104 in the second order. Increasing nitrogen fertilization levels from 40 to 60 kg N fed^{-1} increased the most yield components which led to significant increase in grain yield fed^{-1}. Meantime, rice grain quality was improved significantly with increasing nitrogen fertilizer level. Increasing of splitting N caused significant increases in growth, yield and yield components.

El-Nory (2008) studied the effect of nitrogen levels and compost on yield and grain quality characters of rice cultivars *i.e.* Sakha 101, Sakha 102, Sakha 103, Sakha 104, Giza 177 and Giza 182. Application of 80 kg N fed^{-1} laid to significantly increasing of plant height, number of day to heading, grain shape in both seasons. Moreover, grain and straw yields, for all tested rice cultivars, were ranged from 2.8 to 5.8 t ha^{-1} and 3.5 to 7.5 t ha^{-1}, respectively.

Alam et al. (2009) studied the effect of phosphorus application on hybrid and inbred rice at the rate of 0, 24, 48, 72 and 96 kg P_2O_5 ha^{-1}. They recognized that application of 72 kg P_2O_5 ha^{-1} increased dry matter production, panicle number, plant height, panicle length, panicle weight, filled grains $panicle^{-1}$, grain and straw yield.

Shaalan (2009) conducted two field experiments during the two growing seasons 2005 and 2006 to determine the effect of four nitrogen fertilizer levels; zero, 40, 60 and 80 kg N fed^{-1} on six rice cultivars *i.e.*, Sakha 101, Sakha 102, Giza 182, Hybrid 1, Alex 1 and Alex 2. Results showed insignificant interaction between rice cultivars and N-levels on both hulling and milling percentage but highly significant on whiteness percentage, chalky grains percentage, grain yield (t fed^{-1}) and panicle weight.

Chandel et al. (2010) analyzed the effect of nitrogen application level and native soil properties on rice grain protein, iron and zinc contents. About 32 rice genotypes were grown in three different locations each under 80 and 120 kg N ha^{-1} N fertilizer applications. The results showed that in the treatments with N fertilizer application, the brown rice grain protein content increased significantly (1.1% to 7%) und higher N-fertilizer application (120 kg N ha^{-1}) whereas grain Fe/Zn levels showed non. significant effect of N applied level. Soil property and organic matter contents increase the avail ability of Fe and Zn in rice rhizosphere, which in turn enhances the uptake, translocation and redistribution of Fe/Zn ratio into rice grains.

Gorgy (2010) studied the impact of four nitrogen level; viz, 0, 110, 165 and 220 kg N ha^{-1} on three varieties (hybrid and inbred). He reported that increasing nitrogen level up to 220 kg N ha^{-1} (highest nitrogen level) recorded the highest values for dry matter production, leaf area index, chlorophyll content, days to 50% heading, plant height, number of panicles m^{-2}, panicle weight, number of filled grains $panicle^{-1}$ and straw yield. While, application of 165 kg N ha^{-1} was the optimum nitrogen level for obtaining the maximum 1000-gran weight and grain yield.

Hartinee et al. (2010) determined N, P, K requirements of three rice varieties using four response models in a greenhouse experiment. Five levels of each nutrient were used (N:0-200 kg N ha^{-1}, P:0-120 kg P_2O_5 ha^{-1} and K:0-150kg K_2O ha^{-1}). Grain yield of the rice varieties responded up to 100kg N ha^{-1}, 60kgP_2O_5 ha^{-1} and 120 kg k2o ha^{-1}. addition of N, P and k fertilizers increased the grain yield of all studied varieties with the value ranging from 7 to 22 g $hill^{-1}$ for N,6 to 18 g $hill^{-1}$ for P and from 9 to 22 g $hill^{-1}$)

Hossain et al. (2010) evaluated grain yield and protein content of transplanted *aman* rice as influenced by variety and rate of nitrogen. The experiment consisted of five varieties and four rates of nitrogen viz. 0, 40, 80 and 120 kg ha^{-1}. The tallest plant (131.7 cm) was obtained from 80 kg N ha^{-1}, which was identical with 120 kg N ha^{-1}. Variety showed significant effect on all the yield contributing characters and yield except panicle length. Results revealed that all the characters were significantly influenced by rate of nitrogen except panicle length and weight of 1000 grains. Grain protein content was highest from 80 kg N ha^{-1}. The effect of interaction between variety and rate of nitrogen showed that the highest grain yield was obtained from BRRI dhan39 (4.90 t ha^{-1}) with 120 kg N ha^{-1}. Results showed that the variety BRRIdhan39 produced the highest grain yield and 80 kg N ha^{-1} appeared to be the best nitrogen rate in respect of yield and grain protein content of rice.

Zhang et al. (2010) reported that potassium (K) imbalances are of growing concern in southern China, where rice (*Oryza sativa*, *L.*) is the primary food resource for a growing population. They examined rice yield, K uptake and apparent balance under long-term fertilization in rice-based systems at four experimental sites, including both rice-rice as well as rice–wheat rotations. The experiments consist of four treatments: control (no fertilizer), nitrogen and phosphorus (NP), nitrogen, phosphorus and potassium (NPK), and NPK plus manure (NPKM). Across all sites, rice yields increased by 3–20% due to K fertilization (NPK vs. NP) and 4–20% due to manure application (NPKM vs. NPK). The mean internal K use efficiency (IE) was lower in treatments receiving K (NPK and NPKM) than in those without K application. The higher negative apparent K balances under rice–wheat cropping system were related to the lower K application rate and the soils rich in K-bearing minerals, while the lower negative apparent K balances under rice–rice cropping system were related to the higher K application rate and the soils low in K-bearing minerals.

Mannan et al. (2010) tested four rice genotypes under 0, 25, 50, 75 and 100 kg N ha^{-1} to determine the optimum N level as well as to find out the genotype having high yield potential. The plant height, tiller number, number of panicles, panicle length, spikelet sterility and straw yield increased with the increase of nitrogen levels up to 75 kg N ha^{-1}. Maximum plant growth at the highest level of N caused lodging of plant which increased spikelet sterility and lower number of grains per panicle and ultimately decreased grain yield.

Metwally et al. (2010) studied the physio-morphological behaviors of some rice genotypes under low and high nitrogen application. Twenty-one genotypes i.e. ten Japonica/ Japonica, six japonicas/ japonica and five indica japonica/indica japonica were tested under three different nitrogen levels *i.e.* 0, 75, and 150 kg N ha^{-1} for ten traits; flag leaf area, chlorophyll content, days to heading, panicle weight, number of filled grains $panicle^{-1}$, number of panicles/plant, 1000-grain weight, grain yield t ha^{-1}, grain yield efficiency index (GYEI) and nitrogen use efficiency (NUE). The genotypes were divided into three groups *i.e.* japonica/japonica (J/J), japonica/indica japonica (J/IJ) and indica japonica/ indica japonica (IJ/IJ). Genotype No. 17 (GZ6296 x Giza 178 (IJ/IJ)) and genotype No. 19 (GZ6269 x Giza 178 (IJ/IJ)) gave the highest values of number of filled grain/panicle and number of panicles/hill under low input of nitrogen. Giza 177/Sakha 101 and Giza 176/GZ6944 (J/J) gave the highest values of grain yield under low input of nitrogen followed by the genotypes derived from (GZ6296 x Giza 178 (IJ/IJ)).

Sheta (2010) stated that increasing nitrogen level from 96 to 192 kg N ha^{-1} significantly increased chlorophyll content, dry matter production, crop growth rate, leaf area index, days to 50 % heading, plant height, number of tillers m^{-2}, number of panicles m^{-2}, total grains $panicle^{-1}$, panicle length, panicle weight, 1000- grain weight, grain yield, straw yield, hulling, milling, head rice and grain protein content of different hybrid and inbred rice varieties. On the other hand, harvest index was reduced with increasing nitrogen level.

Hammoud et al. (2011) showed that nitrogen fertilizer treatments had a significant and positive impact on yield and yield components of some promising lines. Increasing nitrogen level up to 165 Kg ha^{-1} significantly increased panicle number m^{-2} and grain yield. While nitrogen rate of 110 kg ha^{-1} gave the maximum number of filled grains $panicle^{-1}$. Couple nitrogen rate of zero and 165 Kg N ha^{-1} were comparable in unfilled grain numbers. The highest nitrogen level (165 kg N ha^{-1}) increased the grain yield by about 50% over that of zero nitrogen application. The obtained improvement in the yield attributes as a result of increasing nitrogen fertilizer might be due to increased accumulation of photosynthesis from source to sink during filling as well as delaying senescence.

Okasha (2011) studied the effect of phosphorus fertilizer rates on the productivity of some rice cultivars. The phosphorus rates were 0, 18, 36 and 54 kg P_2O_5 ha^{-1}. She found that leaf area index, dry weight (g cm^{-2}), plant height (cm), number of tillers $hill^{-1}$, number of panicles $hill^{-1}$, panicle length (cm), panicle weight (g), number of filled grains, 1000-grain weight (g), grain yield (t ha^{-1}), straw yield (t ha^{-1}), harvest index, phosphorus content, nitrogen content and protein content, were increased significantly with increasing phosphorus rate up to 36 kg P_2O_5 ha^{-1}.

Salem et al. (2011) investigated the effect of nitrogen fertilizer and seedling age on Inbred and Hybrid rice genotypes. The results indicated that rice growth characteristics number of tillers $hill^{-1}$, days from sowing up to panicle initiation, heading dates, leaf area index, leaf area ratio, chlorophyll content and grain yield (t ha^{-1}) and its components, were increased by increasing nitrogen levels up to 105 kg N ha^{-1}. The 20 days' seedling age recorded the highest values of each studied attributes. (Sakha 101) rice variety surpassed than other varieties for all studied characters. Seedling age (20 days from sowing) with hybrid rice (Hybrid 1) treatment gave the highest value of utilization efficiency, agronomic efficiency and leaf area ratio. But the same treatment without nitrogen application gave the lowest values of such parameters.

Singh et al. (2011) studied the effects of nitrogen application at different levels (0, 20, 40 and 60 kg/ha) on the characteristics of milled rice and starch from three paddy rice cultivars. Milled rice was evaluated for physicochemical, cooking and textural properties while starch was evaluated for granule size distribution, structure, thermal and rheological properties. Milled rice from paddy grown with nitrogen application showed lower gruel solids loss and water up take ratio during cooking and higher cooked grain hardness, cohesiveness, and chewiness. Starch from rice grown with application of nitrogen showed lower amylose content and higher pasting temperature, gelatinization transition-temperatures and enthalpy of gelatinization. Principal component analysis indicated that cooked grain hardness and cooking time were closely associated with amylose content and protein content, respectively.

Kanfany et al. (2014) conducted a research at the Africa Rice Sahel Regional Station (near Saint Louis, Senegal) during two seasons with the aim of assessing the performances of introduced hybrid cultivars along with an inbred check cultivar under low input fertilizer levels. The five treatments used in this study were (a) the control (without any fertilizer application), (b) 37.5–4.4–8.3 kg N–P–K ha^{-1}, (c) half of recommend application in Senegal (75–8.75–16.5 kg N–P–K ha^{-1}), (d) 112.5–13.3–24.8 kg N–P–K ha^{-1}, and (e) the recommended application in the country (150–17.5–33 kg N–P–K ha^{-1}). There were significant year and cultivar effects for all traits. The fertilizer levels affected significantly most traits except panicle length and 1000-grain weight. The year × fertilizer level and year × cultivar interactions were significant for most traits, but the fertilizer level × cultivar and year × fertilizer level × cultivar interactions were not significant. Days to maturity, plant height, panicle per m2, and grain yield increased with increasing fertilizer levels during the two wet seasons. The grain yield of rice hybrids (bred by the International Rice Research Institute) was not significantly higher than that of the check cultivar widely grown in Senegal. The assessment of other rice hybrid germplasm showing more adaptability to low fertilizer levels will facilitate further hybrid cultivar development in Africa.

Li et al. (2014) studied the accumulation and utilization of nitrogen, phosphorus and potassium of irrigated rice cultivars with high productivities and high N use efficiencies. This study suggested that a decrease of N accumulation before panicle initiation and increase of N, P, and K accumulation during the period from heading to maturity may be helpful to combine the high yield and high N use efficiency in rice.

Metwally et al. (2014) studied the performance of some rice genotypes under different nitrogen levels. The selected genotypes were; (Giza 178, GZ10306-7-1-1-2, GZ10355-9-1-1-4, GZ10154-3-1-1-1, PL-GE-101-SP-17, PL- 101-SP-7 and IET 1444). Three nitrogen levels were used e.g. 0, 80 and 160 kg N ha^{-1}. Genotypes of Giza 178, GZ10355-9-1-1-4 and IET 1444 showed good performance under both normal and saline soils regarding yield and its components. Most of the traits under study had a wide range of variability. All cultivars mean squares for all studied traits were highly significant under normal and saline soil. Thus selection for given traits among these cultivars would be effective in all cases. The phenotypic coefficient of variability (PCV%) was higher than genotypic coefficient variability (GCV%) in two years in all genotypes for all traits, indicating that the most portion of

PCV% was more contributed by environmental conditions and cultural practices.

Wanyama et al. (2015) established the major limiting nutrients and estimation of optimum fertilizer requirements for lowland rice to increase and sustainable production. The study was conducted in two seasons Eastern Uganda. Two sets of trials were conducted; nutrient omission trial for estimating indigenous nutrient supply of the major nutrients and response function and the recovery efficiency trial for estimating recovery of applied Nitrogen. The first one involved 8 treatments of NPK (t0, t1, t2, t4, t5, t6, t7 and t8) each at different rates. While the second experiment involved two treatments (t0 and t1) of N fertilizer. Applications of nitrogen significantly increased yield components and consequently the grain yield of rice. The major limiting nutrient for lowland rice production is nitrogen and the soil nitrogen supplying potential can support yield target of 2.8 t ha^{-1}. Whereas, the indigenous Phosphorus and Potassium supply can support yield target of up to 9 t ha^{-1} and therefore, not limiting at achievable yield targets of 6 tha^{-1}. Use of internal efficiencies was promising in analysis of nutrient status and nutrient requirement to achieve the specific yield targets. 65 kg N ha-1 is the optimum rate for lowland rice and this corresponds to a target yield of 5 t ha^{-1}.

Kamal et al. (2016) reported that crop productivity and quality are dependent on better availability of essential crop nutrients. However, application of nutrients at best optimum is essential depending on genotype for improved yield and quality. Field experiment was carried out to assess the influence of various levels of NPK fertilizers (F1: 108-80- 48, F2: 135-100-60, F3: 162-120-72 and F4: 189-140-84 kg ha^{-1}) on yield and quality of two rice varieties. Results revealed that application of F3 (162-120-72 kg NPK ha^{-1}) improved the yield and related traits viz. productive tillers m^{-2}, number of spikelets per spike, 1000- grain weight, grain and straw yield, and harvest index, as compared to other NPK levels. The quality attributes of both varieties showed a variable response to various levels of NPK.

MATERIAL AND METHODS

Two field experiments were carried out at the experimental farm of Rice Research and Training Center, Sakha, Kafrelsheikh, Egypt, during 2015 and 2016 seasons to study the effect of some fertilization treatments on rice grain quality, nutritional value and yield in four rice genotypes (*Oryza sativa L.*) namely GZ 9461-4-2-3-1, GZ 10101-5-1-1-1, GZ 10147-1-2-1-1 and GZ 10154-3-1-1-1 fertilization treatments were five NPK levels (0,25,50,75 and 100 % of the recommended dose 165 kg N ha^{-1}, 36 kg P_2O_5 ha^{-1} and 50 kg K_2O ha^{-1}).

Pedigree of the rice genotypes used in this study was shown in table (1).

Rice genotype	Parentage	Type	Origin
GZ 9461-4-2-3-1	Dae2 Beyo / GZ 6296	Indica Japonica	Egypt
GZ 10101-5-1-1-1	Sakha 103 / IR 385	Japonica	Egypt
GZ 10147-1-2-1-1	GZ6214 / IR385	Japonica	Egypt
GZ 10154-3-1-1-1	GZ 6522 / Sakha 101	Japonica	Egypt

Soil samples were collected from the experimental site at depth of 0 to 25 cm from soil surface before cultivation to study the soil mechanical and chemical properties of the experimental site according to **Piper (2010).** The mechanical and chemical analysis of the soil is presented in Table (2).

Cultural Practices:

A-The Nursery:

The nursery was well prepared and fertilized with 9.52 kg per hectar's nursery calcium super phosphate (15.5 % P_2O_5) before ploughing and 7.14 kg per hectar's nursery urea (46.5% N) after ploughing as well as, 2.38 kg per hectar's nursery zinc sulphate (22% Zn) immediately before sowing and after puddling. Rice seed at the rate of 96 kg ha^{-1} was soaked in fresh water for 24 hours and incubated for 48 hours to enhance germination. The pre-germinated seed was broadcasted in May 15th in both seasons. Weed were chemically controlled in nursery using Saturn 50% (5-(4- chlorophenol methyl) diethyl carbamatiote) at the rate of 4.5-liter ha^{-1} at seven days after sowing into 3 cm water depth.

Table (2). Soil mechanical and chemical properties of the experimental sites

Soil characteristic	Season	
	2015	**2016**
Soil texture (%)	Clayey	
clay %	57.00	54.00
Sand %	11.00	11.00
Silt %	32.00	35.00
pH (1: 2.5 water suspension)	8.05	8.2
EC (dSm-1)	2.0	2.05
Organic matter	1.65	1.50
Available P mg Kg^{-1}	14.00	12.00
Available NH_4 mg Kg^{-1}	13.5	12.60
Available NO_3 mg Kg^{-1}	10.0	11.80
Available K mg Kg^{-1}	366	350
Cations (meq/L.)		
Ca+ +	7.20	6.00
Mg+ +	2.60	1.50
Na+	12.00	13.00
K+	0.50	0.50
Anions (meq/L.)		
HCO3-	5.60	5.00
Cl-	14.00	14.00
$SO4^{--}$	2.70	2.00
$CO3^{--}$	0.00	0.00

B- The permanent field:

The permanent field was ploughed and then well dry leveled. Phosphorus fertilizer in the form of calcium superphosphate (15.5 % P_2O_5)

was applied before land preparation according to the treatments in this hypothesis.

Potassium fertilizer in the form of potassium sulphate (48 % k_2O) was incorporated in the dry soil before planting according to the treatments used in this study. Nitrogen fertilizer was added according to the treatment in the form of urea (46.5 %N) as two splits ($^2/_3$ was applied and incorporated in dry soil before planting, then the permanent field was immediately irrigated + $^1/_3$ was applied after 25 days from transplanting as topdressing). Thirty days old seedling were manually transplanted into hills 20 x 20 cm spacing among hills with 2-3 seedling $hill^{-1}$. Herbicide Saturn 50 % (5-(4- chlorophenol methyl) diethyl carbamothioate) at the rate of 4.5-liter ha^{-1} was applied after seven days from transplanting into 3 cm water depth mixed with enough sand to easy homogenous distribution. Other cultural practices for growing rice plants were applied according to the recommendation of Rice Research and Training Center (RRTC).

Experimental design:

Split plot design with four replications was used. Four rice genotypes were arranged in the main plots. While, the five NPK levels were arranged in sub plots. The sub plot area was 12 m^2 (3x4 m).

Studied characters:

1-Growth characters:

Plant samples (five hills) were taken randomly from each plot at 40 days after transplanting (DAT) to estimate the following characters:

1-1- Plant height (cm): Average plant height was estimated by measuring the plant height from the soil surface up to the longest leaf in each hill from the five hills of each plot.

1-2- Number of tillers m^{-2}: The total number of tillers was counted in five random hills, then the number per square meter was computed.

1-3- Leaf area index at heading: leaf area of five hills from each plot was estimated using the leaf area meter (Model LI-3000 A). The leaf area index then was computed by dividing the leaves area of the plant leaves per five hills by the area occupied by these hills.

$$\textbf{L.A.I} = \frac{\textbf{Leaf area of the fixed number of hills}}{\textbf{Ground area occupied by these hills}}$$

1-4- Dry matter accumulation (g m^{-2}): Dry weight of five hills was recorded after drying the plant samples in the oven at 70 ^{o}c for 72 hrs. Then the total dry weight per square meter was computed of each plot.

1-5- Chlorophyll content (uE=uMolm-2s-1): Chlorophyll content (Ue=uMol m^{-2} s^{-1}) was determined using chlorophyll fluorometer (model OPTI-SCIENCES OS-30), Opti-sciences, Inc. USA. Five leaves were randomly choosen and measured from the widest part of the leaf of the main culm in each plot.

1-6- Days to heading (days): It was counted from the day of sowing till it reached 50% of heading in each plot.

2- <u>Yield and yield attributes:</u>

2-1- Number of panicles /m²: Average number of panicles from five hills, which randomly selected in each plot were counted, then computed as number of panicles per square meter.

2-2- Panicle length (cm): Average panicle length of ten panicles in each plot was measured from panicle based up to the upper most spikelet of the panicle.

2-3- Panicle weight (g): Ten main panicles were collected randomly from each plot and the actual average weight was determined in grams.

2-4- Number of filled grains/panicle: Average number of filled grains formed on ten panicles randomly chosen was counted and recorded.

2-5- Number of unfilled grains / panicle: Total number of grains formed on ten panicles randomly chosen were counted and immersed in a salt solution (1% NaCl), then the floated spikelets were counted and considered as unfilled grains and the average was presented as number per panicle.

2-6- Thousand grain weight (g): 1000- grain of rough rice were counted from each plot and their weight was recorded.

2-7- Grain yield (t ha^{-1}): Area of 10 m^2 in the center of each sub plot was manually harvested then left for air drying for three days and biological weight (grain + straw) was recorded. Thereby mechanically threshed and the grain weight was recorded and was adjusted to 14 % moisture content, grain yield was converted into tons per hectar.

2-8- Straw yield: Straw yield was calculated as follows**:**

Straw yield = biological yield – grain yield

Then straw yield was converted into ton per hectare

2-9- Harvest index (%)*:* It was calculated as follows:

$$\text{Harvest index (HI)} = \frac{\text{Grain yield (t/ha)}}{\text{Biological yield (t/ha)}} \times 100$$

3. <u>Grain quality characters</u>:

Milling recovery: Hulling, milling and head rice percentage were estimated according to the methods reported by **Juliano (1971) and Khush et.al (1979).**

3.1. Hulling percentage (%): 150 g cleaned rough rice samples at moisture content of 12- 14 % were dehulled with an experimental Satake huller machine (Satake) in Rice Research and Training Center Laboratory, Kafrelsheikh. Hulling % was calculated as follows

Hulling %= (Brown rice wt. / Rough rice wt.) X 100

3.2. Milling percentage (%): Brown rice samples were consequently milled in a McGill Miller No.2. The sample was milled for 60 sec. The milled rice sample was collected and the weight was recorded and percentage of total milled rice was computed as follow:

Milling %= (Milled rice wt. /Rough rice wt.) X 100

3.3. Head rice percentage: Whole grains were separated from the total milled rice using a rice size device. The separation of these particles was termed as grading. However, the broken was fragments of grains, which were less than $^3/_4$ of the whole grains in length. The amount of head rice yield is then obtained and calculated:

$$\textbf{Head rice \%} = \frac{\textbf{Weight of whole grains}}{\textbf{Weight of milled rice}} \times 100$$

Grain dimension: Grain dimension (length and width) were taken on 50 normal grains from each plot with help of a Micrometer in mm

3.4. Grain length (mm): Grain length is measured of milled rice grain in its greatest dimension in mm. It was measured from the base to the top of the grain. Grain length was classified using the standard evaluation system for rice.

