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EFFECT OF TIME AND METHODS OF NITROGEN APPLICATION WITH TRANSPLANTED AND BROADCASTED RICE ON YIELD AND QUALITY CHARACTERISTICS

By

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DEDICATION

To

* My Father, my Brothers, my Sisters and my Wife

* Spirits of my Mother and my Daughter

* All my Friends

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CONTENTS

INTRODUCTION

INTRODUCTION

Rice (*Oryza sativa* L.) is the main food crop for about one half of the world's population, it is staple food in south and southeast Asian Countries. About one-third of mankind (1.3 billion people) depends on rice more than half of its food (Annual Report of International Rice Research Institute (IRRI, 1984).

Concerning to rice production in Egypt, rice is considered to be the second export crop after cotton and also as the second major food crop after wheat. It occupies about 1.225 million feddan with an approximate production of 4.45 million metric tons. In 1998, the national average yield of rice was 3.63 tons/feddan which equals 8.6 tons/ha (Final Report of Rice National Campaign). This was mainly due to replacing the old rice cultivars with newly improved ones such as Giza 177, Giza 178 as well as Sakha 101 and Sakha 102 cvs., good package of recommendation (including optimum culture practices and appropriate nitrogen levels and timing of application) and development infrastructure, excellent arrangement for international cooperation in science and technology and above all, hard working farming community.

It is very interesting to mention that, nitrogen fertilizer management plays a great role in promoting rice crop productivity. So, it is very important to raise nitrogen use efficiency by rice plant under our condition that will be achieved by improving methods of nitrogen application as well as timing of nitrogen application and restricted nitrogen levels.

Hence, timing of nitrogen application is very important factor that limit productivity of rice cultivars particularly with new rice cultivars otherwise medium and short duration cultivars which need further investigation of such important factor to determine the appropriate timing of nitrogen application to obtain maximum yield of rice.

The present study aimed to study the effect of nitrogen application on growth, yield, yield components and grain quality of the five newly cultivated rice cultivars, Giza 181, Giza 177, Giza 178 as well as Sakha 101 and Sakha 102.


REVIEW
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REVIEW OF LITERATURE

The review of literature conerning this investigation was divided into three parts as follows :

1. Rice cultivars
2. Nitrogen application
3. Interaction effect between rice cultivars and nitrogen application

1. Rice Cultivars :

Zeidan *et al.* (1980) recorded highly significant difference among rice cultivars regarding the plant height and panicle length. IR 2061 had the highest tillering, panicle length and grain yield. Giza 159 and IR 2061 gave the same higher grain yield/plant as compared to Arabi. With regard to the straw yield/plant, significant differenes were observed among the tested cultivars.

Aly *et al.* (1984) obtained significant differences were detected among the tested rice cultivars in grain yield and their components. The short stature rice cultivar Giza 181 significantly exeeded the other two tall cultivars; Giza 171 and Giza 172 in grain yield and most of its components.

Mahgoub *et al.* (1986) found highly significant differences among the three tested rice cultivars; Giza 171, Giza 180 and IR 22, for all yield components. Giza 180 was superior in all yield components except for 1000-grain weight in which Giza 171 was the highest. On the other hand, Giza 171 and IR 22 recorded the highest straw yield.

Shaalan *et al.* (1986 a) indicated that IR 28 produced the highest grain yield and yield components compared to the two local cultivars; Giza 171 and Reiho except for 1000-grain weight for which Reiho gave the heaviest weight. On the contrary, IR 28 was significantly earlier in maturity than Giza 171 and Reiho by about 35 days.

Shaalan *et al.* (1986 b) showed that Giza 180 had higher grain yield, harvest index and all yield components than Giza 171, except for 1000-grain weight. Also, Giza 171 was significatly taller and later in heading in comparison with Giza 180.

Assey *et al.* (1987) found that IR 579 was always superior in both number of total tillers and panicles/m^2 compared to Giza 171. The increase percentage in panicles number was about 28%.

Ismail (1989) found that modern high tillering and short stature rice cultivar, Giza 181 produced the highest yield and most of yield components compared to the taller traditional one, Giza 171.

Leilah and El-Kalla (1989) reported that rice cultivars significantly differed in grain yield and harvest index. Rice cultivar IR 28 gave the highest grain yield closely followed by IR 50, while Giza 171 was the lowest yielder cultivar.

Badawi *et al.* (1990 b) found that Giza 181 gave the highest grain yield (10.30, 10.23 t/ha) followed by IR 28 (98.99 t/ha). While Giza 171 gave the lowest grain yield (8.28, 8.35 t/ha) in the first and second seasons, respectively. Also, Giza 181 gave the highest panicle grain weight, number of panicles/m^2, number of filled grains/panicle as well as 1000-grain weight.