3.5. Grain width (mm): Width of milled rice grain was measured from the ventral side to the dorsal side at the widest point of grains in millimeters.

3.6. Kernel elongation (mm): Grain length of the sample of 10 milled grains from each individual plant was measured in millimeters. Grains were placed into 25X100 mm test tubes and 30 ml of distilled water were added. After 30 minutes the test tubes were immersed in a cold water until cooled to room temperature. The cooking liquid was decanted and cooked grains were transferred into properly labeled petri dishes lined with Whatman room temperature overnight. The length of cooked grains was measured in millimeters. Average length of row and cooked grains was calculated. The proportionate change (PC) in L/W ratio was calculated (**Sood and Siddiq,1980**) as shown below:

$$PC = \frac{L_F/W_F - L_O/W_O}{L_O/W_O}$$

Whereas:

L_f/w_f = length and width of the grain after cooking (mm)

Lo/Wo= Length and width of the grain before cooking(mm), respectively.

3.7. Gelatinous temperature: Six grains of whole milled rice in duplicate were placed in plastic boxes containing 10 ml, 7 % KOH and arranged so that the kernels do not touch each other. The boxes were covered and incubated for 23 hours at 30^{o}c. The appearance and disintegration of the endosperm were rated visually on the basis of the following numerical scale:

Rating	***Separation***	***Clearing***
1	Kernel not affected	*Kernel chalky*
2	Kernel swollen	*Kernel chalky; collar powdery*
3	Kernel swollen: collar incomplete or narrow	*Kernel chalky; collar cottony or cloudy*
4	Kernel swollen: collar complete and wide	*Center cottony; collar cloudy*
5	Kernel split or segmented; collar complete and wide	*Center cottony; collar clearing*
6	Kernel dispersed; merging with collar	*Center cloudy; collar clear*
7	Kernel completely dispersed and intermingled	*Center and collar cleared*

A rating of 1 to 3 is classified as high gelatinization temperature (greater than 74^{o}C); a rating of 4 to 5 is classified as intermediate gelatinization temperature (70-40 ^{o}C); and a rating of 6 to 7 corresponds to gelatinization temperature below 70^{o}C **(little et al., 1958)**.

3.8. Oil determination (%): Oil determination of samples was determined using petroleum ether (40-60^{o}C) as a solvent in Soxhelt apparatus for 6 hr. (16 siphon) according to **A.O.A.C. (1970).**

3.9. Total carbohydrates (%): Total carbohydrate was calculated by difference (100-(ash+ protein+ oil)) as mentioned by **(Fraser and Holmes 1959).**

3.10. Protein content percentage (%): Nitrogen content was in milled grain was determined according to the standard micro – kjeldahl method. Then, nitrogen content was multiplied by factor of 5.95 to estimate the crude protein content in rough rice grains.

3.11. Amylose content (%): It was estimated according to **Juliano (1971)** as follows: Grind 10 whole grains milled rice to fine powder in a Wig-L-bug amalgamator for 40 seconds. Weight accurately in duplicate, 100 mg of sample into a 100 ml. Volumetric flask and add 1 ml of 95 %ethanol and 9 ml of 1 N sodium hydroxide. Heat for 10 minutes in a boiling water bath to gelatinize the starch. Cool for 1 hour, bring the sample up to volume with distilled water and mix well. With a pipette put 5 ml of the starch solution in a 100-ml volumetric flask. Add 1 ml of 1 N acetic acid, 2 ml of iodine solution, and make up to volume with distilled water, shake and let stand for 20 minutes. Record the absorbency of the solution at 620 nm. With a spectrophotometer Baush and Lamb spectronic 20 apparatus. Determine amylose content by using a conversion factor, and grouped it on the basis of their amylose content.

4. Determination of N, P, K and Zinc (%) in milled grain rice:

Nitrogen, phosphorus, potassium and Zinc determination: Milled grains samples were placed in paper bags and oven dry at 70 ^{o}c for 48 hours. Grain samples were ground to powder and digested according to the method of **Champan and Pratt (1961),** prior to chemical analysis as follow:

4.1. Nitrogen content (%): N content of milled grains was determined using the Microkieldahl method **(Jackson, 1967)**.

4.2. Phosphorus content (%): Phosphorus content of milled grain was determined following the procedures of **Watanabe and Olsen (1965).**

4.3. Potassium content (%): Potassium content of grain was determined using the flame photometer according to **Peterpurgski (1968)** method.

4.4. Zinc content (%): Was determined by the Atomic Absorption as described by **Jackson (1967).**

Statistical analysis:

All collected data were statistically analyzed, according to **Gomez and Gomez (1984)**, using Costat computer program. Duncan multiple range test (DMRT) was used to compare the differences among treatment means, according to **Duncan (1955)**

RESULTS AND DISCUSSIONS

The results obtained from the present investigation in the two growing seasons of 2015 and 2016 were presented and discussed under the following topics:

3- Growth Characters:

4- Yield and yield attributes.

5- Grain quality characters.

6- Determination of N, P, K and Zinc % in milled grain rice.

1. Growth Characters:

1.1. Plant height (cm):

Plant height (cm) of four rice genotypes as affected by NPK levels application and their interactions in 2015 and 2016 seasons are presented in Tables (3 and 4). Data given in Table (3) showed significant genotypes differences in plant height at 40 days after transplanting (DAT).

It is evident from the data that rice genotype GZ10154-3-1-1-1 significantly produced the tallest plants (66.25 and 70.81) in both seasons. The shortest numerical plant height was recorded by genotype GZ 9461-4-2-3-1 (42.97 and 46.22) in both seasons. These genotypic differences are expected and found also by **Ebaid and El-Rewiny (2005), Gorgy (2010), Sheta (2010), Okasha (2011) and El-Refaee. (2012).**

In the two seasons, highly significant differences were detected in plant height among the different levels of NPK. Data presented in Table (3) showed also that increasing NPK rate up to 100% significantly increased plant height. The increase in plant height obtained by increasing NPK levels may be attributed to adequate supply of NPK which can be explained in terms of more cell division, internodes elongation and gibberellins activity. These findings are in close agreement with those reported by**, Javaid. (2011), Debnath et al. (2013), Uddin et al. (2013) and Hashem et al. (2016).**

Table (3): plant height (cm), No. of tiller (m^2) and leaf area index at 40 days after transplanting (DAT) of rice genotype as affected by NPK in 2015 and 2016 seasons.

Treatments	Plant height (cm)		No. of tillers (m^2)		Leaf area index	
	2015	2016	2015	2016	2015	2016
Genotypes						
GZ 9461-4-2-3-1	42.97 d	46.22 d	500.31a	508.92 a	4.76 a	5.20 a
GZ 10101-5-1-1-1	58.67 c	62.37 c	424.96d	428.97 d	3.27 d	3.66 d
GZ 10147-1-2-1-1	63.60 b	67.82 b	463.53c	468.53 c	4.16 c	4.57 c
GZ 10154-3-1-1-1	66.25 a	70.81 a	481.12b	486.13 b	4.55 b	4.98 b
F. Test	**	**	**	**	**	**
NPK treatments (%)						
100 % NPK	63.66a	68.59 a	569.25a	576.61 a	4.81a	5.26 a
75 % NPK	60.21b	64.42 b	522.73b	530.33 b	4.51b	4.95 b
50 % NPK	58.15c	61.83 c	453.48c	459.33 c	4.27c	4.68 c
25 % NPK	55.02d	58.40 d	411.65d	415.76 d	3.77d	4.17 d
Control (without NPK)	52.69e	55.78 e	380.30e	383.65 e	3.57e	3.95 e
F. Test	**	**	**	**	**	**
Interaction: (G x T)	**	**	**	**	**	**

Data cited in Table (4) showed that the interaction between rice genotypes and NPK fertilizers had a highly significant effect on the plant height at 40 DAT. Data indicated that the tallest plants were found in plots received either 100% or 75 % NPK fertilizers with the rice genotype GZ 10154-3-1-1-1. While, the shortest plants were obtained when rice genotype GZ.9461-4-2-3-1 received 25% or zero NPK.

1.2. Number of tillers m^{-2}:

Data of number of tillers m^{-2} at 40 DAT as affected by the four rice genotypes and different levels of NPK and their interactions in the two seasons are listed in Tables (3 and 5).

Data indicated significant varietal differences in this trait in both seasons of study. In general, rice genotype GZ 9461-4-2-3-1 gave significantly the highest number of tillers m^{-2} (500.319 and 508.92) followed by rice genotype GZ10154-3-1-1-1 (481.12 and 486.13) in 2015 and 2016, respectively. However, the lowest numbers of tillers were obtained from rice genotype GZ10101-5-1-1-1 (424.96 and 428.97) in both seasons. Such differences in tillering capacity may be attributed to different genetic makeup. These results confirm the real genetic differences in tillering capacity. It is noteworthy to mention that the capacity to produce more tillers may has advantage, it protects against conditions that restrict tillering or kill some tillers due to attack by insects or infestation by diseases. Similar findings were reported by **Sheta (2010) and Okasha (2011)**.

Table (4): Plant height (cm) at 40 (DAT) after transplanting as affected by interaction between NPK treatments and rice genotype in 2015 and 2016 seasons

Genotype	NPK				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	50.00 h	42.96 i	41.90 i	40.01 j	40.00 j
GZ 10101-5-1-1-1	64.36 de	62.40 ef	62.10 ef	54.30 g	50.16 h
GZ 10147-1-2-1-1	68.50 bc	65.60 d	62.13 ef	61.50 ef	60.30 f
GZ 10154-3-1-1-1	71.80 a	69.90 ab	66.50 cd	64.36 de	60.30 f
2016					
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	54.00 h	46.47 i	45.10 ij	43.01 j	42.50 j
GZ 10101-5-1-1-1	68.87 cd	66.40 d-f	65.63 d-f	57.80 g	53.17 h
GZ 10147-1-2-1-1	73.80 b	70.10 c	66.40 d-f	65.00 e-f	63.80 f
GZ 10154-3-1-1-1	77.70 a	74.70 ab	70.20 c	67.80 c-e	63.64 f

Table (5): No. of tillers /m^2 at 40 (DAT) after transplanting as affected by interaction between NPK treatments and rice genotype in 2015 and 2016 seasons.

Genotype	NPK				
	2015				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	662.79 a	513.86 de	506.36 f	458.36 h	360.20 n
GZ 10101-5-1-1-1	513.06 de	511.63 e	373.80 k	365.66 m	360.66 n
GZ 10147-1-2-1-1	584.66 b	553.82 c	452.03 i	369.73 l	357.40 n
GZ 10154-3-1-1-1	516.50 d	511.60 e	481.73 g	452.86 i	442.93 j
	2016				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	675.40 a	524.47 d	514.97 g	464.97 i	364.80 p
GZ 10101-5-1-1-1	519.67 e	516.23 fg	377.40 m	368.27 o	363.27 pq
GZ 10147-1-2-1-1	586.27 b	562.43 c	458.63 j	374.33 n	361.00 q
GZ 10154-3-1-1-1	525.10 d	518.20 ef	486.33 h	455.47 k	445.53 l

Data listed in Table (3) reveal that different levels of NPK significantly affected this criterion in both seasons. Data showed that increasing NPK levels from 0 up to 100% gradually increased number of tillers m^{-2}. The rate of 100% NPK gave the highest values of number of tillers m^{-2} (569.25 and 576.61), while control (zero) NPK gave the lowest values (380.30 and 383.65) in both seasons, respectively. These findings indicate that, the application of 100% NPK had a significant effect in improving vegetative growth and increasing tillering capacity, due to increasing the NPK uptake which stimulate the plant growth consequently number of tillers m^{-2}. The obtained data are in a good agreement with those reported by **Javaid (2011), Debnath et al. (2013), Saba et al. (2013) and Uddin et al. (2013).**

Data given in Table (5) indicate that the interaction between rice genotypes and different levels of NPK fertilizers on number of tillers m^{-2} was highly significant in 2015 and 2016 seasons. Results showed that the highest number of tillers m^{-2} were recorded by rice genotype GZ9461-4-2-3-1 at 100% NPK fertilizer rate. Whereas, the lowest values of number of tillers m^{-}

[2] were recorded by rice genotype GZ 10147-1-2-1-1, GZ 10101-5-1-1-1 or GZ 9461-4-2-3-1 at zero NPK (control).

1.3. Leaf area index:

Data in Table (3) showed highly significant genotypes differences in leaf area index (LAI) in both seasons, rice genotype GZ 9461-4-2-3-1 had highest numerical LAI (4.76 and 5.20) in both seasons respectively followed by rice genotype GZ 10154-3-1-1-1 (4.55 and 4.98). While, rice genotype GZ10101-5-1-1-1 recorded the lowest numerical values (3.27 and 3.65) in 2015 and 2016 respectively. The superiority of rice genotype GZ9464-4-2-3-1 in LAI could be largely attributed to high number of tillers and leaves. On the other hand, the inferiority of rice genotype GZ10101-5-1-1-1 in this trait might be primarily described to its lowest numerical number of tillers and leaves. The genotypes differences in LAI reflect different genetic make-up. These genotypes differences in LAI were also reported by **Ebaid and El-Rewiny (2005), Gorgy (2010), Sheta (2010), Okasha (2011) and El-Refaee (2012)**.

Data cited in Table (3) show highly significant effect of NPK fertilization on LAI in both seasons. Progressive significant increase in LAI was recorded with each increment of NPK levels. These results indicate that NPK supply had a controlling influence on LAI, primarily through its effect on tillers number and thus leaf reduction and expansion. These results are in good agreement with those reported by **Gorgy (2010), Fukushima et al. (2011), El-Refaee (2012) and Hashem et al. (2016).**

Regarding the effect of interaction between rice genotypes and NPK levels, data in Table (6) show that in both seasons, rice genotype GZ 9461-4-2-3-1 gave the highest LAI values when it received 100% NPK fertilizer. On the other hand, rice genotype 10101-5-1-1-1 gave the lowest LAI values when it didn't receive any NPK fertilizers (control).

Table (6): Leaf area index at 40 (DAT) after transplanting of four rice genotype as affected by interaction of NPK and rice in 2015 and 2016 seasons.

Genotype	NPK				
	2015				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	5.69 a	5.00 b	4.72 bc	4.39 de	4.01 fg
GZ 10101-5-1-1-1	3.67 ghi	3.40 ij	3.29 j	3.19 j	2.83 k
GZ 10147-1-2-1-1	4.79 bc	4.60 cd	4.17 ef	3.65 ghi	3.61 hi
GZ 10154-3-1-1-1	5.09 b	5.07 b	4.90 bc	3.87 fgh	3.83 fgh
2016					
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	6.17 a	5.45 bc	5.16 de	4.81 fg	4.41 hi
GZ 10101-5-1-1-1	4.07 j-l	3.79 lm	3.67 m	3.56 m	3.20 n
GZ 10147-1-2-1-1	5.24 c-e	5.03 ef	4.57 gh	4.04 j-l	3.98 kl
GZ 10154-3-1-1-1	5.56 b	5.51 bc	5.33 b-d	4.28 ij	4.22 -k

1.4. Dry matter accumulation (g m^{-2}):

Data of dry matter accumulation of the four rice genotypes at 40 DAT as affected by NPK application and their interactions during 2015 and 2016 rice seasons are listed in Tables (7 and 8).

Data in Table (7) show highly significant differences among the tested genotypes in this criterion at 40 DAT in both seasons. Rice genotype GZ 9461-4-2-3-1 out yielded others lines in this trait (616.33 and 623.26 gm^{-2}), followed by rice genotype GZ 10154-3-1-1(583.00 and 588.87 gm^{2}), while rice genotype GZ 10101-5-1-1-1 gave the lowest values (539.67 and 543.68 gm^{-2}) at 40 DAT in both seasons, respectively. It is obvious that the increases in dry matter weight of the rice genotype GZ 9461-4-2-3-1 could be attributed to the increases in number of tillers^{-2} and LAI. Several researches have shown the similar results, **Ebaid and El-Rewiny (2005), Gorgy (2010), Sheta (2010), Okasha (2011) and El-Refaee (2012)**.

It is evident from Table (7) that, all NPK levels under study caused a positive increase in dry matter accumulation at 40 DAT as compared with unfertilized treatment. The highest values of dry matter accumulation (g m^{-2}) where significantly produced when 100% NPK were applied (655.21 and 663.21 gm^{-2}), while the lowest values were obtained from the control (without NPK application) (489.02 and 492.48 gm^{-2}) in both seasons, respectively. Such effect of NPK application could be attributed mainly to its role in the stimulation of various physiological processes including cell division and cell elongation of internodes resulting in more tillers formation, leaf numbers and photosynthetic area (leaf area), which resulted in more photosynthetic production and consequently increased dry matter accumulation. The promoting effect of NPK on dry matter accumulation were reported by **Javaid (2011), Debnath et al. (2013) Uddin et al. (2013) and Hashem (2016).**

The interaction between the tested genotypes and different NPK levels was highly significant at 40 DAT after transplanting in both seasons. Data in Table (8) showed that rice genotype GZ 9461-4-2-3-1 and GZ 10154-3-1-1-1 gave the highest values of dry matter accumulation at 100 % NPK level while, rice genotype GZ 10147-1-2-1-1 gave the lowest ones for this trait with control (without NPK application) at 40 DAT after transplanting in both seasons. In general, the trends of results are similar to those of number of tillers m^{-2} and leaf area index and similar discussion could be cited.

Table (7): Dry matter accumulation (g m^{-2}) , chlorophyll content (uE) at 40 (DAT) after transplanting and days to heading of four rice genotype as affected by NPK in 2015 and 2016 seasons.

Treatments	Dry matter (g m^{-2})		Chlorophyll content (uE)		Days to heading	
	2015	2016	2015	2016	2015	2016
Genotypes						
GZ 9461-4-2-3-1	616.33 a	623.26 a	0.791 b	0.871 b	91.60 d	92.45 d
GZ 10101-5-1-1-1	539.67 d	543.68 d	0.763 c	0.843 c	92.99 c	93.95 c
GZ 10147-1-2-1-1	563.72 c	568.34 c	0.795 a	0.875 a	95.46 b	96.65 b
GZ 10154-3-1-1-1	583.00 b	588.87 b	0.763 c	0.843 a	96.53 a	97.53 a
F. Test	**	**	**	**	**	**
NPK treatments (%)						
100 % NPK	655.21 a	663.21 a	0.790a	0.870 a	95.50 a	97.54 a
75 % NPK	617.92 b	624.18 b	0.784 b	0.864 b	94.83 b	95.99 b
50 % NPK	569.17 c	574.11 c	0.777 c	0.857 c	93.83 c	94.54 c
25 % NPK	547.08 d	551.21 d	0.775 d	0.855 d	93.41 cd	93.98 cd
Control (without NPK)	489.02 e	492.48 e	0.765 e	0.845 e	93.16 d	93.68 d
F. Test	**	**	**	**	**	**
Interaction: G X T	**	**	ns	ns	**	**

Table (8): Dry matter accumulation (gm^{-2}) at 40 (DAT) after transplanting as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	691.67 a	666.67 c	610.83 d	587.50 e	525.00 i
GZ 10101-5-1-1-1	560.00 fg	555.00 g	541.67 h	541.67 h	500.00 j
GZ 10147-1-2-1-1	680.00 b	583.33 e	564.17 f	531.67 i	459.72 l
GZ 10154-3-1-1-1	689.17 a	666.67 c	560.00 fg	527.50 i	471.67 k
2016					
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	702.21 a	674.99 c	617.06 d	593.04 e	529.00 h
GZ 10101-5-1-1-1	565.00 f	559.50 f	545.67 g	545.22 g	503.00 i
GZ 10147-1-2-1-1	687.00 b	588.33 e	568.37 f	535.26 h	462.75 k
GZ 10154-3-1-1-1	698.62 a	673.90 c	565.32 f	531.33 h	475.17 j

1.4. Chlorophyll content (uE):

Data related to leaf chlorophyll content of the tested genotypes as affected by NPK application at 40 DAT as well as, their interaction in both seasons are tabulated in Table (7).

Data in Table (7) show that the leaf chlorophyll content at 40 DAT was significantly affected by genotypes in both seasons. Rice genotype GZ 10147-1-2-1-1 gave the highest chlorophyll content (0.795 and 0.875) followed by rice genotypes GZ 9461-4-2-3-1 (0.791 and 0.871). Rice genotype GZ 10151-3-1-1-1 recorded the lowest leaf chlorophyll content (0.763 and 0.843). The differences in the leaf chlorophyll content which obtained among different rice genotypes might be due almost to the genetical differences. In this connection came to similar results with **Gorgy (2010), Sheta (2010) and Okasha (2011).**

NPK fertilizer affected significantly leaf chlorophyll content in the two seasons. Increasing NPK levels from 0 to 100% increased significantly leaf chlorophyll content. The plants which received 100 % NPK fertilizer produced the highest chlorophyll content in the two seasons (0.790 and 0.870). The lowest values of leaf chlorophyll content recorded when NPK were not applied. Nitrogen is the integral element of the chlorophyll and is the substrate needed for the synthesis of amino acid and protein, which are constituents of protoplasm and chloroplast. Also, application of phosphorus increased significantly the photosynthetic capacity and the chlorophyll content in the leaves. As well as, potassium increase leaf area, leaf chlorophyll content, delays leaf senescence and therefore contributes to greater canopy photosynthesis and crop growth. These results are conformity with those of **Kandil et al. (2010), and Kanafany et al. (2014).**

The interaction effect between rice genotype and NPK was not significant in the two seasons.

1.5. <u>Days to heading (days)</u>:

Number of days from sowing to heading of some rice genotypes as affected by NPK application as well as their interactions in 2015 and 2016 seasons are presented in Tables (7 and 9).

Results in Table (7) show that rice genotypes significantly differed in their heading date in both seasons. Rice genotype GZ 9461-4-2-3-1 needed the shortest period from sowing to heading (91.60 and 92.45 days) in both seasons respectively. Meanwhile, GZ 10101-5-1-1-1 rice genotype came in the second, rank (92.99 and 93.95 days). On contrast, rice genotype GZ 10154-3-1-1-1 significantly had the longest period from sowing to heading (96.53 and 97.53 days) in second seasons, respectively. The detected differences among rice genotype in their period from sowing to heading might be mainly attributed to the genetic background.

Also, data show that days to heading significantly increased by increasing NPK rate in both seasons. The maximum number of days to heading (95.50 days) in the first season and (97.54 days) in the second season were obtained when rice plants treated with 100% NPK, followed by the plants treated by 75% NPK (94.83 and 95.99 days) in both seasons, respectively. Whereas, minimum numbers of days to heading (93.16 and 93.68 days) were observed in 2015 and 2016 seasons, respectively when rice plant untreated by NPK (control). The delay of flowering due to high rate of NPK is may be due to the increase in vegetative growth stage consequently delay the emergence of panicle. These results are in agreement with the results obtained by **Javaid (2011), Petroudi et al. (2011), Saba et al. (2013), Uddin et al. (2013) and Hashem (2016).**

Data presented in Table (9) indicated that there were significant differences in days to heading as affected by the interaction between the rice genotypes and NPK application. The maximum numbers of days to heading were obtained from rice genotype GZ 10147-1-2-1-1 at 100% NPK fertilization (97.67 and 100.00 days) in both seasons. The minimum numbers of days to heading were observed from rice genotype GZ 9461-4-2-3-1 at 50% and 25% NPK (91.33 and 91.00 days) in 2015 and 2016 seasons (91.92 and 91.45 days).

Table (9): Days to heading as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	93.00 gh	91.67 ik	91.33 ik	91.00 j	91.00 j
GZ 10101-5-1-1-1	94.33 ef	93.67 fg	92.33 hi	92.33 hi	92.33 hi
GZ 10147-1-2-1-1	97.67 a	97.00 ab	95.00 de	94.00 e-g	93.67 fg
GZ 10154-3-1-1-1	97.00 ab	97.00 ab	96.67 a-c	96.33 bc	95.67 cd
	2016				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	94.87 fg	92.56 hi	91.92 hi	91.45 i	91.45 i
GZ 10101-5-1-1-1	96.31 de	94.67 fg	93.02 h	92.93 h	92.86 h
GZ 10147-1-2-1-1	100.00 a	98.58 bc	95.83 ef	94.65 fg	94.22 g
GZ 10154-3-1-1-1	99.00 ab	98.16 bc	97.42 cd	96.89 de	96.22 de

2. Yield and its attributes:

2.1. Number of panicles/m^2:

The effect of NPK application and four rice genotypes as well as their interaction on number of panicles m^{-2} in 2015 and 2016 seasons are presented in Tables (10 and 11).

Results in Table (10) reveal that, there were high significant differences in number of panicles m^{-2} among rice genotypes in both seasons. Rice genotypes GZ 9461-4-2-3-1 gave the maximum number of panicles m^{-2} (527.05 and 535.33 m^2) in the first and second season, respectively. While the lowest values were found in rice genotype GZ10154-3-1-1-1 (468.63 and 474.65) in both seasons, respectively. It could be concluded that, the increase in number of panicles m^{-2} resulted from the increase in number of tillers m^{-2} due to stimulation effect of branches which gave more panicles m^{-2}. It is noteworthy to observe that, rice genotypes in producing tillers most of which are productive. Such tendency, as here obtained, seems to be more economical and characteristic of better yielding.

Data in Table (10) show that the successive increase in NPK rates from zero (control) to 100 % NPK resulted in a progressive increase in number of panicles m^{-2} in the two rice seasons. Number of panicles m^{-2} were higher at 100% NPK application (548.75 and 558.28) over those of zero (control) (408.56 and 413.69) in the first and second season, respectively. Such results indicated that, with higher application of NPK, more tillers develop a panicle. The promoting effect of NPK on number of panicles m^{-2} was reported by **Kandil et al., (2010), Debnath et al., (2013), Kanafany et al., (2014) and Hashem (2016).**

Table (10): number of panicle (m^2), length (cm) and weight (g) as affected by rice genotype and NPK treatments in 2015 and 2016 seasons.

Treatments	**No. of panicles (m^2)**		**Panicle length (cm)**		**Panicle weight (g)**	
	2015	**2016**	**2015**	**2016**	**2015**	**2016**
Genotypes						
GZ 9461-4-2-3-1	527.05 a	535.33 a	22.18a	23.14 a	3.31a	3.67 a
GZ 10101-5-1-1-1	433.16d	439.15d	20.63b	21.54 b	3.02b	3.33 b
GZ 10147-1-2-1-1	478.57b	485.63b	18.64c	19.51 c	2.94b	3.26 b
GZ 10154-3-1-1-1	468.63c	474.65c	20.76b	21.62 b	3.21a	3.55 a
F. Test	**	**	**	**	**	**
NPK fertilizer (%)						
100 % NPK	548.75a	558.28a	21.58a	22.72 a	3.47a	3.84 a
75 % NPK	494.89b	502.62b	20.97b	21.90 b	3.39b	3.74 b
50 % NPK	482.30c	488.87c	20.59c	21.45 c	3.18c	3.51 c
25 % NPK	449.4d	455.01d	20.45c	21.24 c	2.98d	3.29 d
Control (without NPK)	408.56e	413.69e	19.17d	19.95 d	2.59e	2.88 e
F. Test	**	**	**	**	**	**
Interaction: (G X T)	**	**	**	**	**	**

Results show in Table (11) reveal that the interaction between rice genotypes and NPK application had a highly significant effect on number of panicles m^{-2} in both seasons. Data indicate also, that the highest values of number of panicles (590 and 602) were found in plots of rice genotype GZ 9461-4-2-3-1 at the rate of 100% NPK application in both seasons, respectively. While, the lowest values of number of panicles m^{-2} (371.9 and 376.98) were obtained when rice genotype GZ10154-3-1-1-1 was unfertilized (no nitrogen, phosphorus and potassium) in the first and second seasons, respectively.

Table (11): number of panicle (m^{-2}) as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	590.00 a	543.30 d	524.30 e	518.00 f	459.66 k
GZ 10101-5-1-1-1	475.00 j	450.00 m	450.00 m	411.43 o	379.40 p
GZ 10147-1-2-1-1	580.00 b	477.96 i	456.60 l	455.00 l	423.30 n
GZ 10154-3-1-1-1	550.00 c	508.30 g	498.30 h	413.30 o	371.90 q
2016					
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	602.00 a	553.30 d	532.30 e	524.20 f	464.87 k
GZ 10101-5-1-1-1	482.60 j	456.50 m	455.60 m	416.63 p	384.40 q
GZ 10147-1-2-1-1	589.80 b	485.77 i	463.40 k	460.70 l	428.50 n
GZ 10154-3-1-1-1	558.70 c	514.90 g	504.16 h	418.50 o	376.98 r

2.2. Panicle length (cm):

Length of panicle of four rice genotypes as influenced by various NPK levels, as well as their interaction in 2015 and 2016 seasons are listed in Tables (10 and 12).

Data in Table (10) indicate that effect of rice genotypes on panicle length were significant in both growing seasons. Rice genotypes GZ9461-4-2-3-1 gave the longest panicle length (22.18 and 23.14 cm) in the first and second seasons, respectively. While, rice genotype GZ10154-1-2-1-1 produced the shortest panicle length (18.64 and 19.51 cm) in 2015 and 2016 seasons. These results may be due to the genetic characters in these new genotypes.

The analysis of variance indicated that panicle length was significantly influenced by NPK levels in both seasons of study (Table 10) Increasing NPK application markedly increased panicle length. These results were similar in both seasons. Application of 100% NPK produced the longest panicles (21.58 and 22.72 cm), while unfertilized plots (control) produced the shortest panicles (19.17 and 19.95 cm) in both seasons, respectively. The increase in panicles length by increasing NPK application could be attributed to the role of mineral fertilizer in the great energy that increase and stimulate cell division and elongation of panicle axis. The obtained results are in good a agreement with those reported by **Kandil et al. (2010), Debnath et al. (2013) and Kanafany et al. (2014)**

Table (12): Panicle length (cm) as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	23.70 a	22.70 b	22.00 bc	21.90 bc	20.60 de
GZ 10101-5-1-1-1	22.10 bc	20.90 cd	20.26 de	20.40 de	19.50 ef
GZ 10147-1-2-1-1	19.60 ef	19.00 f	19.00 f	18.50 f	17.10 g
GZ 10154-3-1-1-1	20.93 cd	21.30 cd	21.10 cd	21.00 cd	19.50 ef
2016					
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	24.94 a	23.74 b	22.91 cd	22.71 c-e	21.40 f-h
GZ 10101-5-1-1-1	23.26 bc	21.85 fg	21.14 gh	21.20 gh	20.29 i
GZ 10147-1-2-1-1	20.68 hi	19.86 ij	19.84 ij	19.29 j	17.88 k
GZ 10154-3-1-1-1	22.00 e-g	22.15 d-f	21.93 e-g	21.78 fg	20.26 i

Data in Table (12) indicate that, the interaction between rice genotype and NPK rate for panicle length was highly significant in both seasons. The tallest panicles were recorded by rice genotype GZ9461-4-2-3-1 with 100% NPK application (23.70 and 24.94cm) in 2015 and 2016 respectively. Whereas the shortest panicles were recorded by rice genotype GZ10147-1-2-1-1 with control (without application of NPK).

2.3. <u>Panicle weight (g):</u>

Tables (10 and 13) present the effect of four rice genotype and NPK levels, as well as their interaction on panicle weight (g) in 2015 and 2016 seasons.

Data in Table (10) indicate that, there were significant differences among the tested genotypes in panicle weight (g). In general, rice genotypes GZ9461-4-2-3-1 gave the heaviest panicle weight (3.31 and 3.67 g) without significant differences with rice genotype GZ10154-3-1-1-1(3.21 and 3.55 g) in both seasons, respectively. Rice genotype GZ10147-1-2-1-1 gave the highest panicle weight (2.94 and 3.26 g) in 2015 and 2016 respectively. The significant increase in panicle weight is attributed to the significant increase in number of grains per panicle and filled grains percentage. These findings agreed with **Okasha (2011), El-Refaee (2012) and Hashem (2016)**.

Results in Table (10) show that, application of NPK fertilizer had a markedly increase on panicle weight in the two seasons. Increasing NPK rate from 0 up to 100% significantly increased panicle weight in both seasons. The heaviest panicles were produced by the rate of 100% NPK (3.47 and 3.84 g) followed by 75 % NPK (3.39 and 3.74 g) in 2015 and 2016, respectively. In contrasted, the lightest panicles were obtained from control treatment without NPK application (2.59 and 2.88 g) during both seasons, respectively. The favorable effect of NPK application might be due to increasing NPK availability and subsequently increased its uptake and its content in rice plants leading to more energy grain filling process. The current findings are in good agreement with those reported by **Kandil et al. (2010), and Kanafany et al. (2014).**

Data in table (13) show that, the interaction between four rice genotypes and NPK application had a highly significant effect on panicle weight (g). Data indicate also that the heaviest panicles were found in plots of rice genotype GZ9461-4-2-3-1 at 100% NPK application (3.47 and 3.84 g) in 2015 and 2016, respectively, While, the lightest panicles were obtained when rice genotypes GZ10147-1-2-1-1 and GZ 10154-3-1-1-1 were unfertilized with

NPK fertilizers (2.59 and 2.88 g) in both seasons, respectively. These results are in harmony with those of **Okasha (2011), El-Refaee (2012) and Hashem (2016).**

Table (13): Panicle weight (gm) as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	3.82 a	3.81 a	3.31 cd	3.03 ef	2.61 ij
GZ10101-5-1-1-1	3.26 cd	3.25 cd	3.10 def	2.80 ghi	2.73 hij
GZ 10147-1-2-1-1	3.29 cd	3.02 ef	2.99 efg	2.92 fgh	2.52 j
GZ 10154-3-1-1-1	3.54 b	3.48 bc	3.33 cd	3.19 de	2.52 j
2016					
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	4.22 a	4.20 a	3.66 c	3.36 d-f	2.92 hi
GZ 10101-5-1-1-1	3.60 c	3.57 c	3.40 de	3.08 gh	3.01 h
GZ 10147-1-2-1-1	3.65 c	3.36 d-f	3.31 ef	3.22 fg	2.80 i
GZ 10154-3-1-1-1	3.92 b	3.85 b	3.68 c	3.51 cd	2.82 i

2.4. Number of filled grains /panicle:

Number of filled grains per panicle of four rice genotypes as affected by NPK levels, as well as, their interaction during 2015 and 2016 rice seasons are listed in Tables (14 and 15).

Results in Table (14) show highly significant differences existed among the four rice genotypes on number of filled grains/panicle. Rice genotype GZ9461-4-2-3-1 gave the highest number of filled grains panicle^{-1} (126.84 in the first season and 149.31 in the second season), while, rice genotype GZ 10101-5-1-1-1 recorded the lowest number of filled grains panicle^{-1} (97.41 and 116.81) in both seasons, respectively. The superiority of rice genotypes GZ9461-4-2-3-1 on filled grains panicle^{-1} mainly due to raising of photosynthesis rate, promoting assimilate translocated resulting more number of filled spikelets by the other meaning higher number of filled grains. The genotypic variation among rice genotypes may be due to the background of new genotypes.

Data in Table (14) indicated that number of filled grains per panicle was significantly increased by the application of NPK fertilizers in both rice seasons as compared with control. The greatest number of filled grains per panicle was obtained when rice plants received 100% NPK application. The favorable effect of NPK application might be due to the increase in NPK availability and subsequently content in rice plants leading to produce more energy which enhance photosynthetic rate that improved grain filling process. The current finding are in a good agreement with those reported by **Kandil et al. (2010) and Kanafany et al. (2014)**.

Table (14): Number of filled grain panicle^{-1}, unfilled No. of unfilled grains panicle^{-1} and 1000-grain weight (g) of rice genotype as affected by NPK rate in 2015 and 2016 seasons.

Treatments	No. of filled grain panicle^{-1}		No. of unfilled grains panicle^{-1}		1000-grain weight (g)	
	2015	2016	2015	2016	2015	2016
Genotypes						
GZ 9461-4-2-3-1	126.84 a	149.31 a	10.84 b	15.54 b	29.63 a	30.07 a
GZ 10101-5-1-1-1	97.41 b	116.81 c	6.10 c	10.53 c	29.03ab	29.46 ab
GZ 10147-1-2-1-1	98.90 b	119.05bc	11.68 a	16.01 a	28.33 b	28.74 b
GZ 10154-3-1-1-1	102.05b	123.65 b	5.69 c	10.72 c	27.03 c	27.41 c
F. Test	**	**	**	**	**	**
NPK Fertilizer						
100 % NPK	119.09 a	142.59 a	10.46 a	15.66 a	27.93 b	28.32 d
75 % NPK	112.15b	134.16 b	9.46 b	14.43 b	28.19 b	28.59 cd
50 % NPK	110.59b	131.19 b	8.68 c	13.36 c	28.54ab	28.95 bc
25 % NPK	100.26 c	119.92 c	7.90 d	12.29 d	28.80 a	29.23 ab
Control(without NPK)	89.41 d	108.17 d	6.38 e	10.26 e	29.06 a	29.51 a
F. Test	**	**	**	**	**	**
Interaction: G * T	**	**	**	*	ns	ns

Number of filled grains per panicle as affected by the interaction between rice genotype and NPK application in both seasons are presented in Table (15). Data show that there was highly significant effect on number of filled grains per panicle. When rice genotype GZ9461-4-2-3-1 fertilized with 100% NPK rate, the highest number of filled grains per panicle were obtained (145.93 and 171.93) in both seasons, respectively. However, the lowest number of filled grains per panicle were found when rice genotypes GZ10101-5-1-1-1, GZ 10147-1-2-1-1 and GZ 10154-3-1-1-1 were unfertilized (control).

Table (15): No. of filled grain as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	145.93 a	134.90 b	127.23 bc	120.73 cd	105.43 ef
GZ 10101-5-1-1-1	106.06 ef	105.06 ef	111.26 def	83.13 g	81.53 g
GZ 10147-1-2-1-1	109.93 def	102.53 ef	98.53 f	97.40 f	86.13 g
GZ 10154-3-1-1-1	114.43 de	106.13 ef	105.33 ef	99.80 f	84.56 g
	2016				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	171.93 a	158.90 b	149.23 c	141.53 cd	124.93 f-i
GZ 10101-5-1-1-1	127.07 f-h	124.87 f-i	130.67 f	101.93 j	99.53 j
GZ 10147-1-2-1-1	131.93 ef	123.73 f-i	118.53 hi	116.40 i	104.63 j
GZ 10154-3-1-1-1	139.43 de	129.13 fg	126.33 f-h	119.80 g-i	103.57 j

2.5. Number of unfilled grains /panicle:

Tables (14 and 16) showed the data of number of unfilled grains per panicle as affected by the four rice genotypes and the various rates of NPK fertilizer, as well as, their interaction in 2015 and 2016 seasons.

Data in Table (14) show significant genotypic differences in number of unfilled grains panicle^{-1} in both seasons. In 2015 and 2016 seasons, the highest number of unfilled grains per panicle were recorded by rice genotype GZ10147-1-2-1-1 (11.68 and 16.01), respectively. While, the lowest values were registered by rice genotypes GZ10154-3-1-1-1 (5.69 and 10.72) and rice genotype 10101-5-1-1-1 (6.10 and 10.53) in the two seasons respectively. Such genotypes differences in this trait might reveal different genetic makeup.

Respecting the effect of NPK rates, data in Table (14) indicate significant increase in number of unfilled grains panicle^{-1} due to NPK application in both seasons. The successive increase in NPK rates consequently increased number of unfilled grains panicle^{-1} in the two seasons. The maximum rate (100% NPK) resulted in the highest significant increase in number of unfilled grains panicle^{-1} (10.46 and 15.66). While the lowest numerical values were recorded in control treatment (without NPK application) (6.38 and 10.26) in both seasons, respectively. In this connection, the higher increases in number of unfilled grains /panicle of rice plants maintained at the highest level of NPK application as a result of a shortage of carbohydrate supplied per grain which indirectly caused by a successive number of grains produced by heavy NPK fertilization. Similar trend of results in number of unfilled grains panicle^{-1} were reported by **Javaid A., (2011), Petroudi et al. (2011), Saba et al. (2013), Uddin et al. (2013) and Hashem (2016).**

Data in Table (16) indicate that the interaction between rice genotypes and NPK rates on the number of unfilled grains panicle^{-1} were highly significant in 2015 and 2016 seasons.

The highest numerical panicle were produced by rice genotype GZ10147-1-2-1-1 at 100% NPK fertilizer (14.46 and 19.38) in both seasons of study, while, rice genotype GZ10154-3-1-1-1 recorded the lowest numerical (4.40 and 8.04) in both seasons, respectively.

Table (16): No. of unfilled grains as affected by the interaction between rice genotypes and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	12.73 b	12.33 bc	11.60 bc	9.60 d	7.93 ef
GZ 10101-5-1-1-1	7.80 ef	7.13 fg	5.73 hij	5.46 hij	4.40 j
GZ 10147-1-2-1-1	14.46 a	12.06 bc	11.86 bc	11.20 c	8.80 de
GZ 10154-3-1-1-1	6.86 fgh	6.33 ghi	5.53 hij	5.33 ij	4.40 j
	2016				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	17.95 b	17.41 bc	16.48 cd	14.02 ef	11.85 gh
GZ 10101-5-1-1-1	12.82 fg	11.96 g	10.15 ij	9.70 ij	8.04 k
GZ 10147-1-2-1-1	19.38 a	16.80 bc	16.27 cd	15.28 de	12.33 g
GZ 10154-3-1-1-1	12.48 g	11.57 gh	10.55 hi	10.17 j	8.82 k

2.6. Thousand grains weight (g):

Data of 1000-grain weight (g) of the tested four rice genotypes as affected by different rates of NPK fertilizers. (Table 14).

Concerning the genotypic performance, genotypes differences were detected among the four genotypes in this criterion. In general, rice genotype GZ9461-4-2-3-1 produced the heaviest 1000-grains weight (29.63 and 30.07) followed by GZ10101-5-1-1-1 (29.03 and 29.46) without any significant differences in both seasons, respectively. On the other hand, rice genotype GZ10154-3-1-1-1 recorded the lightest 1000-grain weight (27.03 and 27.41) in 2015 and 2016 rice seasons. From these facts, it can be concluded that each rice genotypes has its own different grain size which may be a scribed to different genetical makeup. Similar findings were reported by **Gorgy (2010), Sheta (2010), Okasha (2011), El-Refaee (2012), and Hashem (2016)**.

Also, the results in the same Table revealed that NPK rates were highly significant effected on 1000-grain weight in both seasons. Whereas, control treatment (without NPK application) gave the heaviest 1000-grains weight (29.06 and 29.51), and rate of 100% NPK fertilizers gave the lightest 1000-

grains weight (27.93 and 28.32) in both seasons, respectively. This Mainly due to the higher number of spikelets per panicle in plants received NPK at any of the rates than those did not received any NPK. So the sink capacity is high and the source is limited, therefore, the filling of grains will be more consequently the weight of grains will be high. These results are in harmony with the results obtained by **Javaid (2011), Petroudi et al (2011), Saba et al (2013), Debnath et al (2013), Uddin et al. (2013) and Hashem (2016).**

Concerning the interaction between genotypes and different fertilization treatments data in table (14) showed that, no significant effect due to the interaction I n both seasons.

2.6. Grain yield (t ha^{-1}):

Grain yield is the final indicator of crop behavior under different crop management practices. Data pertaining to grain yield of the four rice genotypes as influenced by different NPK rates, as well as their interaction in 2015 and 2016 are presented in Tables (17 and 18).

Data in Table (17) show grain yields was highly significantly different among the four rice genotypes in both seasons. Rice genotype 9461-4-2-3-1 out yielded other rice genotypes and ranked first which gave (8.73 and 9.60 t ha^{-1}) followed by rice genotype GZ 10147-1-2-1-1 which gave (8.68 and 9.56 t ha^{-1}) without any significant differences between them. While rice genotype GZ 10154-3-1-1-1 ranked last in both season which gave the lowest values (8.17 and 9.05 t ha^{-1}). Obtained results suggest the importance of number of panicle m^{-1} and the number of filled grains per panicle in determining magnitude of the increase or decrease in grain yield of some rice genotypes. The differences in grain yield is attributed mainly to the variations in most yield components, i.e. number of panicles/m^2, number of grains per panicle, 1000-grain weight and filled grains percentage. As well as, genotypes variation in root size are so far common thus, genotypes which having vigorous and extensive root systems, can explore large soil volumes and absorb more water and nutrients and can increase crop yield and nutrient use efficiency. These results agree with those reported by **Okasha (2011), El-Refaee, I.S. (2012) and Hashem (2016).**

Nitrogen, Phosphorus and potassium application led to significant increment of rice grain yield with raising NPK levels from 0 to 100% NPK in both seasons of study Table (18). The plot fertilized by the rate of 100% NPK gave the greatest grain yielded (9.01 and 9.90 t ha^{-1}), while the lowest grain yield (8.09 and 8.98 t ha^{-1}) in both seasons were produced when the plants were unfertilized (control treatment). Grain yield, in fact, is the out product of its main components. Any increase in one or more of such components without decrease in others will lead to an increase in grain yield. Therefore, the increase in grain yield due to applying 100% NPK treatment was the logical resultant due to the achieving increased in its components. i.e. the number of panicles m^{-2}, filled grains % and the number of grains $panicle^{-1}$. Also, the positive effect of 100 % NPK rate in increasing grain yield might be due to increase leaf area index which improved photosynthesis and accumulated more photosynthetic metabolites which translocate to the sink consequently produce higher grain yield. The current findings are in good agreement with those reported by **Kandil et al. (2010), Javaid (2011), Petroudi et al. (2011), Debnath et al. (2013), Uddin et al. (2013), Saba et al. (2013) and Hashem (2016).**

Table (17): Grain yield, straw yield and harvest index of rice genotypes as affected by NPK treatment in 2015 and2016 seasons.