El-Kalla *et al.* (1990) detected significant differences among rice varieties in grain yield and most of its components. Giza 181 variety gave the highest grain yield, panicle weight, 1000-grain weight and grain protein content, while IR 28 had the shortest period from sowing to maturity, shortest plants and the highest number of panicles/m^2. On the other hand, Giza 175 had the shortest stature and latest maturity.

Saha and Gupta (1990) found that IET 9071 cultivar had the highest value of harvest index, and highest grain yield which was closely correlated with grain number/plant and 1000-grain weight.

El-Kassaby *et al.* (1991) concluded that Giza 181 surpassed Giza 175 in number of grains/panicle, 1000-grain weight, grain protein content, while Giza 175 produced more panicles/m^2.

Assey *et al.* (1992) reported that the grain yield of IR 28 significantly surpassed that of Giza 171 by about 40%. This increase could be attributed to the increase in number of panicles/m^2 and 1000-grain weight. In opposite, the straw yield of Giza 171 surpassed that of IR 28 by about 28% which could be attributed to taller plants and higher dry weight of stems and leaves.

El-Kalla *et al.* (1994) evaluated three rice cultivars; Giza 176, GZ 1368 and IR 25571. They recorded significant differences among the evaluated cultivars. Giza 176 had the highest values of panicle/m^2, panicle weight, grains/panicle, 1000-grain weight, and grain yield compared to other cultivars.

Gorgy (1995) found that IR 28 outyielded significantly Giza 175 and Giza 176 at all growth stage. Giza 176 gave the tallest plants, highest values of leaf area, relative crop growth rate, panicle weight, 1000-rough grain weight and hulling, head rice and milling recovery percentages. IR 28 cv. gave the highest values of crop growth rate, earliest heading, highest paddy yield/fed., number of panicles/hill, number of spikelets/panicle and grain protein content.

2. Time of Nitrogen Application :

Seetanum and De Datta (1973) found that the split application of nitrogen increased grain yield over single basal application in the tested rice cultivars by minimizing lodging.

IRRI (1977) reported that split application of nitrogen fertilizer as basal dressing 30 days after transplanting and at 5-7 days before panicle initiation markedly increased grain yield as compared with dates selected by the farmers. Adding nitrogen at 5-7 days before panicle initiation increased the unproductive tillers/plant.

Lai *et al.* (1977) studied the effect of nitrogen application at different times. They found that the application of 50% as basal dressing and the remainder applied either all at 2 weeks after transplanting or in two equal split dressings at 2 weeks after transplanting and 25 days before heading led to increasing plant height, number of panicles, grain yield and grain protein content.

Hamissa *et al.* (1980) indicated that the most suitable time of nitrogen application and proper method of fertilizer placement were achieved when N was applied just before transplanting or when N rate was split in two equal doses to be applied at transplanting and at panicle initiation.

Dias *et al.* (1985) studied the effect of nitrogen application at three rice growth stages; **(1)** one half of nitrogen at tillering and the other half at panicle differentiation, **(2)** one half at tillering and the second at anthesis, or **(3)** as three equal splits; at tillering, panicle differentiation and anthesis. They found no significant differences among the three treatments.

Badawi (1982) reported that hulling, milling and head rice percentages were higher in fertilized rice plants than in unfertilized ones, while a reverse situation was recorded for 1000-grain weight. generally, the basal application of nitrogen resulted in better grain quality than top-dressing.

Heenan and Bacon (1985) reported that the N-fertilizer application at sowing or into the floodwater soon after permanent flooding resulted in low N use efficiency and poor rice growth. By contrast, fertilizing just prior to permanent flooding promoted rapid N uptake, increased crop growth and produced higher yields. In some cultivars, however, the excess vegetative growth induced by high levels of N uptake was detrimental to grain yield. This excess growth often resulted in shading for lower leaves and severe lodging of tall rice crops. Application of most of the fertilizer at panicle initiation minimizes such problem and stimulates the grain production.

Rao *et al.* (1985) found that three equal split applications of nitrogen (at planting, maximum tillering and panicle initiation) recorded the maximum grain yield.

Reddy *et al.* (1985) in India, mentioned that the nitrogen application in 3 split dressings, at transplanting (50%), tillering (25%) and the panicle emergence (25%) gave higher values of plant height, root length, number of tillers and leaves/plant and paddy yield than when application were in 2 equal split dressings; at transplanting and tillering or in a single dressing at transplanting.