Treatments	Grain yield (t ha^{-1})		Straw yield (t ha^{-1})		Harvest index (%)	
	2015	2016	2015	2016	2015	2016
Genotypes						
GZ 9461-4-2-3-1	8.68 ab	9.56 a	11.13a	12.26 a	0.442 b	0.442 c
GZ 10101-5-1-1-1	8.58 b	9.46 ab	9.78 c	10.20 d	0.469 a	0.483 a
GZ 10147-1-2-1-1	8.73 a	9.60 a	11.05 a	11.53 b	0.444 b	0.457 b
GZ 10154-3-1-1-1	8.17 c	9.05 b	10.19 b	10.64 c	0.446 b	0.461 b
F. Test	**	**	**	**	**	**
NPK Fertilizer (%)						
100 % NPK	9.01 a	9.90 a	12.49 a	13.12 a	0.421 d	0.431 d
75 % NPK	8.66 b	9.55 b	11.05 b	11.84 b	0.439 c	0.448 c
50 % NPK	8.56 b	9.44 c	10.61c	11.57 c	0.447 c	0.451 c
25 % NPK	8.36 c	9.25 d	9.71 d	10.13 d	0.462 b	0.477 b
Control (without NPK)	8.09 d	8.98 e	8.81 c	9.12 e	0.482 a	0.497 a
F. Test	**	**	**	**	**	**
Interaction: G*T	**	**	**	**	**	**

Concerning the interaction effect between the four rice genotypes and NPK treatments, data in Table (18) indicated that there were significant differences between the two factors under study. The highest grain yield (29.9 and 10.17 t ha^{-1}) obtained when rice genotype (GZ 9461-4-3-2-1) fertilized with the 100% of NPK. On the other side, the unfertilized plots of rice genotype GZ10154-3-1-1-1 gave the lowest grain yields (7.85 and 8.73 t ha^{-1}) followed by GZ10101-5-1-1-1 at the same NPK treatments without any significant differences between them in both seasons. The yield increases resulted mainly from higher NPK uptake, utilization and accumulation. It can be concluded that NPK fertilizers are effective in improving.

Table (18): Grain yield (t ha^{-1}) as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	9.29 a	8.78 bcd	8.47 def	8.49 def	8.37 efg
GZ 10101-5-1-1-1	8.95 bc	8.76 bcd	8.68 cde	8.59 de	7.92i
GZ 10147-1-2-1-1	9.07 ab	9 bc	8.97 bc	8.4 efg	8.25 fgh
GZ 10154-3-1-1-1	8.76 bcd	8.13 ghi	8.13 ghi	7.99 hi	7.85 i
2016					
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	10.17 a	9.66 c	9.35 ef	9.37 ef	9.25 fg
GZ 10101-5-1-1-1	9.83 b	9.64 c	9.56 cd	9.47 de	8.80 ij
GZ 10147-1-2-1-1	9.95 b	9.88 b	9.85 b	9.28 f	9.13 gh
GZ 10154-3-1-1-1	9.64 c	9.01 h	9.01 h	8.87 i	8.73 j

2.7. Straw yield (t ha^{-1}):

Straw yield of the four rice genotypes as affected by different rates of NPK fertilizers and their interaction are presented in Tables (17 and 19).

Data in Table (17) revealed that, there were significant differences existed among four tested rice genotypes in this criteria in both seasons. Rice genotype GZ9461-4-2-3-1 gave the highest straw yield (11.13 and 12.26 t ha^{-1}) in the first seasons, respectively followed by rice genotype GZ 10147-1-2-1-1 which gave (11.05 and 11.53 t ha^{-1}) for the two seasons, respectively. Whereas the lowest ones were (9.78 and 10.20 t ha^{-1}) for rice genotypes GZ10101-5-1-1-1 in 2015 and 2016 growing seasons, respectively. In general, the highest straw yield of rice genotype GZ 9461-4-2-3-1 might be due to its higher tillering capacity and genetic makeup. In general, the trend of results are similar with those reported by **Ebaid and El-Rewiny (2005), Gorgy (2010), Sheta (2010), Okasha (2011), El-Refaee (2012), and Hashem (2016).**

Regarding the effect of different NPK rates on this trait, data in Table (17) showed that all NPK treatments have highly significant effect in both seasons. The highest straw yield was (12.49 and 13.12 t ha^{-1}) at 100% NPK treatment. On the other, the lowest values for straw yield were (8.81 and 9.12 t ha^{-1}) obtained from control (without NPK application in both seasons of the study. The increase in straw yield by increasing NPK rates up to100% was due to the increase in most growth characters, i.e. plant height (cm), dry matter accumulations (g m^{-2}), leaf area, number of tillers per m^2 and leaf chlorophyll content. These findings are in close agreement with those reported by **Kandil et al. (2010), Javaid (2011), Petroudi et al. (2011), Debnath et al. (2013) Saba et al. (2013), Uddin et al. (2013) and Hashem (2016).**

Results in Table (19) emphasize that the interaction between rice genotypes and NPK rates application had a significant effect on straw yield ha^{-1} in both seasons. The highest values of rice straw yield were recorded when rice genotype GZ9461-4-2-3-1 and GZ10147-1-2-1-1 fertilized with 100% of NPK. On the other hand, the lowest values were recorded when NPK fertilizer was not applied to GZ10101-5-1-1-1.

Table (19): Straw yield (t ha^{-1}) as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	**NPK**				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	13.56 a	12.48 b	11.10 cd	9.04 j	9.45 hij
GZ 10101-5-1-1-1	10.87 cde	10.32 efg	10.15 fgh	9.82 ghi	7.75 k
GZ 10147-1-2-1-1	13.39a	11.35 c	11.16 cd	10.56 def	8.78 j
GZ 10154-3-1-1-1	12.14 b	10.05 fgh	10.03fgh	9.48 hij	9.26 ij
	2016				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	14.33 a	14.14 b	13.61 c	9.46 m	9.78 l
GZ 10101-5-1-1-1	11.37 g	10.77 i	10.58 j	10.22 k	8.05 o
GZ 10147-1-2-1-1	14.06 b	11.91 e	11.61 f	10.96 h	9.09 n
GZ 10154-3-1-1-1	12.74 d	10.55 j	10.49j	9.87 l	9.56 m

2.8. Harvest index (%):

Data pertaining to harvest index of the four rice genotypes as influenced by the different NPK levels, as well as, their interaction in 2015 and 2016 seasons are tabulated in Tables (17 and 20). Data in Table (17) show significant genotypes differences existed among the tested genotypes for this trait. The highest values (0.469 and 0.483) were obtained by rice genotype GZ 10101-5-1-1-1 while, rice genotype GZ 9461-4-2-3-1 gave nearly the lowest values with GZ 10147-1-2-1-1 and GZ 10154-3-1-1-1 in 2015 and rice genotype GZ 9461-4-2-3-1 recorded the lowest values on 2016 only, respectively. These findings are in close agreement with those reported by **Sheta (2010), Okasha (2011), El-Refaee (2012), and Hashem (2016).**

Harvest index was significantly affected by NPK application in both seasons. Adding NPK at the rate of zero (without NPK application) produce the greatest harvest index (0.481 and 0.496) in the two seasons of study as compared with the other tested treatments. It can be easily noticed that there were no significant differences among the tested treatments i.e. 75% NPK and 50% which gave nearly the same values of harvest index in this respect. These findings are in close agreement with those reported by **Javaid (2011), Debnath et al. (2013), Uddin et al. (2013) and Hashem (2016).**

Concerning the interaction between the four rice genotypes and the different rates of NPK application during both seasons as shown in Table (20).

Table (20): Harvest index (%) as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	0.407 h	0.413 h	0.433 fg	0.486 b	0.470 bc
GZ 10101-5-1-1-1	0.453 c-e	0.460 c-e	0.461 cde	0.470 b-d	0.503 a
GZ 10147-1-2-1-1	0.404 h	0.442ef	0.446 ef	0.440 ef	0.485 b
GZ 10154-3-1-1-1	0.420 gh	0.443ef	0.448 d-f	0.453 c-e	0.468 bc
2016					
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	0.415 gh	0.406 h	0.407 h	0.500 bc	0.486b-d
GZ 10101-5-1-1-1	0.464 d-f	0.472 d-f	0.475 c-f	0.480 b-e	0.523 a
GZ 10147-1-2-1-1	0.413 gh	0.453 f	0.459 ef	0.456 ef	0.500 ab
GZ 10154-3-1-1-1	0.430 g	0.460 ef	0.462 d-f	0.473 d-f	0.476 c-f

Data indicated that rice genotype GZ10101-5-1-1-1 with the control treatment gave the highest values of harvest index (0.503 and 0.522) on the other hand, the lowest values were obtained when rice genotypes GZ 9461-4-2-3-1 with the rate of 100 and 75 % NPK in 2015 season and 75 and 50% NPK in 2016 season. Also, GZ 10147-1-2-1-1 gave the lowest harvest index when fertilized by the rate of 100 % NPK (0.404) in 2015 season.

3. <u>Grain quality characters</u>:

3.1. <u>Hulling percentage (%):</u>

Hulling involves removing of the husk from the paddy with a minimum damage to the grain and separation the husk from the paddy to produce the brown rice. Hulling percentage as affected by the four rice genotypes and different levels of NPK fertilizers, as well as, their interaction is cited in Table (21 and 22).

Data in Table (21) show that four rice genotypes differ significantly in this trait in both seasons. In general, rice genotype GZ 10147-1-2-1-1 gave the highest values of hulling percentage (79.32 and 80.74 %) in the first and second seasons. While, rice genotype GZ 9461-4-2-3-1 gave the lowest ones (76.53 and 77.88 %) in both seasons. Such differences could be attributed to the genetic makeup. These results agree with those of name **Salem (1997), Ebaid and El-Hissewy (2001**), **Abd El-Hamed (2002) and Sheta (2010).**

In both seasons, highly differences existed among the different levels of NPK treatments for this trait. Data in Table (21) indicate that, applying NPK at the rate of 100% gave the highest values and ranked first (79.63 and 81.15 %) followed by applying NPK at the rate of 75% (79.35 and 80.85 %), while control treatment (without NPK application) gave the lowest ones (77 and 78.29 %) in both seasons, respectively. The effect of NPK application on hulling percentage mainly due to the maximum storing of starch in the endosperm of grains which caused a reduction in the hull components such as palea, lemma, pericarp, a leurone layers and rachilla. The obtained results are in accordance with the findings of **Murthy et al. (2015).**

Table (21): Percentage of hulling (%), milling (%) and head rice (%) of rice genotype as affected by NPK treatment in 2015 and2016 seasons.

Treatments	**Hulling (%)**		**Milling (%)**		**Head rice (%)**	
	2015	**2016**	**2015**	**2016**	**2015**	**2016**
Genotypes:						
GZ 9461-4-2-3-1	76.53 c	77.88 c	66.86 b	67.87 b	48.08 d	48.63 d
GZ 10101-5-1-1-1	79.39 a	80.84 a	66.92 b	67.91 b	53.44 c	53.91 c
GZ 10147-1-2-1-1	79.32 a	80.74 a	68.02 a	69.04 a	59.66 a	60.20 a
GZ 10154-3-1-1-1	78.84 b	80.22 b	67.8 a	68.81 a	57.24 b	57.76 b
F. Test	**	**	**	**	**	**
NPK Fertilizer (%):						
100 % NPK	79.63 a	81.15 a	69.20 a	70.27 a	59.00 a	59.67 a
75 % NPK	79.35 b	80.85 b	68.42 b	69.47 b	56.85 b	57.40 b
50 % NPK	78.80 c	80.19 c	67.15 c	68.15 c	54.20 c	54.70 c
25 % NPK	77.80 d	79.13 d	66.47 d	67.43 d	52.60 d	53.07 d
Control(without NPK)	77.00 e	78.29 e	65.75 e	66.71 e	50.37 e	50.79 e
F. Test	**	**	**	**	**	**
Interaction: G*T	**	**	**	**	**	**

As for the effect of interaction between four rice genotypes and different rates of NPK, data in Table (22) indicate that, there were significant differences in hulling percentage. Result observed that, the highest percentages were found in plots of rice genotypes GZ 10101-5-1-1-1 received NPK at the rate of 100% (80.80 and 82.37 %), while the lowest percentages were obtained when rice genotype GZ 9461-4-2-3-1 was unfertilized (without NPK application) which gave (74.20 and 75.46 %) in both seasons, respectively.

Table (22): Hulling percentage as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	78.03 fg	78.03 fg	76.70 h	75.70 i	74.20 j
GZ 10101-5-1-1-1	80.80 a	80.20 b	79.73 bcd	78.53 ef	77.70 g
GZ 10147-1-2-1-1	80.20 b	79.90 bc	79.70 bcd	78.60 ef	78.23 fg
GZ 10154-3-1-1-1	79.50 bcd	79.30 cd	79.10 de	78.40 fg	77.90 fg
2016					
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	79.50 fg	79.48 fg	78.03 h	76.97 i	75.46 j
GZ 10101-5-1-1-1	82.37 a	81.74 b	81.18 cd	79.90 f	79.01g
GZ 10147-1-2-1-1	81.75 b	81.41 bc	81.11 cd	79.95 f	79.52 fg
GZ 10154-3-1-1-1	81.00 cd	80.77 de	80.47 e	79.71 f	79.17 g

3.2. <u>Milling percentage (%):</u>

The process of removing the embryo and the outer bran layer from the brown rice is termed as whitening or milling. Data related to milling percentage as affected by the four rice genotypes and different rates of NPK fertilizers, as well as, their interaction in 2015 and 2016 rice seasons are shown in Table s (21 and 23).

Results in Table (21) show significant differences among the four rice genotypes for this trait in both seasons. Data revealed that rice genotype

GZ10147-1-2-1-1 gave the highest values (68.02 and 69.04%) which was statistical at bar with rice genotype GZ9461-4-2-3-1 which gave (66.86 and 67.87%) in both seasons, respectively. Such differences could be attributed to genetic makeup. **Salem (1997), Ebaid and El-Hissewy (2001)**, **Abd El-Hamed (2002) and Sheta (2010)** reported similar findings for this trait

The application of any of NPK levels caused an increase in milling percentage as compared with the control treatment (Table 21). The application of NPK at the rate of 100% gave the highest milling percentages (69.20 and 70.27%) as compared with the other levels including control treatments (without NPK application) which gave (65.75 and 66.71 %) in both seasons, respectively. The increase in milling percentage due to increasing NPK levels may be due to the increase in metabolite substances in grains. These findings are in close agreement with those reported by **Murthy et al. (2015).**

Data listed in Table (23) show that interaction between four rice genotypes and different levels of NPK fertilizers had a highly significant effect on milling percentage in both seasons. Data indicate that the highest values of milling percentage were found by rice genotypes GZ 10154-3-1-1-1 and GZ9461-4-2-3-1 received NPK fertilizers at the rate of 100%, while the lowest values were obtained when no NPK fertilizers were applied to rice genotype GZ 10101-5-1-1-1 and GZ 9461-4-2-3-1 in both seasons of the study.

Table (23): Milling percentage as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	69.30 ab	68.60 bc	66.30 e	65.50 f	64.60 g
GZ 10101-5-1-1-1	68.80 bc	68.60 bc	67.13 d	65.60 f	64.50 g
GZ 10147-1-2-1-1	68.80 bc	68.60 bc	67.70 d	67.50 d	67.50 d
GZ 10154-3-1-1-1	69.90 a	67.90 cd	67.50 d	67.30 d	66.40 e
2016					
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	70.39 ab	69.65 c	67.31 f	66.48 g	65.53 h
GZ 10101-5-1-1-1	69.87 bc	69.64 c	68.11 e	66.55 g	65.40 h
GZ 10147-1-2-1-1	69.88 bc	69.64 c	68.69 de	68.41 de	68.60 de
GZ 10154-3-1-1-1	70.96 a	68.96 d	68.52 de	68.30 de	67.34 f

3.3. Head rice percentage (%) in milled grain rice:

Head rice percentage as affected by the four rice genotypes and different levels of NPK application, as well as, their interaction in the first and second seasons are listed in Tables (21 and 24).

Data given in Table (21) showed highly significant differences existed among the four rice genotypes in both seasons. In general, rice genotype GZ10147-1-2-1-1 gave the highest values of head rice percentage (59.66 and 60.20 %) than did rice genotype GZ 9461-4-2-3-1 which gave the lowest values (48.08 and 48.63%) in both seasons. The advantage of rice genotype GZ10147-1-2-1-1 in head rice percentage could be attributed to genetic makeup. In general, the trends of results are similar to those of hulling and milling% and similar discussion could be cited. Similar findings were reported by **Salem (1997), Abd El-Hamed (2002) and Sheta (2010)**.

Head rice percentage significantly affected by NPK application. Increasing NPK levels from zero up to 100% significantly increased head rice percentage as compared with control treatment. The highest head rice percentage were found when rice received NPK at the rate of 100% (59.00 and 49.67%), so the rate of 100% was the best in contrast the lowest head rice percentage were obtained from control (without NPK application) in 2015 and 2016 seasons. Similar findings were observed by **Murthy et al. (2015).**

Data presented in Table (24) show that the interaction between the four rice genotypes and different levels of NPK application had a highly significant effect on head rice percentage in both seasons. Data revealed that the rice genotype GZ 10147-1-2-1-1 combined with the rate of 100% NPK fertilizers gave the highest values of head rice percentage (63.00 and 63.74 %), while the lowest values of head rice percentage were observed from rice genotype GZ 9461-4-2-3-1 with control treatment (without NPK application) (43.00 and 43.22) in both seasons, respectively.

Table (24): Head rice percentage as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	**NPK**				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	56.90 g	51.30 L	44.60 n	44.60 n	43.00 o
GZ 10101-5-1-1-1	55.90 h	55.30 i	54.10 j	52.30 k	49.60 m
GZ 10147-1-2-1-1	63.00 a	61.60 b	58.80 e	57.90 f	57.00 g
GZ 10154-3-1-1-1	60.20 c	59.20 de	59.30 d	55.60 hi	51.90 k
2016					
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	57.59 g	51.97 n	45.11 p	45.08 p	43.42 q
GZ 10101-5-1-1-1	56.45 h	55.81 j	54.57 k	52.72 l	50.00 o
GZ 10147-1-2-1-1	63.74 a	62.14 b	59.32 e	58.40 f	57.44 g
GZ 10154-3-1-1-1	60.90 c	59.71 d	59.80 d	56.08 i	52.33 m

3.4. <u>Grain length(mm) in milled grain rice</u>:

Data in Tables (25 and 26) show the effect of four rice genotypes and different levels of NPK application, as well as, their interaction on grain length in both seasons of the study. As indicated in Table (25), the four genotypes were significantly differed in grain length in the two seasons. The result indicated that rice genotype GZ 10154-3-1-1-1 and GZ10101-5-1-1-1 had significantly the longest grain (4.93 and 5.07 mm) and (8.20 and 8.44 mm) in both seasons, respectively. Rice genotype GZ 10147 1-2-1-1 gave the shortest grains (4.48 mm and 4.60 mm) in both seasons, respectively. The difference among the four rice genotypes regards grain length may be attributed to their genetic variation. Similar trend of results was found by **Salem (1997), Abd El-Hamed (2002) and Sheta (2010).**

In addition, data in Table (25) show that the grain length was significantly differed as affected by NPK application in both seasons. The results show that the rate of 100% NPK produced the longest grains (4.80 and 4.96 mm) as compared with the other treatments, while the shortest grains were observed by control treatment (without NPK application). These results were hold true in both seasons. The effect of NPK application on grain length mainly attributed to that NPK were rapidly deposited in spikelet's during the ripening stage. With the progress of ripening, P ultimately accumulates in the form of phytic acid in cellular particles of the aleurone layer. Phytic acid becomes the source of phosphoric acid. Phytic acid functions to adjust the concentration of phosphoric acid utilized for the starch synthesis leading to a longest spikelet Also, the current findings are in good agreement with those of **Salem (1997) and Abd El-Hamed (2002).**

Table (25): Grain length (mm), grain width (mm), kernel elongation (%) and gelatinous temperature (ºc) of rice genotype as affected by NPK rate in 2015 and 2016 seasons.

Treatments	Grain Length (mm)		Grain Width (mm)		Kernel Elongation (%)		Gelatinous Temperature (ºc)	
	2015	2016	2015	2016	2015	2016	2015	2016
Genotypes:								
GZ 9461-4-2-3-1	4.57 b	4.70 b	3.11 d	3.13 d	43.78 a	45.05 a	7.11 a	7.33 a
GZ 10101-5-1-1-1	4.92 a	5.07 a	3.31 b	3.34 b	38.09 b	39.09 b	6.30 b	6.49 b
GZ 10147-1-2-1-1	4.48 c	4.60 c	3.50 a	3.52 a	32.34 c	30.82 d	4.83 d	4.99 d
GZ 10154-3-1-1-1	4.93 a	5.07 a	3.21 c	3.23 c	30.16 d	33.09 c	4.95 c	5.13 c
F. Test	**	**	**	**	**	**	**	**
NPK Fertilizer (%):								
100 % NPK	4.80 a	4.96 a	3.52 a	3.55 a	36.11 a	37.25 a	5.83 a	6.06 a
75 % NPK	4.75 b	4.90 b	3.33 b	3.36 b	36.10 b	37.13 b	5.82 ab	6.03 ab
50 % NPK	4.71 c	4.84 c	3.32 b	3.27 c	36.09 c	37.04 c	5.81 bc	6.00 bc
25 % NPK	4.69 c	4.81 cd	3.25 c	3.34 b	36.08 d	36.87 d	5.79 c	5.97 c
Control(withoutNPK)	7.67 c	4.78 d	2.99 d	3.01 d	36.08 e	36.76 e	5.73 d	5.88 d
F. Test	**	**	**	**	**	**	**	**
Interaction: G*T	**	**	**	**	**	**	**	**

The interaction between the four rice genotypes and different rates of NPK fertilizers showed significant effect on grain length in two studied seasons. Data in Table (26) classified that in the first season, application of 100,75 or 50 % NPK to GZ 10101-5-1-1-1 recorded the longest grains. In the same direction, GZ 10154-3-1-1-1 treated with any of NPK treatments produced statistically similar trend of above mentioned combinations. in the second season, the longest grains were observed where 100% NPK was applied to rice genotypes GZ 10101-5-1-1-1-1 and GZ 10154-3-1-1-1 or 75% NPK was applied to GZ10101-5-1-1-1. Data also, indicated that the shortest grain were obtained from rice genotype GZ 10147-1-2-1-1 with control treatment (without NPK application) which gave (4.44 and 4.53 mm) in the two growing rice seasons.

Table (26): Grain length (mm) as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	4.64 c	4.63 d	4.58 e	4.50 e	4.50 e
GZ 10101-5-1-1-1	5.00 a	4.98 ab	4.92 ab	4.86 b	4.85 b
GZ 10147-1-2-1-1	4.50 e	4.50 e	4.50 e	4.50 e	4.44 e
GZ 10154-3-1-1-1	4.98 ab	4.92 ab	4.92 ab	4.92 ab	4.92 ab
	2016				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	4.90 e	4.77 f	4.63 g	4.62 gh	4.60 gh
GZ 10101-5-1-1-1	5.18 a	5.13 a-c	5.06 cd	4.99 d	4.98 d
GZ 10147-1-2-1-1	4.65 g	4.63 g	4.69 gh	4.62 gh	4.53 h
GZ 10154-3-1-1-1	5.15 ab	5.07 b-d	5.05 cd	5.04 d	5.04 d

3.5. Grain width (mm) in milled grain rice:

Data in Tables (25 and 27) show the effect of four rice genotypes and different rates of NPK fertilizers, as well as, their interaction in 2015 and 2016 seasons.

As indicated in Table (25), the mean values of grain width of the four rice genotypes were significant differed in both seasons. The results indicated that rice genotype GZ 10147-1-2-1-1 had significantly the highest values of grain width (3.50 and 3.52 mm) which the lowest ones were found in rice genotype GZ 9461-4-2-3-1 which gave (3.11 and 3.13 mm) in 2015 and 2016 seasons, respectively. Such differences in grain width among rice genotypes might be attributed to different genetic makeup.

Data cleared that there was high significant difference in grain width due to NPK treatments in 2015 and 2016 seasons, (Table 25). The widest grains were obtained when rice plots fertilized using the rate of 100% NPK (3.52 and 3.55 mm) in both seasons, respectively. on the other side, the lowest values of grain width were found in plots which didn’t receive any of the tested fertilizers (without NPK application) in both seasons (2.99 and 3.01 mm), respectively. The favorable effect of NPK application might be due to the increase in NPK availability and subsequently increased its uptake and its content in rice plants leading to produce more energy which enhance photosynthetic rate that improved grain filling and grain width. The current findings are in good agreement with those reports by **Salem (1997) and Abd El-Hamed (2002).**

Grain width (mm) as affected by the interaction between four rice genotypes and different rates of NPK application in both seasons are listed in Table (27). Data show that there are a highly significant effect on grain width in both seasons. When rice genotypes GZ10101-5-1-1-1 in the first and second seasons or GZ10147-1-2-1-1 in first season only fertilized by the rate of 100% NPK, highest values of grain width were observed (3.74 and 3.78 mm) or (3.68 mm) in both seasons, respectively. On the other hand, the lowest values (2.42 and 2.43 mm) where obtained when rice genotypes GZ9461-4-2-3-1 was unfertilized (control treatment) in 2015 and 2016 seasons.

Table (27): Grain width (mm) as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	3.26 fg	3.18 ghi	3.10 i	3.60 b	2.42 j
GZ 10101-5-1-1-1	3.74 a	3.33 ef	3.18 ghi	3.17 gh	3.15 hi
GZ 10147-1-2-1-1	3.68 a	3.57 bc	3.52 c	3.43 d	3.32 ef
GZ 10154-3-1-1-1	3.40 de	3.26 fg	3.20 gh	3.10 i	3.09 i
	2016				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	3.28 hi	3.20 j	3.12 k	3.61 c	2.43 l
GZ 10101-5-1-1-1	3.78 a	3.37 fg	3.21 j	3.19 j	3.16 jk
GZ 10147-1-2-1-1	3.71 b	3.59 cd	3.54 d	3.44 e	3.34 gh
GZ 10154-3-1-1-1	3.42 ef	3.28 hi	3.22 ij	3.11 k	3.10 k

3.6. <u>Kernel elongation (%) in milled grain rice:</u>

Data in Tables (25 and 28) show that the mean values of the tested rice genotypes regarding kernel elongation (%) were significantly differed as influenced by different level of NPK fertilizers and their interaction during first and second seasons.

Kernel elongation is one of the major determination of cooking and eating quality characters of rice. Data in Table (25) revealed that rice genotypes significantly varied in their elongation during both seasons. Rice genotypes GZ9461-4-2-3-1 produced the highest values of kernel elongation (43.78 and 44.05 %), while the lowest values were recorded by rice genotype GZ10154-3-1-1-1 which gave (30.16 and 33.09 %) in the two seasons of study, respectively. The genotypes variation might be due to their differences in their genetic makeup. These results are similar to **Salem (1997), Abd El-Hamed (2002) and Sheta (2010)**.

The analysis of variance of the data resulted in 2015 and 2016 seasons, showed that varying NPK levels caused significant effect as listed in Table (25). Data show that the highest elongation values were recorded by the rate of 100% NPK (36.11 and 37.25 %) in the first and second seasons. However, the lowest ones were found when rice plants didn't fertilize with any of the tested fertilizer (control treatment) (36.08 and 36.76 %) in both seasons. These results are in agreement with these detected by **Salem (1997), and Ebaid and El-Hissewy (2001**), **Abd El-Hamed (2002), and Sheta (2010).**

Regarding to the interaction between four rice genotypes and different rates of NPK fertilizers, data in Table (28) show a significant effect in kernel elongation % in both seasons. The highest values of kernel elongation (43.81

and 45.21 %) were recorded when rice plants of genotype GZ9461-4-2-3-1 fertilized by the rate of 100% NPK in first season or by the rates 100, 75 and 50 % NPK in the second season. Meanwhile rice genotype GZ10147-1-2-1-1 produced the lowest kernel elongation when unfertilizer with NPK (30.16 and 30.58 %) or fertilized with 25% NPK (30.16 and 30.66 %) in 2015 and 2016 seasons. Elongation is the expansion of rice starch upon cooking and rice varieties differ in their starch constitution which controlled by genetic background, so, rice varieties differ in elongation %.

Table (28): Kernal Elongation (%) as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	43.81 a	43.8 b	43.78 c	43.78 c	43.77 d
GZ 10101-5-1-1-1	38.11 c	38.11 e	38.09 f	38.08 g	38.08 g
GZ 10147-1-2-1-1	30.17 j	30.17 j	30.17 j	30.16 k	30.16 k
GZ 10154-3-1-1-1	32.35 h	32.35 h	32.35 h	32.33 i	32.33 i
2016					
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	45.21 a	45.18 a	45.13 a	44.98 b	44.77 c
GZ 10101-5-1-1-1	39.31 d	39.22 e	39.09 f	38.96 g	38.88 g
GZ 10147-1-2-1-1	31.15 l	30.87 m	30.87 m	30.66 n	30.58 n
GZ 10154-3-1-1-1	33.35 h	33.24 i	33.12 j	32.89 k	32.83 k

3.7. Gelatinous temperature (°c) in milled grain rice:

Gelatinous temperature is determined water uptake and time required for cooking. Gelatinization temperature affected by the four rice genotypes and rates of NPK application, as well as, their interaction is presented in Tables (26, 30).

Results in Table (25) show that there was a significant difference among the tested rice genotypes in both seasons. The minimum gelatinization temperature values were recorded by rice genotype GZ10147-1-2-1-1 (4.83

and 4.99) in the first and second seasons, respectively. However, the maximum gelatinization temperature values were found in rice genotypes GZ9461-4-2-3-1 (7.11 and 7.33) in both seasons. Gelatinization temperature differed among the tested genotypes mainly regarding to differences of the genetic factors. Combing to similar was recorded **Ebaid and El-Hissewy (2001**), **Abd El-Hamed (2002) and Sheta (2010).**

Data in Table (25) illustrate that NPK rates significantly affected the gelatinization temperature in the two seasons of the study. The maximum gelatinization temperature values were recorded when rice plants fertilized by the rate of 100% or 75% NPK application (5.83, 5.82 and 6.06, 6.03) in both seasons, respectively. Whereas the minimum gelatinization temperature values were recorded when the rice plants were unfertilized with any of tested fertilizers rates (control treatment) (5.73 and 5.88) in both seasons, respectively. This might be explained that decreasing NPK fertilizers rates could produce hard starch granules that that needs more time to be well digested.

Regarding to the interaction between four rice genotypes and different rates of NPK fertilizers, data in Table (29) showed a significant effect in gelatinization temperature values in both seasons. The highest values of gelatinization temperature values were recorded when rice plants of genotype GZ9461-4-2-3-1 fertilized by any rate of NPK in the first season or by 100,75 and 50 % NPK in the second season. Meanwhile unfertilized rice genotype GZ10147-1-2-1-1 produced the lowest kernel elongation (4.77 and 4.92 %) in 2015 and 2016 seasons.

Table (29): Gelatinous temperature (°c) as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	7.13 a	7.12 ab	7.12 ab	7.10 ab	7.09 b
GZ 10101-5-1-1-1	6.32 c	6.30 cd	6.29 cd	6.29 cd	6.28 d
GZ 10147-1-2-1-1	4.85 g	4.85 g	4.83 gh	4.82 gh	4.80 hi
GZ 10154-3-1-1-1	5.01 e	5.00 ef	5.00 ef	4.97 f	4.77 i
	2016				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	7.39 a	7.36 ab	7.34 a-c	7.30 b-c	7.27 c
GZ 10101-5-1-1-1	6.56 d	6.52 de	6.49 d-f	6.47 ef	6.43 f
GZ 10147-1-2-1-1	5.05 i	5.03 ij	4.99 i-k	4.95 jk	4.92 k
GZ 10154-3-1-1-1	5.23 g	5.20 gh	5.18 gh	5.14 h	4.91 k

3.8. Oil content in milled grain rice (%):

Data in Table (30) showed the effect of four rice genotypes and different levels of NPK application, as well as, their interaction on oil concentration in 2015 and 2016 seasons.

Data tabulated in Table (30) reveled that, there were a significant difference among four rice genotypes in oil concentration in 2015 and 2016. The highest oil concentration values were recorded by rice genotype GZ 10154-3-1-1-1 (6.95 and 7.39 %) in both seasons, respectively. However, the lowest oil concentration values were observed by rice genotype GZ 9461-4-2-3-1 (5.08 and 5.49%) in both seasons respectively. The four rice genotypes differ significantly in their oil concentration which controlled by genetic back ground. These results are in accordance with those reported by **Ebaid and El-Hissewy (2001**).

The results in Table (30) indicated that the different rates of NPK caused significant effect on oil concentration in both growing seasons. Data showed that the plants fertilized by the rate of 100%, 75%, 50% or 25% NPK produced the highest values of oil concentration in both seasons. On the other hand, the lowest values of oil concentration were observed when rice plants did not fertilize by any of the tested fertilizers (control treatment) which gave (5.61 and 6.00%) in both seasons respectively.

Table (30): Oil content (%), carbohydrate content (%), protein content (%) and amylose content (%) of four rice genotype as affected by NPK treatment in 2015 and2016 seasons.

Treatments	Oil concentration		Carbohydrate (%)		Protein content (%)		Amylose content (%)	
	2015	2016	2015	2016	2015	2016	2015	2016
Genotypes:								
GZ 9461-4-2-3-1	5.08c	5.49c	87.33a	87.48 a	6.81 b	7.00 b	16.22b	16.55b
GZ 10101-5-1-1-1	5.77bc	6.19b	87.67a	87.84 a	5.86 c	6.04 c	18.35 a	18.68 a
GZ 10147-1-2-1-1	6.00b	6.43b	86.03b	86.17b	7.28 a	7.48 a	16.59b	16.92b
GZ 10154-3-1-1-1	6.95a	7.39a	87.30a	87.46 a	5.15 d	5.32 d	17.53ab	17.86ab
F. Test	**	**	*	*	**	**	*	*
NPK Fertilizer (%)								
100 % NPK	6.25a	6.71a	87.48a	87.64 a	6.54 a	6.77 a	17.24	17.57
75 % NPK	6.03ab	6.48ab	87.09b	87.24b	6.44 b	6.64 b	16.97	17.30
50 % NPK	5.77ab	6.19ab	87.08b	87.24b	6.34 c	6.53 c	17.04	17.37
25 % NPK	6.09ab	6.49ab	86.90b	87.02b	6.27 d	6.43 d	17.14	17.47
Control(without NPK)	5.61b	6.00b	86.85b	87.01b	5.79 e	5.93 e	17.47	17.80
F. Test	*	*	*	*	**	**	NS	NS
Interaction: G*T	**	**	NS	NS	**	**	NS	NS

Data in Table (31) show that the interaction between the four rice genotypes and the different levels of NPK application was highly significant in both seasons on oil concentration (%) trait. Rice genotype GZ 10154-3-1-1-1 gave the maximum values of oil concentration regardless the level of NPK (7.06 and 7.54%) in both seasons. On the other country, the minimum values of oil concentration were observed when rice genotype GZ 9461-4-2-3-1 was unfertilized by any of the tested fertilizers (without NPK application) which gave (4.76 and 5.13 %) in both seasons, respectively.

3.9. Carbohydrate in milled grain rice (%):

The effects of different level of NPK application on the four rice genotypes, as well as, their interaction on carbohydrate during 2015 and 2016 seasons are recorded in Table (30).

Data in Table (30) show significant genotypes differences in carbohydrate in both seasons of the study. Rice genotype GZ 10101-5-1-1-1 gave the highest values of carbohydrate which gave (87.67 and 87.84) in both seasons and there were insignificant differences between the three rice genotypes GZ 9461-4-2-3-1, GZ10101-5-1-1-1 and GZ10154-3-1-1-1. On the other side, the lowest values of carbohydrate were observed by rice genotype GZ 10147-1-2-1-1 which gave (86.03 and 86.17) in both seasons, respectively, similar finding, were reported by **Ebaid and El-Hissewy (2001**), **Sheta (2010)**. The genotypes difference in carbohydrate could be attributed to different genetic make-up. It is clear from Table (30) that carbohydrate was significant affected by different level of NPK application in both seasons. The maximum values of carbohydrate were recorded by the rate of 100%NPK application (87.48 and 87.64) in both seasons. Whereas, the minimum values (86.85 and 87.01) were produced with control treatment (without NPK application). There are no significant differences among the tested rate 75% NPK and 50%, 25% and 0 % NPK during the two seasons. These results might be due to the application of high amount of NPK fertilizers which encouraged faster and earlier effective tillers and improved growth and photosynthetic rate, consequently increased stored carbohydrates at pre-heading which relatively translocate to the spikelet in the panicles.

Table (31): Oil content (%) as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	5.08ef	5.25ef	4.99ef	5.35d-f	4.76f
GZ 10101-5-1-1-1	6.53a-c	5.94b-e	5.49c-f	5.53c-f	5.37d-f
GZ 10147-1-2-1-1	6.33a-d	5.91b-e	5.74c-f	6.51a-c	5.53c-f
GZ 10154-3-1-1-1	7.06a	7.05a	6.88ab	6.98a	6.79ab
2016					
	100%	75%	50%	25%	Control
GZ 9461-4-2-3-1	5.53de	5.68c-e	5.40e	5.73c-e	5.13e
GZ 10101-5-1-1-1	7.00a-c	6.39a-e	5.91b-e	5.93b-e	5.76c-e
GZ 10147-1-2-1-1	6.80a-d	6.35a-e	6.17a-e	6.91a-d	5.92b-e
GZ 10154-3-1-1-1	7.54a	7.51a	7.31a	7.40a	7.19ab

3.10. Protein content in milled grain rice (%):

The protein content (%) data of four rice genotypes as affected by different levels of NPK fertilizer and their interaction in 2015 and 2016 seasons are present in Tables (30 and 32). Results in Table (30) show the behavior of the four rice genotypes which significantly differed regarding protein content (%) in the two seasons. Whereas rice genotype GZ10147-1-2-1-1 gave the highest values of protein content (7.28 and 7.48%), rice genotype GZ10154-3-1-1-1 showed the lowest values of protein content (%) (5.15 and 5.32%) in both seasons, respectively. Such difference is mainly due to the genotypic variations among these genotypes. Similar conclusion was reported by **Ebaid and El-Hissewy (2001**), **El-Refaee (2012) and Sheta (2010).**

The data in Table (30) indicated that all NPK fertilization rates under investigation increased protein content (%) over control treatment in the two seasons. The highest values (6.54 and 6.77 %) were recorded by adding 100% NPK rate in both seasons, respectively. The lowest values of protein content (5.79 and 5.93 %) were obtained from control treatment (without NPK application) in both seasons. Since all amino acid contain nitrogen in their molecular configuration and protein are assembled from component amino acid, nitrogen is necessary for protein synthesis. Also, this mainly due to that phosphorus plays an important role in energy transfer in protein synthesis. It is also, a component of RNA, the compound that reads the DNA genetic code to build protein. Finally, application of potassium increased the translocated metabolites included amino acids to the grain, resulting more protein content. Similar trends were found in a parallel genotype with those of **Hao et al. (2007)**, **Petroudi et al. (2011) and Singh et al. (2011).**

Grain protein content % as affected by the interaction between four rice genotypes and different levels of NPK fertilizer in both seasons are listed in Table (32). Data showed that the interaction between rice genotypes and NPK fertilizer had a highly significant effect on grain protein content in both seasons. Data indicated that the highest values of protein content % were found in rice genotypes GZ10147-1-2-1-1 which received NPK at the rate of 100% (7.51 and 7.75%) in both seasons. While the lowest values of protein content were found in rice genotypes GZ10154-3-1-1-1 when no NPK were applied in both seasons.

Table (32): Protein content (%) as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	**NPK**				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	7.20 d	7.03 e	6.90 f	6.86 g	6.05 i
GZ 10101-5-1-1-1	6.05 i	5.97 j	5.87 k	5.81 l	5.61 m
GZ 10147-1-2-1-1	7.51 a	7.47 b	7.47 b	7.35 c	6.61 h
GZ 10154-3-1-1-1	5.43 h	5.27 n	5.14 o	5.05 p	4.87 q
2016					
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	7.43 d	7.24 e	7.09 f	7.02 g	6.21 j
GZ 10101-5-1-1-1	6.27 i	6.17 j	6.05 k	5.96 l	5.76 m
GZ 10147-1-2-1-1	7.75 a	7.69 b	7.67 b	7.53 c	6.76 h
GZ 10154-3-1-1-1	5.63 n	5.45 o	5.31 p	5.20 q	5.00 k

3.11. Amylose content in milled grain rice (%):

Amylose content % is a major determinant of cooking and eating quality of rice. Data in Table (30) showed the effect of four rice genotypes, different levels of NPK fertilizers and their interaction on amylose content%.

It is clear from Table (30) that amylose content was highly significant affected by four rice genotypes. Data cleared that rice genotypes GZ10101-5-1-1-1 gave the highest values of amylose content (18.35 and 18.69 %) in 2015 and 2016 seasons, respectively. This genotypes variation might be attributed to their differences in their genetic makeup. Since all the tested genotypes exhibited amylose content less than 20%, they are considered low amylose content. According to William (1958), amylose content is the major influencing water absorption and volume expansion during cooking as well as the texture and glass of boiled rice. Similar results were reported by **Ebaid and El-Hissewy (2001**), **Sheta (2010) and El-Refaee, (2012),**

Analysis of variance in Table (30) indicated that, NPK levels had no significant effect on amylose content in the first and second seasons.

The interaction between the four rice genotypes and different rates of NPK application under this experiment had insignificant effect on amylose content (%) in both seasons of the study.

4- Determination of N, P, K and Zinc % in milled grain rice:

4.1. Nitrogen content in milled grain rice (%):

Data pertaining to nitrogen percentage in milled grains of the four rice genotypes as affected by the different rates of NPK application, as well as, their interaction during 2015 and 2016 rice seasons are shown in Tables (33 and 34).

Concerning the effect of four rice genotypes, significant differences were found among the tested genotypes during both seasons as shown in Table (33). Data indicate that rice genotype GZ 10147-1-2-1-1 gave the highest values of nitrogen percentage and ranked first (1.237 and 1.301 %) during both seasons. Also, data cleared that rice genotype GZ 10154-3-1-1-1 produced the lowest values and ranked last (0.887 and 0.937%) in both seasons, respectively. The variation in this trait among the different genotypes could be attributed to the variation in their genetic construction. These findings are in agreement with those reported by **Hashem (2010), Okasha (2011), Islam et al. (2011), El-Refaee (2012) and Hashem (2016).**

The effect of NPK levels on nitrogen content (%) in milled grains in the two seasons are presented in Table (33). Data show that nitrogen content (%) in milled grains was significantly affected by the application of NPK fertilizer in both seasons. Nitrogen content (%) increased significantly when NPK rates increased from zero up to 100% NPK. This trend was found in both seasons. The highest values were (1.096 and 1.181 %) at the rate of 100% NPK, while the lowest values (1.021 and 1.041 %) with the control treatment (without NPK application). This might be due to that phosphorus plays avital role in virtually every plant process that involves energy transfers. High energy phosphate, held as a part of chemical structure of adenosine diphosphate (ADP) and adenosine triphosphate (ATP), is the source of energy that drives the multitude of chemical reaction with in the plant. The energy stored in these phosphate compounds allows for the transportation of nutrients such as nitrogen across the cell wall. The nitrogen translocation to grain could be dependent upon availability of the high-energy currency, ATP with high level of ATP, more phosphorus would be available of phosphorylation reaction as well as translocation nitrogen to grain. These finding are consistent with those reported by **Hashem (2010), Debnath et al. (2013), Li et al. (2014), Wanyama et al. (2015) and Hashem (2016).**

Data in Table (34) show that the interaction between NPK level and the rice genotype had a highly significant effect on nitrogen content (%) in milled rice grains in both seasons. Data noticed that highest nitrogen content were observed from rice genotype GZ10147-1-2-1-1 with the rate of 100% (1.273 and 1.346 %) in both seasons, while, the lowest values were found when rice genotypes GZ10154-3-1-1-1 was unfertilized with any of the tested fertilized with any of the tested fertilizers during both seasons.

Table (33): Concentration of nitrogen (%), phosphorus (%), potassium (%) and zinc(ppm) as affected by NPK rate in 2015 and2016 seasons.

Treatments	**Nitrogen concentration (%)**		**Phosphorus concentration (%)**		**Potassium concentration (%)**		**Zinc concentration (ppm)**	
	2015	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Genotypes:								
GZ 9461-4-2-3-1	1.169b	1.219b	0.208 b	0.194 b	0.307 b	0.299 b	44.90 b	41.93 b
GZ 10101-5-1-1-1	1.023c	1.059c	0.199 c	0.183 c	0.294 c	0.287 c	42.95 c	38.01c
GZ 10147-1-2-1-1	1.237a	1.301a	0.217 a	0.205 a	0.316 a	0.308 a	47.49 a	45.57 a
GZ 10154-3-1-1-1	0.887d	0.937d	0.152 d	0.172 d	0.283 d	0.275 d	39.91 d	36.22 d
F. Test	**	**	**	**	**	**	**	**
NPK Fertilizer (%)								
100 % NPK	1.096a	1.181a	0.215 a	0.238 a	0.350 a	0.343 a	47.98 a	43.93 a
75 % NPK	1.092c	1.159b	0.215 a	0.228 b	0.340 b	0.332 b	47.11 a	43.01 a
50 % NPK	1.093b	1.141c	0.210 b	0.216 c	0.327 c	0.319 c	42.63 b	39.93 b
25 % NPK	1.093b	1.123d	0.173 c	0.198 d	0.310 d	0.301 d	37.39 c	36.02 c
Control(without NPK)	1.021d	1.041e	0.157 d	0.182 e	0.292 e	0.285 e	33.99 d	30.85 d
F. Test	**	**	**	**	**	**	**	**
Interaction: G*T	**	**	**	**	**	**	ns	ns

Table (34): Nitrogen concentration (%) in milled grains as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	1.202 e	1.191 f	1.185 g	1.203 e	1.068 i
GZ 10101-5-1-1-1	1.027 k	1.030 j	1.031 j	1.025 k	1.002 l
GZ 10147-1-2-1-1	1.273 a	1.260 b	1.257 c	1.246 d	1.150 h
GZ 10154-3-1-1-1	0.910m	0.890 n	0.886 o	0.887o	0.864 p
2016					
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	1.292 d	1.261 e	1.235 f	1.223 g	1.088 ij
GZ 10101-5-1-1-1	1.097 i	1.080 j	1.061 k	1.045 l	1.012 m
GZ 10147-1-2-1-1	1.346 a	1.337 ab	1.333 b	1.310 c	1.18 h
GZ 10154-3-1-1-1	0.990 n	0.960 o	0.936 p	0.917 q	0.884 r

4.2. <u>Phosphorus content in milled grain rice (%)</u>:

Data related to phosphorus percentage in rice grains of the four rice genotypes as affected by different levels of NPK fertilizers, as well as, their interaction during 2015 and 2016 rice seasons are shown in Tables (33 and 35).

Data in Table (33) show that the four rice genotypes differ significantly in phosphorus percentage in both seasons. Rice genotype GZ 10147-1-2-1-1 produced the highest numerical values (0.217 and 0.205 %) of phosphorus percentage, while rice genotype GZ 10154-3-1-1-1 was inferior to all other rice genotypes in this respect which gave (0.152 and 0.172 %) in both seasons, respectively. Such differences in phosphorus content in the four rice genotypes controlled by genetic background. These findings are in close agreement with those reported by **Hashem (2010), Islam et al. (2011) and Okasha (2011).**

The effect of different level of NPK fertilizers on phosphorus content (%) of the rice milled grains in the two seasons are presented in Table (33).

Milled grain phosphorus concentration tends to increase as NPK fertilizers levels increased. Increasing NPK levels from zero up to 100 % NPK increased significantly phosphorus content in rice grains which gave (0.157 and 0.182 %) with control treatment and (0.215 and 0.238 %) with the rate of 100 % NPK in both seasons, respectively. This could be attributed to that most of phosphorus applied to rice plants was accumulated in grains. **Tanaka et al. (1995)** reported that more than 70% of absorbed phosphorus by rice plants translocated to and accumulated in seeds in stored in the form of phytin.

Data listed in Table (35) show that the interaction between the four rice genotypes and the different levels of NPK fertilizers had a highly significant effect on phosphorus content (%) in rice grains in both seasons. Data indicated that the maximum percentage of phosphorus content were found in plots of rice genotype GZ 10147-1-2-1-1 which received the rate of 100% NPK (0.230 and 0.256 %), while the minimum percentages were obtained by rice genotype GZ 10154 -3-1-1-1 when no NPK fertilizers were applied (control treatment) (0.072 and 0.163 %) in both seasons, respectively.

Table (35): Phosphorus concentration (%) in milled grains as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	NPK				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	0.218 c	0.221 c	0.218 c	0.198 g	0.185 i
GZ 10101-5-1-1-1	0.212 de	0.213 d	0.207 f	0.193 h	0.173 j
GZ 10147-1-2-1-1	0.230 a	0.226 b	0.221 c	0.209 ef	0.199 g
GZ 10154-3-1-1-1	0.201 g	0.200 g	0.197 g	0.094 k	0.072 l
2016					
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	0.243 b	0.235 b	0.222 d	0.202 f	0.190 g
GZ 10101-5-1-1-1	0.234 c	0.225 c	0.210 e	0.193 g	0.174 i
GZ 10147-1-2-1-1	0.256 a	0.240 b	0.231 c	0.211 e	0.200 f
GZ 10154-3-1-1-1	0.221 d	0.210 e	0.200 f	0.184 h	0.163 j

4.3. <u>Potassium content in milled grain rice (%)</u>:

Data associated to potassium content (%) in milled grains of the four rice genotypes as affected by different levels of NPK application, as well as, their interaction during 2015 and 2016 rice seasons are shown in Tables (33 and 36).

Data given in Table (33) show that the four tested rice genotypes differs significantly from each other in potassium content percentage in both seasons. In 2015 and 2016 rice seasons, rice genotype GZ 10147-1-2-1-1 significantly produced more potassium percentages (0.316 and 0.308). Rice genotype GZ 10154-3-1-1-1 gave the lowest percentages (0.283 and 0.275%). The differences in potassium content might be attributed to the different genetic makeup of the tested genotypes. Similar trends were found by **Hashem (2010) and Okasha (2011) Hashem (2016).**

The effect of different levels of NPK application on potassium (%) of milled rice grains in the two seasons are tabulated in Table (33). Data show that NPK application increased significantly the potassium (%) when levels of NPK increased from 0 up to 100 %NPK without any significant differences with 75 % NPK. The highest values were (0.350 and 0.343%) by the rate of 100% NPK and the lowest values were (0.292 and 0.285 %) by control treatment (without NPK application) in both seasons. The increase in potassium % in rice grains due to NPK application could be attributed to that phosphorus in grain stored in phytic acid molecules. Each molecule of phytic acid contains six carbon atoms and six phosphorus atoms, and each of phosphorus atoms has negative charge. Therefore, the entire molecule contains six negative charges which can attract positively charged cations like potassium. This considered as effective way for grains to store potassium. The addition of NPK fertilizers ensures that rice will reach their potential by using the additional NPK to encourage root growth thus increase the amount of potassium absorption by rice plant than transplanted and accumulated in seeds. The obtained results are in coincidence with the findings by **Islam et al. (2011) and Hashem (2016)**.

Potassium % in milled rice grains as affected by the interaction between four rice genotypes and different levels of NPK are listed in Table (36). Data show that interaction had a highly significant effect on potassium % in both seasons. Data indicated that the highest values were found when rice genotypes GZ 10147-1-2-1-1 fertilized by the rate of 100% NPK (0.368 and 0.360%), while the lowest values (0.275 and 0.267 %) were obtained when no NPK fertilizers were applied to rice genotype GZ10154-3-1-1-1 in both seasons respectively.

Table (36): potassium concentration (%) in milled grains as affected by the interaction between rice genotype and NPK treatment in 2015 and 2016 seasons.

Genotypes	**NPK**				
	2015				
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	0.355 b	0.347 c	0.335 d	0.315 f	0.300 h
GZ 10101-5-1-1-1	0.347 c	0.335 d	0.320 f	0.305 g	0.284 i
GZ 10147-1-2-1-1	0.368 a	0.335 b	0.343 d	0.324 f	0.311 g
GZ 10154-3-1-1-1	0.332 e	0.324 f	0.311 g	0.295 h	0.275 j
2016					
	100%	**75%**	**50%**	**25%**	**Control**
GZ 9461-4-2-3-1	0.348 b	0.340 c	0.326 d	0.306 f	0.293 h
GZ 10101-5-1-1-1	0.340 c	0.328 d	0.311 f	0.297 g	0.277 i
GZ 10147-1-2-1-1	0.390 a	0.347 b	0.335 c	0.317 e	0.305 f
GZ 10154-3-1-1-1	0.325 d	0.313 f	0.304 g	0.285 h	0.267 j

4.4. <u>Zinc content in milled grain rice (ppm)</u>:

Data pertaining to zinc content (ppm) in milled grains of the four rice genotypes as affected by different levels of NPK application, as well as, their interaction during 2015 and 2016 rice seasons are shown in Table (33).

Results revealed that the mean values of the tested four rice genotypes were differed significantly in zinc content in two seasons. The highest values have been obtained by rice genotype GZ 10147-1-2-1-1 (47.49 and 45.57 ppm) in the first and second season. while, the lowest values (39.91 and 36.22 ppm) were found by rice genotype GZ 10154-3-1-1-1 in both seasons. The differences in zinc content which recorded among the tested rice genotypes, might be almost due to the genetically differences. Then findings are consistent with those reported by **Ebaid and El-Hissewy (2001)**, **Ebaid and El-Rewiny (2005) and Hashem (2010).**

Data listed in Table (33) showed that the successive increase in NPK levels from zero up to 100% NPK resulted in progressive increase in zinc content (ppm) in two seasons. The rate of 100% NPK fertilizers produced the highest values of zinc content (47.98 and 43.93 ppm) in both seasons, respectively; while the control treatment (without NPK application) gave the lowest ones (33.99 and 30.85 ppm). The increase of zinc content (ppm) mainly due to that high amount of NPK are responsible for rice plant taking up a greater total quantity of zinc from the soil through enhancement of root growth. These results are supported by **Hao et al. (2007).**

The interaction between the four tested rice genotypes and different levels of NPK fertilizers did not show any significant effect on zinc control (ppm) in both seasons.

SUMMARY

Two field experiments were conducted at Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during 2015 and 2016 rice growing seasons, to study the performance of some rice genotypes under different NPK levels. the effect of NPK-fertilizer level in permanent field on plant growth, yield and yield components of four rice genotypes namely GZ.9461-4-2-3-1, GZ.10101-5-1-1-1, GZ.10147-1-2-1-1 and GZ.10154-3-1-1-1.

The experiments were carried out in a split plot design with Three replications.

In the permanent field, growth characters such as number of tiller, plant height, dry matter production, leaf area index, chlorophyll content at (40 DAT) after transplanting, days to heading, yield and its attributes were also estimated at harvest time, grain quality characters and determination of NPK and Z in milled grains.

II) Effect of NPK-levels on the rice genotypes in permanent field:

1) Growth Characters:

1.1. Plant height (cm):

Regarding to the interaction among the factors under study there were significant differences among all the tested factors regarding to plant height at harvest. GZ 10154-3-1-1-1 rice genotypes with the highest rate of NPK fertilizer in permanent field gave the highest plant height in both seasons.

1.2. Number of tillers /m^2:

The increase of NPK levels caused an increase in number of tillers/m^2 gradually in both studied seasons. GZ.9461-4-2-3-1 rice genotypes produced

a high number of tillers/m^2 in both seasons of study compared with the rest other genotypes under the high level of NPK fertilizer.

1-3: Leaf area index (LAI):

Increasing NPK fertilizer up to 100% caused a significant increase in LAI of rice. Gz.9461-4-2-3-1 rice genotype had the highest LAI followed by GZ.10154-3-1-1-1 while GZ.10101-5-1-1-1 gave the least value in this respect.

1.4. Dry matter production (g/m^2):

Fertilizing the permanent field by 100% NPK caused a significant increase in dry matter content of rice. Gz.9461-4-2-3-1 produced the highest dry matter followed by rice genotype GZ 10154-3-1-1, while rice genotype GZ 10101-5-1-1-1 gave the least.

1.5. Chlorophyll content (UE):

The application of NPK levels at the rate of 100% gave the maximum value of chlorophyll content. Rice genotype GZ 10147-1-2-1-1 gave the highest chlorophyll content followed by rice genotypes GZ 9461-4-2-3-1. Rice genotype GZ 10151-3-1-1-1 the lowest leaf chlorophyll content.

1.6. Days to heading (Days):

The high NPK levels recorded the highest number of days to heading in both studied seasons. Rice genotype GZ 9461-4-2-3-1gave the shortest period from sowing to heading in both seasons. Meanwhile, GZ 10101-5-1-1-1 rice genotype came in the second rank. On the other hand, rice genotype GZ 10154-3-1-1-1 significantly had the longest period from sowing to heading in the first and second seasons.

2: Yield and Yield attributes:

2.1. Number of panicle /m^2:

Application of 100% of NPK in the permanent field gave the highest number of panicles/m^2. Rice genotypes GZ 9461-4-2-3-1 with the highest dose of NPK gave the highest number of panicle/m^2 in both seasons compared with the other genotypes which gave nearly the same values in this aspect.

2.2. Panicle length (cm):

Rice genotypes GZ9461-4-2-3-1 gave the longest panicle length cm. while rice genotype GZ10154-3-1-1-1 produced the shortest panicle length. Application of 100% NPK produced the longest panicles cm, while unfertilized plots (control) produced the shortest panicles cm in both seasons, respectively.

2.3. Panicle weight (g):

Rice genotypes GZ9461-4-2-3-1 gave the heaviest panicle weight without significant differences in with rice genotype GZ10154-3-1-1-1 in both seasons, respectively. The heaviest panicles were produced by the rate of 100% NPK followed by 75 % NPK.

2.4. Number of filled grain/panicle:

Rice genotype GZ 9461-4-2-3-1 gave the highest number of filled grains panicle^{-1} in both seasons, while, rice genotype GZ 10101-5-1-1-1 recorded the lowest number of filled grains/panicle in both seasons. When rice genotype GZ9461-4-2-3-1 fertilized with 100% NPK rate, the highest number of filled grains per panicle were obtained in both seasons.

2.5. Number of unfilled spikelets /panicle:

rice genotype GZ10147-1-2-1-1 recorded the highest number of unfilled spikelets per panicle, while, the lowest values were registered by rice genotypes GZ10154-3-1-1-1. By increasing rates of 100% NPK significant increase in number of unfilled spilelets /panicle. While the lowest numerical values were recorded in control treatment (without NPK application).

2.6. 1000-grain weight (g):

Increasing rates of 100% NPK to the field decrease the 1000-grain weight. Rice genotype GZ9461-4-2-3-1 produced the heaviest 1000-grains weight in both seasons.

3.7. Grain yield (t ha^{-1}):

Rice genotype 9461-4-2-3-1 showed significant superiority in grain yield in both seasons. In contrast, rice genotype GZ 10154-3-1-1-1 showed the lowest grain yield. The highest grain yield was obtained when the permanent field fertilized by 100% NPK in both seasons.

3.8. Straw yield (t ha^{-1}):

The highest rate of NPK (100%) produced the maximum straw yield in both seasons. Rice genotype GZ9461-4-2-3-1 recorded the greatest value of straw yield followed by rice genotype GZ 10147-1-2-1-1 which gave for the two seasons. Whereas the lowest ones were for rice genotypes GZ10101-5-1-1-1 in 2015 and 2016 growing seasons.

3.9. Harvest index:

The highest values were obtained by rice genotype GZ 10101-5-1-1-1 while, rice genotype GZ 9461-4-2-3-1 gave nearly the lowest values with GZ 10147-1-2-1-1 and GZ 10154-3-1-1-1 in 2015 and rice genotype GZ 9461-4-

2-3-1 recorded the lowest values on 2016 only, respectively. Harvest index was significantly affected by NPK application in both season. Adding NPK at the rate of zero (without NPK application) produce the greatest harvest index as compared with the other tested treatments.

4. <u>Grain quality characters</u>:

4.1. <u>Hulling percentage (%):</u>

In general, rice genotype GZ 10147-1-2-1-1 gave the highest values of hulling percentage. While, rice genotype GZ 9461-4-2-3-1 gave the lowest ones in both seasons. applying NPK at the rate of 100% gave the highest values and ranked first followed by applying NPK at the rate of 75% while control treatment (without NPK application) gave the lowest ones in both seasons, respectively.

4.2. <u>Milling percentage (%):</u>

The application of any of NPK levels caused an increase in milling percentage as compared with the control treatment. The application of NPK at the rate of 100% gave the highest milling percentages as compared with the other levels including control treatments (without NPK application) which gave the lowest value in both seasons respectively. Rice genotype GZ10147-1-2-1-1 gave the highest values over those of rice genotype GZ9461-4-2-3-1 which gave the lowest in both seasons of study.

4.3. <u>Head rice percentage (%):</u>

Rice genotype GZ10147-1-2-1-1 gave the highest values of heading percentage than did rice genotype GZ 9461-4-2-3-1 which gave the lowest values in both seasons. Increasing NPK levels from zero up to rate 100%

significantly increased head rice percentage as compared with control treatment.

4.4. Grain length (mm):

The result indicated that rice genotype GZ 10154-3-1-1-1 and GZ10101-5-1-1-1 had significantly the largest grain in both seasons as compared with the other genotypes. The results showed that the rate of 100% NPK produced the largest grains as compared with the other treatments, while the shortest grains were observed by control treatment (without NPK application).

4.5. Grain width (mm):

The widest grains were obtained when rice plots fertilized using the rate of 100% NPK in both seasons. Rice genotype GZ 10147-1-2-1-1 had significantly the highest values of grain width which the lowest ones were found in rice genotype GZ 9461-4-2-3-1 which gave in 2015 and 2016 seasons.

4.6. Kernel elongation (%):

Rice genotypes GZ9461-4-2-3-1 produced the highest values of kernel elongation, while the lowest values were recorded by rice genotype GZ10154-3-1-1-1 in the two seasons of study. Data showed that the highest elongation values were recorded by the rate of 100% NPK in the first and second seasons.

4.7. Gelatinous temperature (^{o}c) :

Data showed that the minimum gelatinization temperature values were recorded by rice genotype GZ10147-1-2-1-1 in the first and second seasons, respectively. However, the maximum gelatinization temperature values were found in rice genotypes GZ9461-4-2-3-1 in both seasons. the minimum gelatinization temperature values were recorded when the rice plants were unfertilized with any of tested fertilizers (control treatment) in both seasons.

4.8. Oil content (%):

The highest oil concentration values were recorded by rice genotype GZ 10154-3-1-1-1 in both seasons. However, the lowest oil concentration values were observed by rice genotype GZ 9461-4-2-3-1 in both seasons respectively. Data showed that the plants fertilized by the rate of 100% produced the highest values of oil concentration in both seasons.

4.9. Carbohydrate (%):

Rice genotype GZ 10101-5-1-1-1 gave the highest values of carbohydrate which gave in both seasons and there were insignificant differences between the three rice genotypes GZ 9461-4-2-3-1, GZ10101-5-1-1-1 and GZ10154-3-1-1-1. The maximum values of carbohydrate were recorded by the rate of 100%NPK application in both seasons. Whereas, the minimum values were produced with control treatment (without NPK application).

4.10. Protein content (%):

Rice genotype GZ10147-1-2-1-1 gave the highest values of protein content, whereas rice genotype GZ10154-3-1-1-1 showed the lowest values of protein content (%) in both seasons, respectively. Adding 100% NPK rate recorded the highest values of protein in both seasons.

4.11. Amylose content (%):

Data cleared that rice genotypes GZ10101-5-1-1-1 gave the highest values of amylose content in 2015 and 2016 seasons. Data indicated that NPK levels had no significant effect on amylose content in the both study seasons.

4- Determination of N, P, K and Zinc % in milled grain rice:

4.1. Nitrogen content of milled grains (%):

Rice genotype GZ 10147-1-1-1-1 gave the highest values of nitrogen percentage and ranked first during both seasons. Nitrogen content (%) increased significantly when NPK rates increased from zero to 100% NPK. This trend was found in both seasons.

4.2. Phosphorus content of milled grains (%):

Rice genotype GZ 10147-1-2-1-1 produced the highest numerical values of phosphorus percentage. Increasing NPK levels from zero to 100 % NPK increased significantly phosphorus content in rice grains.

4.3. Potassium content of milled grains (%):

The highest values were by the rate of 100% NPK and the lowest values were by control treatment (without NPK application) in both seasons. Rice genotype GZ 10147-1-2-1-1 significantly produced more potassium percentages.

4.4. **Zinc content of milled grains (ppm)**:

Rice genotype GZ 10147-1-2-1-1 recorded the highest values have been obtained by in the both study season. while, the lowest values were found by rice genotype GZ 10154-3-1-1-1 in both seasons. The rate of 100% NPK fertilizers produced the highest values of zinc content, while the control treatment (without NPK application) gave the lowest ones in the both study season.

C O N C L U S I O N

Application of 100% NPK of recommended dose (165 kg ha^{-1} N,36 kg ha^{-1} P and 50 kg ha^{-1} K) improved growth, yield of all the four tested genotypes GZ.9461-4-2-3-1, GZ.10101-5-1-1-1, GZ.10147-1-2-1-1 and GZ.10154-3-1-1-1. GZ.9461-4-2-3-1 as *Indica/Japonica* variety and GZ.10147-1-2-1-1 as *Japonica* variety responded more and produced the highest grain yield.

REFERENCES

A.O.A.C. (1970). Official methods of Analysis of the Association Official Analytical Chemists, 11th Ed Washington, D.C., U.S.A.

Abd El-Hamed, M.I. (2002). Agricultural studies on rice. M.Sc. Thesis, Agron. Dept., Fac. of Agric., Kafrelsheikh, Tanta Univ., Egypt.

Abd El-Salam, R.M. (2003). Effect of some cultural treatments on rice yield and its components. M.Sc. Thesis, Agron. Dept., Fac. of Agric., Cairo Univ., Egypt.

Abd-El-Maksoud, M.F. (2008). Effect of levels and Splitting of N-fertilization on growth, yield components, yield and grain quality of some rice cultivars. R.J. of Agric. and Bio. Sci., 4(5): 392-398.

Aide, M.; J. Picker and R. Skidmore (1999). Potassium and phosphorus nutrition in rice. Transactions of the Missouri Academy of Science, 1999-2000, Pub-2000, 33-34: 17-21.

Alam, M.M.; M. Hasanuzzaman and K. Nahar (2009). Tiller dynamics of three irrigated rice varieties under varying phosphorus levels. Americ. J. Agric., 2(2): 89-94.

Ali, A.; M.S. Zia; F. Hussain; M. Slim and A. Shahzad (2005). Efficacy of different methods of yield of potassium fertilizer application on paddy yield, K uptake and agronomic efficiency. Pak. J. Agric. Sci. 42 (1-2): 27-32.

Artacho, P.; C. Bonomelli and F. Meza (2009). Nitrogen application in irrigated rice grown in Mediterranean condition. J. Plant Nutr. 32: 1574-1593.

Baba, M. H; S. S. Hussain; M. A. Wani and F. A. Misgar (2010). Response of rice (*Oryza sativa*.) to levels of nitrogen and bio-fertilizers. Res. j. Agr. Sci., 1(3):237-241.

Badawi, Shaimaa, A.T. (2002). Physiological studies on rice crop. M.Sc. Thesis, Fac. Of Agric., Kaferelsheikh, Tanta Univ., Egypt.

Bagayoko, M. (2012). Effects of plant density, organic matter and nitrogen rates on rice yields in the system of rice in ten signification (SRI) in the (office du Niger) in Mali. ARPN J. Agr. Bio. Sci 7(8):620-632.

Bahmanyar, M.A. and S.S. Mashaee (2010). Influences of nitrogen and potassium top dressing on yield and yield components as well as their accumulation in rice (*Oryza sativa L.*). African J. Biotechnology, 9(18): 2648-2653.

Bahmeniar, M.A. and G.A. Ranjbar (2007). Response of rice cultivars to rates of nitrogen and potassium application in field and potassium conditions. J. Bio. Sci., 10(9)1430-1437.

Balasubramanian, R. (2002). Response of hybrid rice to levels and time of application of nitrogen. Ind. J. Agron., 47(2): 203-206.

Bera, A. K., K. Pramanik (2012). Response of hybrid rice (oryza sativa l.) to varying levels of nitrogen and Homo brassino stroid in latertic zone of west Bengal. Department of ASEPAN, Institute of Agriculture, visva-Bharati, sriniketan, west Bengal (731236), India.

Bharat, S. (2006). Response of rice to nutrients in salt soil. Farm, 15(1): 15-16.

Bhowmick, N. and R.L. Nayak (2000). Response of hybrid rice (*Oryza sativa* L) varieties to nitrogen, phosphorus and potassium fertilizers during dry (boro) season in West Bengal. Ind.J. Agron., 45(2): 323-326.

Bi, L; J. Xia; K.liu; D. Li and X. Yu. (2014). Effects of long – term chemical fertilization on trends of rice yield and nutrient use efficiency under double rice cultivation in subtropical China. Plant Soil Environ.,60 (12):537-543.

Chakraborty, K. (2011). Influenced of inorganic fertilizer on plant characters, yield generation and the incidence of yellow stem borer. scirpophaga incertulas walker in the field of local scented paddy cultivar Tulaipanji. Int. J. Appl.Bio. and Pharmaceutical Technol;2(4):264-273.

Chandel, G.; S. Banerjee; S. See; R. Meena; D.J. Sharma and S.B. Verulkar (2010). Effect of different nitrogen fertilizer levels and native soil properties on rice grain Fe, Zn and protein contents. Rice Sci., 17(3): 234-248.

Channabasavanna, A.S.; K.S. Jagadish and D.P. Biadar (2001). Effect of Azoospirillum and N levels on the growth and yield of rice. Karnataka J. Agric. Sci., 14(4): 928-931.

Chapman, H.D. and Pratt, P.F. (1961). Methods of Analysis for Soils, Plants and Waters. Division of Agric. Sci., Berkeley, Univ. California, USA, pp. 150–152.

Chettri, M.; S.S. Mondal and B. Roy (2002). Studies on the effects of sources of potassium and phosphorus with or without farmyard manure on the yield components, grain yield and percent disease index of rice under intensive cropping system. J. Interacademicia, 6(1): 45-50.

Chopra, N.K. and N. Chopra (2000). Effect of row spacing and nitrogen level on growth, yield and seed quality of rice (*Oryza sativa, L*.) under transplanted conditions. Ind. J. Agron., 45(2): 304-308.

Das, M. R. and D. K. Borah, (2000). Effect of ionic environment on root growth of rice in iron toxic soils. J. Agric. Sci. Soc. of North-East Ind., 13(1): 62-67.

Debanumaiti and D. Kdas (2005). Influence of manures and fertilizers on the yield and fertility build-up of soil under rice *(Oryza sativa, L*.)-wheat (*Triticum aestivum L*.) irrigated ecosystem. Ind. J Agric. Sci., 75(6): 343-345.

Debnath M.; M.T. Islam; E. J. Emi; S. Hasna; M.H.O. Rashid and S.C. Samanta (2013). An effect of fertilizer management practices on the yield of T. Aman rice under tidal ecocystem. American J. Agric. Foresty, 1(4):74-79.

Devasenamma, V.; M.R. Reddy and M.S. Soundararajan (2001). Effect of varying levels of nitrogen yield and yield components of hybrid rice. Ind.J. Agron., 29(29):1-3.

Devi, M.G.; S.T. Reddy; V. Sumati; T. Pratima and K. John (2012). Nitrogen management to improve the nutrient uptake, yield and quality parameters of scented rice under aerobic culture. International J. Applied Biology and Pharm. Tech., 3(1): 340-344.

Duan, Y.H.; X. Shi; S.LI; X. Sun and X. He 2014. Nitrogen Use Efficiency as Affected by Phosphorus and Potassium in Long-Term Rice and Wheat Experiments. J. Integrative Agric., 13(3):588–596·

Duncan, B. (1955). Multiple Range and Multiple F. test. Biometrics, 11: 1-42.

Dwivedi, A.P.; R.S. Dixit and G.R. Singh (2006). Effect of nitrogen, phosphorus and potassium levels on growth, yield and quality of hybrid rice (*Oryza Sativa*). Ind. J., Agron., 43(1): 64-66.

Ebaid, R.A. and A.A. El-Hissewy (2001). Effect of nitrogen and potassium fertilizers levels on grain quality characters of Sakha 101 rice cultivar. Egypt. J. Appl. Sci., 16(7): 143-150.

Ebaid, R.A. and I.M. El-Rewiny (2005). Response of some Egyptian Rice cultivars to different levels of nitrogen fertilizer. Egypt. J. Agric. Res., 83(5B):359-366.

Ebaid, R.A. and S.A. Ghanem (2000). Productivity of Giza 177 rice variety growth after different winter crops and fertilized with different nitrogen levels. Egyptian J. Agric. Res.,78(2): 717-731.

Ebaid, R.A. and S.A. Ghanem (2001). Effect of nitrogenous and potash fertilizers on the productivity of Sakha101 rice cultivar. J. Agric. Sci. Mansoura Univ., 26(4); 1833-1840.

Ebaid, R.A., (2005). Productivity of Giza 182 rice cultivar as affected by seed rates and nitrogen levels under drill. Seeding method. Egypt. J. Agric. Res., 83(5B):347-358.

El-Nory, M.I.S. (2008). Effect of organic and nitrogen fertilizer on the performance of some rice cultivars under North Delta conditions. M.Sc. Thesis, Agron. Dept., Fac. of Agric., Kfrelsheikh, Univ., Egypt.

El-Refaea, I. S. (2012). Effect of application of rice straw compost and NPK fertilizers under some irrigation regimes on grain yield and water productivity of EHRI hybrid rice cultivar. J. plant prod.Man.Univ.,3(3):445-462.

El-Rewainy, I.M. (2002). The effect of different nitrogen fertilizer sources on yield and some agricultural characters in rice. Ph.D. Thesis, Agron. Dept., Fac. of Agric., Menofiya., Egypt.

El-Shayb, O.M. (2003). Effect of hill spacing, nitrogen levels and harvest date on rice productivity and grain quality. M.Sc. Thesis, Agron. Dept., Fac. of Agric., Mansoura Univ., Egypt.

El-Siginy, M.M.M. (2004). Effect of some agronomic practices on growth yield and quality of some rice varieties (*Oryza sativa, L.*). M.Sc. Thesis, Agron. Dept., Fac. of Agric., Alexandria Univ., Egypt.

FAO, (2004). FAO STAT, FAO Statistical Databases. http://apps.fao.org.

Figeria, N.K. and V.C. Baliger (2001). Low land rice response to nitrogen fertilization. Commun. Soil Sci. Plant Anal., Vol. 32(9-10): 1429-1429.

Fraser J.R. and D.C. Holmes (1959). Proximatic analysis of wheat flour carbohydrates. J. Sci. of food and Agric. 10 (9): 506-512.

Fukushima, A.; H. Shiratsuchi.; H. Yamaguchi and A. Fukuda (2011). Effect of nitrogen application and planting density on morphological traits, dry matter production and yield of large grain type rice variety Bekouba and strategies for super high yielding rice in the Tohoku Region of Japan. Plant Prod. Sci., 14(1):56-63.

Gomez, K. and A. Gomez (1984). Statistical procedures of Agricultural Research. John Wiley and Sons. Inc., New York, USA.

Garica, L.F, and D.M.P. Azevedo (2000). Nitrogen fertilizer in irrigation rice crops. Comunicado-Embrapa-Meio-Norte.111:4.

Gorgy, R.N. (2010). Effect of transplanting spacing and nitrogen levels on growth, yield and nitrogen use efficiency of some promising rice varieties. J. Agric. Res. KafrelSheikh Univ., 36(2)123-146.

Gorgy, R.N.; I.S. El-Refaea and M.M. Nasser (2011). Influence of seedling age and nitrogen fertilizer levels on growth, grain yield, N-uptake and N-use efficiency of hybrid rice varieties. J. Plant Production, Mansoura Univ., 2(1):67-80.

Hammoud, S.A.A.; R.N. Gorge; R.A.S. El-Shafey and B.A. Zayed (2011). Evaluation of some rice quantitative characters and blast resistance under different nitrogen fertilizer levels in some promising lines. J. Agric. Res., Kafrelsheikh Univ.,37(3):418-450.

Hao, H.; W. Youzhang; Y. Xiaoe; F. Ying and W. Chunyong (2007). Effects of different nitrogen fertilizer levels on Fe, Mn, Cu and Zn concentrations in shoot and grain quality in rice (*Oryza sativa L.*). Rice Sci., 14(4): 289-294.

Hari, OM; S.K. Katyal and S.D. Dhiman (2000). Response of two rice hybrids to graded levels of nitrogen. Ind. J. Agric. Sci., 70 (30):140-142.

Hartinee, A.; M.M. Hanafi; J. Shukor and T.M.M. Mahmud (2010). Model comparisons for assessment of NPK requirement of upland rice for maximum yield. Malaysian J. Sci., 14:15-25.

Hasanuzzaman, M.; M. Ali and J. Mahmud (2012). Response of hybrid rice to different levels of nitrogen and phosphorus. Inter. Res. J. of Applied and Basic Sciences, 3(2): 2522-2528.

Hashem I. M.; E. S. Naeem; T. F. Metwally and H. M. ElSharkawi (2016). Enhancement of lodging resistance and productivity of rice using growth regulators at different nitrogen levels. Acad. J. 8(3):34-44

Hatamifar, B.; M. Ashoury; H.S. Vahed and P.S. Rokhsar (2013). Effects of irrigation and various rates of nitrogen and potassium on yield and yield components *of* rice plant (*Oryza sativa L.*). Persian Gulf Crop Protection, 2(2): 19-25.

Hirzel, J.; A. Pedreros and K. Cordero (2011). Effect of nitrogen rates and split nitrogen fertilization on grain yield and its components in flooded rice. Chilean J. Agric. Res., 71(3): 437-444.

Hossain S.; F.I. Monshi, A.M.A. Kamal and M.F. Miah (2010). Grain yield and protein content of transplant *aman* rice as influenced by variety and rate of nitrogen. J. Agric. Environ., 3(2): 235-238.

Howlader; M.I.A.; M.S. Islam; S. Rafiquzzaman; M.M.A.A. Chowdhury and M.M. Rashid (2007). Yield Response of Mungbean, T. Aus. and T. Aman Rice to NPK Fertilizers in Ganges Tidal Floodplain. J. Soil. Nature., 1 (3):11-19.

Hu, H. and W.G. Huo, (2004). Nutrient uptake and use efficiency of irrigated rice in response to potassium application .Pedosphere-(Beijing), 14(1): 125-130

Ibrahim, R. (2001). Effects of nitrogen and phosphorus levels on yield and yield components of three upland rice (*Oryza sativa*, *L.*) varieties at Samaru, Nigeria.ASSET-Series-A: Agriculture and Environment.,1(2): 115-119

Islam, M.Sh; F-Rahman and A.T.M.S. Hossain (2011). Effects of NPK briquette on rice (*Oryza Sativa, L.*) in Tidal flooded ecosystem. J.Agric.Sci. 9(152): 37-43.

Islam, M. S.; M. I. A. Howlader; S. Rafiquzzaman; H.M K. Bashar and M.H. Al-Mamun (2008a). Yield response of chili and t. Aman rice to NPK fertilizers in ganges tidal. Flood plain. J. Soil. Nature., 2 (1):07-13.

Islam, M.S.; M.A. Hossain; M.A.H. Chowdhury and M.A. Hannan (2008b). Effect of nitrogen and transplanting date on yield and yield components of aromatic rice. J. Bangladesh Agri. Univ., 6(2): 291-296.

Jackson, M. L. (1967). Soil Chemical Analysis Prentice Hall of Indica، New Delhi, PP. 144- 197.

Javid A., (2011). Effect of bio fertilizers combined with different soil amendments on potted rice plants. Chilean J. Agric. Res., 71(1):157-163.

Jean, C.P.T.N. and T. Mateille (2005). Interaction between irrigated rice *(Oryza sativa, L.*) Growth, nitrogen amendaments and infection by Hirschmanniella oryza (*Nematoda Tylenchida*). Appl. Soil Ecolo., 29: 166-177.

Juliano, B. (1971). Amplified assay for milled rice amylose cereal Sci. Today (16): 334-338, 340-360.

Kamal, M. A.; F. Rasul; A. Zohaib; K. Ahmad; T. Abbas; T. Rasool and M. Nawaz (**2016).** Effect of NPK application at various levels on yield and quality of two rice hybrids. Sci. J. Seoul Sci., 4 (1), 14-19.

Kamruzzaman, M.; M. A. Kayum; M. M. Hasan; M. M. Hasan and J. A. T. Da Silva. (2013). Effect of split application of nitrogen fertilizer on yield and yield attributes of transplanted Aman Rice (*Oryza sativa L.*). Bangladesh J. Agric. Res., 38(4): 579-587.

Kandil, A. A; S.E. El-Kalla; A.T. Badawi and O.M. El-Shayb (2010). Effect of hill spacing, nitrogen levels and harvest date on rice productivity and grain quality. Crop and Envi.,1(1):22-26.

Kanfany Gh.; R. El-Namaky; K. Ndiaye; K. Traere and R. Ortiz (2014). Assessment of rice inbred lines and hybrids under low fertilizer levels in Sengal. Sustainability, 6: 1153-1162.

Khush, G.; C. Parle and N. Delacruze (1979). Rice grain quality evaluation and improvement at IRRI Proc. Workshop on chemical aspect of rice grain quality.

Krishnakumar, S.; R. Nagarajan, S. Natarajan; D. Jawahar and B. Pandian (2005). NPK fertilizers for hybrid rice (*Oryza sativa* L.) productivity in alfisols of Southern Districts of Tamil Nadu. Asian J. of Plant Sci., 4(6): 574-576.

Kumar, N. and R. Prasad (2004). Nitrogen uptake and apparent N recovery by a high yielding variety and a hybrid of rice as influenced by levels and sources of nitrogen. Fert. News. 49 (5): 65-67.

Li, M.; H. Zhang; X. Yang; M. Ge; Q. Ma; H. Wei; Q. Dai; Z. Huo; K. Xu and D. Luo (2014). Accumulation and utilization of nitrogen, phosphorus and potassium of irrigated rice cultivars with high productivities and high N use efficiencies. Field Crops Res.,161:55-63.

Liao, Y; Sh. Zheng; Y. Lu; Z. Yang; J. Nie and J. Xie (2010). Long term effect of fertilizer application on rice yield, potassium uptake in plants and potassium balance in double rice cropping system. Front. Agric.,4 (4):406-415.

Little; R, G. Hilder and E. Dawson (1958). Differential effect of dilute alkali of 25 varieties of milled white rice. Cereal Chem., 35: 111-126.

Mahtalat, A.; M.M. Islam and S.K. Paul. (2005). Effect of nitrogen on yield and other plant characters of local T. aman rice, var. Tatai. Res. J. Agric. and Bio. Sci., 1(2): 158-161.

Maiti, S.; N. Naleshwar and S. Pal (2003). Response of high yielding and hybrid rice to varied levels of nitrogen nutrition. Environ. and Ecol., 21(2): 296-300.

Mannan, M.A.; M.S.U. Bhuiya; H.M.A. Hossain and M.I.M. Akhand. (2010). Optimization of nitrogen rate for aromatic basmati rice (*Oryza* sativa *L.*). Bangladesh J. Agric. Res., 35(1): 157-165.

Manzoor, Z.; T.H. Awan; M.A. Zahid and F.A. Faiz (2006). Response of rice (Super Basmati) to different nitrogen levels. J. Anim. Plant Sci. 16 (1-2): 52-55.

Maqsood, M.; M. A. Shehzadi and S.N. Azam (2013). Rice culture and nitrogen rate effects on yield and quality of rice (*Oryza sativa, L.*). Turk. J. Agric., 37: 665- 673.

Mauad, M.; C.A. Crusciol; H.G. Filho and J.C. Correa (2003). Nitrogen and silicon fertilization of upland rice. Scientia Agricola, 60(4): 761-765.

Meena, M.; S. Singh and Y.S. Shivay (2003). Response of hybrid rice to nitrogen and potassium application in sandy clay-loam soils. Indian J. of Agric. Sci., 73 (1): 8-11.

Metwally, T.F.; E.E. Gewaily and S.S. Naeem (2011). Nitrogen response curve and nitrogen use efficiency of Egyptian hybrid rice. J. Agric. Res. Kaferelsheikh Univ., 37(1): 73-84.

Metwally, T.F.; S.A.A. Hammoud; M.M.H. El-Malky and S.M. Bassiouni (2014). Genetic variability and performance of some promising rice genotypes as affected by nitrogen fertilizer under salt stress condition. Minufiya J. Agric. Res., 2(2): 685-702.

Metwally, T.F.; S.E.M. Sedeek;A.F. Abdelkhalik and I.M. El-Rewiny (2010). Varietal differences in physiological efficiency of nitrogen utilization in rice. Egypt J. Agric. Res., 88(1): 361-381.

Metwally, T.F. (2007). Performance of Sakha 104 rice cultivar as affected by the interaction between Zn and N, P and K fertilizer. Ph.D. Thesis, Fac. Agric., Kafrelsheikh Univ., Egypt.

Mhaskar, N.V.; J.H. Dongale; A.A. Dademal and S.A. Khanvilkar (2005). Performance of scented rice varieties under different nitrogen levels in lateriyic soil of Konkan. Oryza, 42(4):323-326.

Mingsheng, F.; R. Jiang; X.L. Zhang; S.L. Zeng and P. Christie (2005). Interactions between non-flooded mulching cultivation and varying nitrogen input in rice-wheat rotations. Field Crops Res., 71: 307-317.

Mohammed, A.A.D.A. (2007). Response of rice to chemical and biofertilizers. Ph.D. Thesis, Fac. Agric., Kafrelsheikh Univ., Egypt.

Mohammed, I.; D.R. Kumar and M. Ikramullah (2001). Influence of nitrogen on grain yield quality traits of scented rice varieties under normal and late planting. Crop Res. Hisar, 22(2): 297-299.

Murthy, K.M.D.; A.U. Rao; D Vijay and T.V. Sridhar (2015). Effect of levels of nitrogen, phosphorus and potassium on performance of rice. Ind. J. Agric. Res., 49(1)83-87.

Nagappa, M.A. and D.P. Biradar (2002). Response of hybrid rice to different levels of nutrient application in TBP area. Karnataka J. of Agric. Sci., 15(2): 356-358.

Neelam, K. C. and N. Chopra (2000). Effect of row spacing and nitrogen level on growth, yield and seed quality of rice *(Oryza sativa)* under transplanted condition. Ind. J. Agron., 45(2): 304 – 308.

Okasha, Amira M.E. Amira (2011). Effect of zinc and phosphorus fertilizer on rice crop under saline soil condition. M.Sc. Agric., Fac. Agric., Kafrelsheikh Univ.

Pandey, N.; S.K. Upadhyay and R.S. Tripathi (2001). Effect of plant growth regulators and fertility levels on growth and yield of transplanted rice. Ind. J. Agric. Res., 35(3):205-207.

Pariyani, A.K. and K.R. Naik, (2004). Effect of nitrogen level and seedling number on yield and yield attributes of rice hybrid. J. Soils and Crops. 2004,111 (2):234 – 236.

Peterpurgski, A.V. (1968). Handbook of Agronomic Chemistry. Kolop Publishing House, Moscow (In Russian, pp. 29-86).

Petroudi, R.; G.N. Mohammadi; M. J. Mirhadi; H. Madani; H.R. Mobasser (2011). Effect of nitrogen fertilization and rice harvest height on agromic yield indices of ratoon rice-berseem clover intercropping system. Australian j. Crop sci., 5(5):566-574.

Piper, C.S. (2010). Soil and Plant Analysis: A Laboratory Manual of Methods for the Examination of Soils and the Determination. Scientific Publishers Journals Dept. ISBN 10: 8172336209.

Pramanik, K. and A. K. Bera (2013). Effect of seedling age and nitrogen fertilizer on growth, chlorophyll content, yield and economics of Hybrid rice (*Oryza sativa L.*). Int. J. Agron. and Plant Prod., 4(S): 3489-3499.

Reghuwanshi, S.; Y. Swati and N. Jain (2003). Effect of nitrogen levels on grain yield and grain attributes of scented rice. JNKVV Res. J., 37(1): 24-26.

Rehman, O, M.A. Zaka, H.U. Rafa and N.M. Hassan, (2006). Effect of Balanced Fertilization on Yield and Phosphorus Uptake in Wheat-Rice Rotation. J. Agric. Res., 44(2) 105 – 113.

Reis, M.de. S; A.A. Soares; P.C. Soares and V.M.de.O. Cornelio (2005). N, P, K, Ca, Mg and S absorption as influenced by nitrogen fertilizer applied to irrigated rice. Ciencia-e-Agrotecnologia., 29(4): 707-713.

RRTC (2005). Final results of season 2004, Proc. of the 8th National rice program workshop. Rice Res. and Training Center (RRTC), Sakha, Kafrelsheikh, Egypt.

RRTC (2008). Rice research and Training Center, Proceedings of the 13th Rice Workshop, Annual Report Agronomy, Sakha, Kafrelsheikh, Egypt, pp. 38.

Saba, N.; I.U. Awan; M.S. Baloch; I.H. Shah; M.A. Nadim and J. Qadir (2013). Improving synthetic fertilizer use efficiency through bio-fertilizer application in rice. Gomal univ., J. Res., 29(2):32-38.

Sahrawat, K.L.; M.K. Abekoe; S. Diatta; G. Tian; F. Ishida; D. Keatinge; R. Carsky and J. Wendt (2001). Application of inorganic phosphorus fertilizer. In: proc. Symp. Sponsored by the American Soc. Agron., U.S.A., 5-9 November 2000, pp. 225-246.

Salama, H.S.A. (2004). Agronomic and quality characters of rice varieties as affected by nitrogen fertilization. M.Sc. Thesis, Agron. Dept., Fac. of Agric., Alexandria Univ., Egypt.

Salama, S.A.A. (2005). Effect of some cultural practices on rice crop. M.Sc. Thesis, Agron. Dept., Fac. of Agric., Kafrelsheikh, Tanta Univ., Egypt.

Salem, A.K.; W.M. Elkhoby; A.B. Abou-Khalifa and M. Ceesay (2011). Effect of nitrogen fertilizer and seedling age on Inbred and Hybrid rice varieties. American-Eurasian J. Ageric. & Environ Sci., 11(5): 640-646.

Sarker, R.R.; M.M. Ali; M.H. Rahman and M.K. Khan, (2013). Effect of Fertilizers on Yield and Nutrient Uptake by Binadhan-7 Rice Grown in old Brahmaputra Floodplain Soils. J. Environ. Sci. & Natural Resources, 6(2): 55-59.

Satyanarayana, V.P.; V.V. Prasad; V.R.K. Murthy and K.J. Boote (2002). Influence of integrated use of farmyard manure and inorganic fertilizers on yield and yield components of irrigated lowland rice. J. of Plant Nutr., 25(10): 2081-2090.

Sengar, S. S.; L. J. Wade; S. S. Baghel; R. K. Singh, and G. Singh, (2000). Effect of nutrient management on rice (Oryza sativa) in rain fed lowland of southeast Madhya Pradesh. Ind. J. Agron.45(2): 315-322.

Shaalan, A.M.A. (2009). Studies on some factors affecting quality characteristics in rice crop. Ph.D. Thesis, Agron. Dept., Fac. of Agric., Univ., Alexandria, Egypt.

Sharma, M.P. and S.V. Bali, (2001) Effect of row spacing and farmyard manure with increasing levels of nitrogen, phosphorus and potassium on yield and nutrients uptake in rice (*Oryza sativa, L.*) -wheat (Triticum Aestivum) cropping sequence. Ind. J. Agric. Sci.71(10) 661-663.

Sheta, I.A.A., (2010). Effect of planting methods and nitrogen levels on the productivity of some hybrid and inbred rice cultivars.M.SC.thesis, Agron. Dept. Fac Agric.Kafr El-Sheikh Univ., Egypt.

Shivay, Y.S. and S. Singh (2003). Effect of planting geometry and nitrogen level on growth, yield and nitrogen- use efficiency of scented hybrid rice (*Oryza sativa, L.*). Ind. J. Agron., 48(1):42-44.

Singh, A. K. and V. K. Srivastava. (2001). Response of hybrid rice to nitrogen levels under transplanted condition. Reseach on Crops.2001; vol.2 (2):243-245.

Singh, C.S. and U.N. Singh (2002). Effect of nitrogen and Sulphur nutrition on growth and yield of rice (*Oryza Sativa, L.)* cultivars. Res. Crops, 3(3):643-646.

Singh, K.K. and K. Singh (2005). Effect of nitrogen and silicon levels on growth, yield attributes and yield of rice in Alfisols. Inter. Rice Res. Notes, 30(1): 31-40.

Singh, M.K; R. Thakur; U.N. Verma and R.R. Upasani (2000). Effect of planting time and nitrogen on production potential of Basmati rice (*Oryza sativa, L.*) cultivars in Bihar Plateay. Indian J. Agron., 45(2): 300-303.

Singh, N.; N. Pal; G. Mahajan; Singh and K. Shevkani (2011). Rice grain and starch properties. Effects of nitrogen fertilizer application. Carbohydrate Polymerers, 86 (1):219-225.

Singh, T.; Y.S. Shivay and S. Singh (2004). Effect of date of transplanting and nitrogen on productivity and nitrogen use indices in hybrid and non-hybrid aromatic rice. Ind. Agric. Res. Institute, 52(3): 245-252.

Sood, G.B and E.A. Siddiq (1980). Studies on component quality attributes of basmati rice (*Oryza Sativa L.*) Z. Pflanzenziichtg., 84:294-301.

Sudharkar, G.; A. Solaimala; and N. Ravisankar. (2001). Yield and economic of semi **dry** rice as influenced by cultivars and levels of nitrogen. Indian Journal of dry land agricultural research and development .2001; vol. 16(1):42-44.

Suriya-Arunroj, D.; P. Chaiyawat, S. Fukai and P. Blamey (2000). Identification of nutrients limiting rice growth in soils of Northeast Thailand under water-limiting and non-limiting conditions. Plant Prod. Sci., 3(4): 417-421.

YosefTabar, Y.S. (2012). Effect of nitrogen and phosphorus fertilizer on growth and yield rice (*Oryza sativa, L.*). Int. J. Agron. Plant Prod., 3(12): 579-584.

YosefTabar, Y.S. (2013). Effect nitrogen management on panicle structure and yield in rice (*Oryza sativa, L.*). Int. J. of Agric. Crop Sci., 5(11): 1224-1227.

Tanaka, K.; Z. Kasai and M. Ogawa (1995). Physiology of ripening. Science of the Rice Plant. Volume two, Physiology, Food and Agricultural Policy Research Center, Tokyo, pp. 97-118.

Tang X.R. and T.Q. Yu, (2002). Effects and mechanisms of P and K nutrients on yield and protein content of fodder rice. Agric. Sci. China.1 (4): 432-437.

Tunio, G. S., Agustin, M. B; Nihal, ud. din-Mari and Babar, M.A. (2002). Growth and yield of scented rice varieties under different nitrogen levels. Sharhad J. Agric. 8 (3):303-305.

Uddin, S.; M.A.R. Sarkar and M.M. Rahman (2013). Effect of nitrogen and potassium on yield of dry direct seeded rice cv. NERICA 1. Int. J. Agro. Plant Prod.,4(1):69-75.

Upendra, R.; D. Prasad and S.K. Choudhary (2004). Evaluation of newly developed hybrid rice under different levels of nitrogen and potassium on calcitharants of North Bihar. J. Appl. Bio., 14 (1): 42-43.

Wanyama, I.; V.A. Ochwo; E. Nankya and P.J.A. Van Asten (2015). Optimization of major nutrients (N, P and K) for lowland rice production in Eastern Uganda. Int. J. Agron. Agric. Res., 7(2): 218-227.

Watanabe, F.S. and S.R. Olsen. 1965. Test of an ascorbic acid method for determining phosphorus in water and $NaHCO_3$ extracts from soils. Soil Sci. Soc. Am. Proc. 29:677-678.

Zayed, B.A.; A.M. El-Ekhtyar and M.A. Badawi (2006). Response of hybrid and inbred rice varieties to various nitrogen levels under saline soil conditions. J. Agric. Sci. Mansoura Univ., 31(12): 7497-7509.

Zhang, H.; Z.; M. Xu; X. Shi; Z. Li; Q. Huang and X. Wang (2010). Rice yield, potassium uptake and apparent balance under long-term fertilization in rice based cropping systems in sothern Chaina. Nutr. Cycle Agroecosyst, 88:341-349.

الملـخص العربي

أجريت تجربتان حقليتان بمزرعة مركز البحوث والتدريب فى الأرز - سخا- كفر الشيخ - مركز البحوث الزراعية عامى ٢٠١٥- ٢٠١٦ لدراسة تأثير بعض المعاملات السمادية على جودة الحبوب والقيمة الغذائية للمحصــول لبعض التراكيب الوراثية للأرز. اســتخدم لهذا البحث أربعة سلالات مبشرة من الأرز تسمى GZ9461-2-3-1 ، GZ 10101-5-1-1-1، GZ 10147-1-2-1-1 ، GZ 10154-3-1-1 حيث تم تســميدها بثلاثة أنواع من العناصــر الســمادية وهى النيتروجين بمعدل ١٦٥كجم/ هكتار فى صورة يوريا ٤٦,٥ % أزوت أضيفت على دفعتين الأولى ٣/٢ الكمية ٥٠ كجم /فدان علي الشراقى وقبل الرى مباشـرة والثلث الباقى بعد الشـتل بشـهر أما الفوسفور ١٥,٥% فو٢أ٥ فقد تم إضافتة مرة واحدة قبل الخدمة مباشرة بمعدل ٣٦ كجم /هكتار فى صورة سوبر فوسفات الكالسيوم ١٥,٥% وذلك لضمان خلطه بالتربة الجافة أما البوتاسيوم ٤٨% فتم إضـافتة مرة واحدة قبل الرى مباشـرة بمعدل ٥٠ كجم / هكتار فى صـورة كبريتات البوتاسـيوم وتمت الإضــافة للعناصــر الســابقة بمعدلات صــفر ، ٢٥، ٥٠، ٧٥، ١٠٠ تم إجراء كل العمليات الزراعية والمخاضــة بالأرز حسـب التوصـيلت الفنية للمحصـول طبقا للنشـرة الإرشـادية لبرنامج محصول الأرز.

استخدم تصميم القطع المنشقة مرة واحدة فى أربع مكررات حيث وضعت السلالات فى القطع الرئيسية بينما وضعت معاملات التسميد فى القطع المنشقة.

<u>بالنسبة للحقل:</u>

قدرت صـــفات النمو مثل عدد الفروع، طول النبات، المادة الجافة المتكونة، دليل مســاحة الاوراق، محتوي الكلورفيل عند ٤٠ يوم من الشـــتل، كما تم أيضـــا تقدير عدد الأيام حتى طرد السنابل وكذلك المحصول ومكوناتة و بعض صفات التكنولوجية والكيماوية.

<u>ويمكن تلخيص اهم النتائج المتحصل عليها فيما يلى:</u>

ب) تأثير التسميد النيتروجيني والفوسفاتى والبوتاسى علي صفات النمو والمحصول ومكوناته لبعض سلالات الأرز :

أولا: صفات النمو :

١. طول النبات(سم):

سجلت السلاله GZ.10154-3-1-1-1 أعلي طول نبات مع أعلي معدل من التسميد مقارنة بالسلالات الأخري في كلا الموسمين، أدت زيادة التسميد النيتروجيني والفوسفاتى والبوتاسى الي زيادة طول النبات .

٢. عدد الفروع (م٢):

أعطت السلاله GZ.9461-2-3-1 أعلي عدد من الفروع في المتر المربع بكلا الموسمين مقارنة بالسلالات الأخري، أدت زيادة مستوي التسميد النيتروجيني والفوسفاتى والبوتاسى إلي حدوث زيادة تدريجية في عدد الفروع/م٢ في كلا الموسمين .

٣. دليل مساحة الاوراق:

سجلت السلاله GZ.9461-2-3-1 أعلى دليل مساحة أوراق تلاها فى ذلك السلالة GZ 10154-3-1-1، بينما أعطت السلاله GZ.10101-5-1-1-1 أقل قيم لدليل مساحة الأوراق. نتج عن زيادة التسميد النيتروجيني والفوسفاتى والبوتاسى بنسبة ١٠٠% زيادة معنوية في دليل مساحة الاوراق.

٤. المادة الجافة المتجمعة (جم/ م٢):

أظهرت السلاله GZ.9461-2-3-1 أعلي مادة جافة تلاها فى ذلك السلاله GZ.10154-3-1-1-1، بينما أعطت السلاله GZ.10101-5-1-1-1 أقل مادة جافة متجمعة. أظهر التسميد بمعدل ١٠٠% من النيتروجين والفوسفوروالبوتاسيوم تفوقا معنويا في المادة الجافة المتكونة .

٥. محتوي الكلورفيل:

أعطت السلالة GZ.10147-1-2-1-1 أعلى محتوي كلورفيل تلاها فى ذلك السلالة GZ.9461-2-3-1 فى حين سجلت السلاله -GZ.10154-3-1-1 أقل قيم من محتوى

الكلورفيل. أظهرت النتائج أن التســـميد بمعدل ١٠٠% من النيتروجين والفوســـفور والبوتاسيوم قد سجلت أعلي قيم لمحتوي الكلورفيل.

٦. عدد الأيام حتى الطرد (يوم) :

ســـجلت الســـلالة GZ.9461-2-3-1 أقل عدد الأيام حتى الطرد تلاها فى ذلك الســـلالة GZ.10101-5-1-1-1، فى حين ســـجلت الســـلاله GZ.10154-3-1-1-1 أكبر عدد من الأيام حتى الطرد فى كلا الموسمين. سجلت أعلي قيم لعدد الأيام حتى الطرد مع التسميد بـ ١٠٠% من النيتروجين والفوسفوروالبوتاسيوم فى كلا الموسمين.

ثانيا" : المحصول ومكوناتة:-

١. عدد السنابل/ م^{٢}:

أعطت الســلالة GZ.9461-2-3-1 أعلى عدد للسـنابل بالمتر المربع عند إضــافة التسـميد النيتروجيني والفوسفاتي والبوتاسي عند مستوى١٠٠% فى كلا الموسمين، فى حين أعطت السـلالات الأخرى نسب متقاربة فى عدد السـنابل بالمتر المربع . سجل أعلي عدد سـنابل بالمتر المربع بأضافة التسميد النيتروجيني والفوسفاتي والبوتاسي عند معدل١٠٠% .

٢. طول السنبلة (سم) :

أظهرت النتائج ان الســلاله GZ.9461-2-3-1 أعلى طول سـنابل، بينما سـجلت السـلاله GZ10154-1-2-1-1 أقل القيم فى طول الســـنابل، أظهرت النتائج أن التســـميد بمعدل ١٠٠% من النيتروجين والفوسفات والبوتاسيوم قد سجلت أعلي قيم لطول السنابل فى كلا الموسمين.

٣. وزن السنابل (جرام) :

أظهرت النتائج ان الســـلالة GZ.9461-2-3-1 أعطت أعلى وزن الســـنابل بدون إختلاف معنوى مع السـلاله GZ.10154-3-1-1-1 فى كلا الموسـمين، سـجل أعلى وزن السـنابل بإضافة معدل ١٠٠% من النيتروجين والفوسفور والبوتاسيوم تلاها فى ذلك التسميد بمعدل ٧٥% من النيتروجين والفوسفور والبوتاسيوم

٤.عدد الحبوب الممتلئة:

نتج عن زراعة السـلالة GZ9461-2-3-1 أعلى عدد من الحبوب الممتلئة بالنورات بكلا الموسـمين . سـجلت الزيادة في التسـميد النيتروجيني والفوسـفاتى والبوتاســى حتى معدل ١٠٠% أعلي عدد من الحبوب الممتلئة .

٥. عدد الحبوب الغير الممتلئة:

سجلت السلاله GZ.10147-1-2-1-1 أعلى عدد من الحبوب الغير ممتلئة فى حين سجلت السلالتان GZ.10154-3-1-1-1 - GZ10101-5-1-1-1 أقل عدد حبوب غير ممتلئة فى كلا الموســمين. بزيادة مســتوى التســميد حتى معدل ١٠٠% من التســميد النيتروجيني والفوسفاتى والبوتاسى زاد عدد الحبوب الغير ممتلئة.

٦. وزن الألف حبة (جم) :

كان أعلي وزن حبة قد سجل مع السلاله GZ.9461-2-3-1 فى كلا الموسمين. أدت زيادة التسميد حتي ١٠٠% من النيتروجين والفوسفور والبوتاسيوم الي نقص وزن الألف حبة.

٧. محصول الحبوب (طن/هكتار) :

أظهرت الســلالة GZ.9461-2-3-1 تفوق معنوي في محصــول الحبوب بينما ســجلت الســلالة GZ.10154-3-1-1-1 أقل محصــول حبوب في كلا الموســمين. ســجل أعلي محصول حبوب عند التسميد بـ١٠٠% من النيتروجين والفوسفور والبوتاسيوم.

٨. محصول القش (طن/هكتار) :

ســجلت الســلالهGZ.9461-2-3-1 أعلى محصــول قش للهكتار تلاها فى ذلك الســلاله GZ.10147-1-2-1-1 أعلي القيم في محصــول القش في حين ســجل الســلالـه GZ.10101.5.1-1-1 أقل القيم في محصـول القش في كلا الموسـمين .أظهرت النتائج أن التسـميد النيتروجيني والفوسـفاتى والبوتاسـي بمعدل ١٠٠% قد أعطى أعلي محصـول قش للهكتار في كلا الموسمين من الدراسة .

٩. دليل حصاد:

أظهرت النتائج أن أعلى القيم من دليل الحصـاد قد سـجلت بواسـطة السـلاله GZ.10101-5-1-1-1 بينما أعطت السـلالة GZ9461-4-2-3-1 أقل القيم لدليل الحصــاد بكلا الموسـمين .وقد أعطت الســلاله GZ10147-1-2-1-1 والســلالةGz10154-3-1-1-1 قيم متقاربه

بموسمى الزراعة ، أيضا قد تأثر دليل الحصاد بإضافة السماد وذلك حتى مستوى ١٠٠% فى كلا الموسمين حيث وجد عدم إضافة أى سماد أعطت أعلى القيم من دليل الحصاد مقارنة بباقى المعاملات فى كلا الموسمين.

ثالثاً : صفات جودة ضرب الأرز:-

١- نسبة التقشير(%) :

سجلت السلالة GZ.10147-1-2-1-1 أعلى القيم فى نسبة التقشير، بينما أعطت السلاله GZ.9461-2-3-1 اقل القيم فى نسبة التقشير. أظهرت النتائج أن التسميد النيتروجيني والفوسفاتى والبوتاسي بمعدل ١٠٠% قد أعطت أعلي القيم فى نسبة التقشير تلاها فى ذلك التسميد بمعدل ٧٥% ، فى حين سجل عدم إضافة سماد أقل القيم فى نسبة التقشيرفي كلا الموسمين.

٢- نسبة التبيض (%) :

أعطت السلالة GZ10147-1-2-1-1 أعلى قيم مقارنة بالسلالة -GZ9461-4-2 3-1 التى اعطت أقل القيم فى كلا الموسمين أدت إضافة أى مستوى من السماد النيتروجيني الفوسفاتى البوتاسى الى زيادة نسبة التبيض مقارنة بمعاملة الكنترول (بدون سماد).

٣- نسبة الحبوب السليمة (%) :

سجلت السلالة GZ.10147-1-2-1-1 أعلى القيم من نسبة الحبوب السليمة ، بينما أعطت السلالة GZ.9641-4-2-3-1 أقل القيم من نسبة الحبوب السليمة فى كلا الموسمين. أدت زيادة التسميد النيتروجيني والفوسفاتى والبوتاسي حتى مستوى ١٠٠% الى زيادة معنوية فى نسبة الحبوب السليمة مقارنة بالكنترول (بدون تسميد).

٤- طول الحبة (مم) :

أوضحت النتائج أن السلالتان GZ 10101-5-1-1-1 GZ.10154-3-1-1-1 أعطت أعلى طول حبوب بكلا الموسمين. أعطت زيادة مستوى التسميد حتى معدل ١٠٠% أعلى طول حبوب مقارنة بباقى المعاملات بكلا موسمى الدراسة.

٥- عرض الحبة (مم):

سـجلت السـلاله GZ.10147-1-2-1-1 أعلى القيم فى عرض الحبة فى حين سـجلت السـلالة GZ.9641-4-2-3-1 أقل عرض حبة فى كلا الموسـمين. أعطت زيادة التسميد في الحقل حتي ١٠٠% من النيتروجين والفوسفور والبوتاسيوم أعلى عرض حبة .

٦- إستطالة الحبة (مم):

سـجلت السـلالة GZ.9641-4-2-3-1 أعلى القيم من إسـتطالة الحبة، بينما أعطت السلالة GZ.10154-3-1-1-1 أقل القيم من إستطالة الحبة فى كلا الموسمين. أدت زيادة التسـميد النيتروجيني والفوسـفاتى والبوتاسـي حتى مسـتوى ١٠٠% الى زيادة معنوية فى إستطالة الحبة فى كلا الموسمين.

٧- درجة الجلتنة (ºc) :

سـجلت السـلالة GZ.10147-1-2-1-1 أقل القيم من درجة الجلتنة، بينما أعطت السـلالة GZ.9641-4-2-3-1 أعلى القيم من درجة الجلتنة فى كلا الموسـمين. أدت زيادة التسـميد النيتروجيني والفوسـفاتى والبوتاسـي حتى مسـتوى ١٠٠% الى زيادة معنوية فى درجة الجلتنة فى كلا الموسمين.

٨- نسبة الزيت (%):

سـجلت السـلالة GZ.10154-3-1-1-1 أعلى نسـبة زيت فى حبوبها فى كلا الموسمين. فى حين أعطت السلالة GZ.9641-4-2-3-1 أقل نسبة زيت فى كلا الموسمين، أدت زيادة التسـميد النيتروجيني والفوسـفاتى والبوتاسـي حتى مسـتوى ١٠٠% الى زيادة معنوية فى نسبة الزيت فى الحبوب فى كلا الموسمين.

٩- نسبة الكربوهيدرات (%):

سجلت السلالة GZ.10101-5-1-1-1 أعلى نسبة كربوهيدرات فى حبوبها فى كلا الموسـمين. أدت زيادة التسـميد النيتروجيني والفوسـفاتى والبوتاسـي حتى مسـتوى ١٠٠% الى زيادة معنوية فى نسبة الكربوهيدرات فى الحبوب فى كلا الموسمين.

١٠- نسبة البروتين (%):

سـجلت السـلالة GZ.10147-1-2-1-1 أعلى محتوى بروتين فى حبوبها فى كلا الموسـمين، فى حين أعطت السـلالة GZ.10154-3-1-1-1 أقل القيم من محتوى البروتين

فى كلا موســمي الزراعة. أدت زيادة التســميد النيتروجيني والفوســفاتى والبوتاســي حتى مستوى ١٠٠% الى زيادة معنوية فى نسبة البروتين فى الحبوب فى كلا الموسمين.

١١- نسبة الأميلوز (%):

أعطت الســلالة GZ.10101-5-1-1-1 أعلى نســبة أميلوز فى حبوبها فى كلا الموســمين.زادت نســبة الأميلوز عند التســميد بـــــ١٠٠% من النيتروجين والفوســفور والبوتاسيوم في الحقل.

رابعاً: إمتصاص العناصر بحبوب الأرز البيضاء:-

١- محتوى النيتروجين الممتص (%):

أعطت السلالة GZ10147-1-2-1-1 أعلى القيم من نسبة النيتروجين الممتص فى حبوبها خلال الموســمين. أدت زيادة التســميد النيتروجيني والفوســفاتى والبوتاســي حتى مســتوى ١٠٠% إلى زيادة معنوية فى محتوى النيتروجين الممتص فى حبوبها فى كلا الموسمين.

٢- محتوى الفوسفور الممتص (%):

أعطت السلالة GZ10147-1-2-1-1 أعلى القيم من نسبة الفوسفور الممتص فى حبوبها خلال الموســمين. أدت زيادة التســميد النيتروجيني والفوســفاتى والبوتاســي حتى مســتوى ١٠٠% إلى زيادة معنوية فى محتوى الفوســـفور الممتص فى حبوبها فى كلا الموسمين.

٣- محتوى البوتاسيوم الممتص (%):

أعطت الســلالة GZ10147-1-2-1-1 أعلى القيم من نســبة البوتاســيوم الممتص فى حبوبها خلال الموسمين. أدت زيادة التسميد النيتروجيني والفوسفاتى والبوتاسي حتى مستوى ١٠٠% الى زيادة معنوية فى محتوى البوتاسيوم الممتص فى حبوبها فى كلا الموسمين.

٤- نسبة الزنك (ppm):

أعطت الســلالة GZ10147-1-2-1-1 أعلى القيم من محتوى الزنك الممتص فى حبوبها خلال الموسمين. أدت زيادة التسميد النيتروجيني والفوسفاتى والبوتاسي حتى مستوى ١٠٠% إلى زيادة معنوية فى محتوى الزنك الممتص فى حبوبها فى كلا الموسمين.

الخلاصـــــــــــة

أوضـحت نتائج الدراسـة أن إضـافة ١٠٠% من السـماد النيتروجينى الفوسـفاتى البوتاســـى (النيتروجين ١٦٥كجم / هكتار أما الفوســـفور ٣٦ كجم / هكتار وبالنســـبة للبوتاســيوم ٥٠ كجم /هكتار) في الحقل أدت إلي تحســين النمو والمحصــول بالنســبة للأربع سلالات المستخدمة (GZ.9461-2-3-1، GZ.10101-5-1-1-1، GZ.10147-1-2-1-1، GZ.10154-3-1-1-1)، و أعطت السلالة GZ.9461-2-3-1 كسلالة هندى/ ياباني، والســلالة GZ.10147-1-2-1-1 كســلالة يابانى أعلي إســتجابة للتســميد وإعطاء أعلي محصول حبوب.

المستخلص

أجريت تجربتان حقليتان بمزرعة مركز البحوث والتدريب فى الأرز - سخا- كفر الشيخ - مركز البحوث الزراعية عامى 2015- 2016 لدراسة تأثير بعض المعاملات السمادية على جودة الحبوب والقيمة الغذائية للمحصول لبعض التراكيب الوراثية للأرز. استخدم لهذا البحث أربعة سلالات مبشرة من الأرز تسمى GZ9461-2-3-1 ، GZ 10101-5-1-1-1، GZ 10147-1-2-1-1 ، GZ 10154-3-1-1 حيث تم تسميدها بثلاثة أنواع من العناصر السمادية وهى النيتروجين بمعدل 165كجم/ هكتار فى صورة يوريا 46.5 % أزوت أضيفت على دفعتين الأولى 3/2 الكمية 50 كجم /فدان علي الشراقى وقبل الرى مباشرة والثلث الباقى بعد الشتل بشهر أما الفوسفور 15.5% فو $_2$أ5 فقد تم إضافتة مرة واحدة قبل الخدمة مباشرة بمعدل 36 كجم /هكتار فى صورة سوبر فوسفات الكالسيوم 15.5% وذلك لضمان خلطه بالتربة الجافة أما البوتاسيوم 48% فتم إضافتة مرة واحدة قبل الرى مباشرة بمعدل 50 كجم / هكتار فى صورة كبريتات البوتاسيوم وتمت الإضافة للعناصر السابقة بمعدلات صفر ، 25، 50، 75، 100 تم إجراء كل العمليات الزراعية والمخاضة بالأرز حسب التوصيلت الفنية للمحصول طبقا للنشرة الإرشادية لبرنامج محصول الأرز.استخدم تصميم القطع المنشقة مرة واحدة فى أربع مكررات حيث وضعت السلالات فى القطع الرئيسية بينما وضعت معاملات التسميد فى القطع المنشقة و أعطت السلالة GZ.9461-2-3-1 كسلالة هندى/ يابانى، والسلالة GZ.10147-1-2-1-1 كسلالة يابانى أعلي إستجابة للتسميد وإعطاء أعلي محصول للحبوب وجودتها .

جامعة كفر الشيخ
كليــة الزراعــة
قسم المحاصيل

جودة الحبوب والقيمة الغذائية والمحصول لبعض تراكيب الأرز الوراثية المبشرة المتأثرة ببعض المعاملات السمادية

رسالة مقدمة من

غادة عبدالفتاح أحمد السيد

بكالوريوس العلوم

كلية العلوم - جامعة طنطا 2003م

كجزء من متطلبات الحصول على درجة

(الماجستير)

في العلوم الزراعية (المحاصيل)

قسم المحاصيل - كلية الزراعة

جامعة كفر الشيخ

2017 م

جامعة كفر الشيخ
كليـــة الزراعــة
قسم المحاصيل

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مركز البحوث الزراعية