Reddy *et al.* (1986) showed that plant height, number of tillers increased when nitrogen was applied in two splits dressings; 50% at transplanting and 50% at panicle emergence stage, than 2 equal ones; at transplanting and tillering or as a single application at transplanting.

Hamissa *et al.* (1987) reported that the nitrogen fertilizer became more efficient when applied by one of the following methods in a descending order: **a)** point placement 10 cm deep in the soil one day after transplanting (DT), **b)** $^2/_3$ top-dressing 35 DT + $^1/_3$ at panicle initiation (PI), **c)** dry application banded in the soil, and **d)** dry application, $^2/_3$ banded in the soil + $^1/_3$ top-dressed at panicle initiation.

Keisers (1987) applied 120 kg N/ha in split dressings at mid-tillering, panicle primordium initiation, panicle differentiation and pollen mother cell differentiation. He indicated that N application at mid-tillering was a prerequisite for high grain yields, a second dressing early in the reproductive period was required for maximum spikelet differentiation, while late top-dressing slightly increased grain weight.

Bhuiyan *et al.* (1988) found that application of urea in three splits ($^1/_3$ at initial tillering + $^1/_3$ at rapid tillering + $^1/_3$ at 5-7 days before panicle initiation) produced highest grain yield and panicle number/m^2 as major yield components compared to the other two application times ($^1/_2$ basal + $^1/_2$ at maximum tillering) or ($^1/_3$ basal + $^1/_3$ at initial tillering + $^1/_3$ at 5-7 days before panicle initiation).

Inocencio *et al.* (1988) found that application of 150 kg N/ha in 3- split dressings; **(a)** 50 kg at sowing + 50 kg at active tillering + 50 kg at primordial differentiation or **(b)** 50 kg at sowing + 50 kg at active tillering + 50 kg at panicle initiation gave similar grain yields but higher head rice was found with (b) treatment.

Gorgy (1988) applied 3 modes of nitrogen fertilizer: **a)** all basal, **b)** $^1/_2$ basal + $^1/_2$ at 7 days after transplanting (DAT), and **c)** $^1/_2$ at 7 DAT + $^1/_2$ at 15 DAT. He found that, compared to the basal application of the single dose, splitting nitrogen gave no significant differenes in plant height, tillers per hill, heading dates, panicles per hill, panicle length and branches per panicle, while it increased spikelets per panicle, filled grain per panicle, panicle weight and 1000-grain weight .

Park and Lee (1988) reported that grain yield of rice cv. Seomjinbyeo was higher when N was applied three times (basal and two top dressings 15 days after transplanting (DAT) and 25 days before heading compared to two times; basal and top dressing 15 DAT. However, the yield of cv. Samgangbyeo was not different among the N split rates.

Salam *et al.* (1988) reported that application of nitrogen as $^1/_3$ basal + $^1/_3$ at tillering + $^1/_3$ at panicle initiation gave the highest yields of rice grain and straw compared to its application as $^1/_2$ basal + $^1/_4$ at tillering + $^1/_4$ at panicle initiation, $^1/_2$ basal + $^1/_2$ at tillering or full as basal.

Leilah and El-Kalla (1989) found that split application of nitrogen as $^1/_3$ incorporated dry soil + $^1/_3$ at 30 days after sowing + $^1/_3$ at panicle initiation gave the maximum grain yield.

Badawi *et al.* (1990 a) found that split application of nitrogen in broadcasted seeded rice ($^1/_3$ incorporation into a dry soil + $^1/_3$ at 30 days after sowing + $^1/_3$ at panicle initiation) gave the maximum grain yield, as well as its major yield components; panicle grain weight, number of panicles/m^2 and number of filled grains/panicle.

Badawi *et al.* (1990 b) found that split application of nitrogen in broadcast-seeded rice($^1/_3$ incorporation into the dry soil + $^1/_3$ at maximum tillering + $^1/_3$ at panicle initiation) was more efficient than application of all nitrogen before planting.

De Datta *et al.* (1990) found that the highest grain yield was obtained with split application of urea at 30 days after sowing, and at panicle initiation.

El-Bably (1990) showed that addition of nitrogen in two equal portions; $^1/_2$ incorporation into dry soil + $^1/_2$ at 20 days after transplanting, significantly increased plant height , number of filled grains per panicle, panicle weight and 1000-grain weight as well as rice grain and straw yields.

Islam *et al.* (1990) reported that the nitrogen fertilization at tillering stage gave higher grain yield which resulted from higher tillering ability, higher percentage of tiller survival and greater grain bearing capacity than when nitrogen was applied at any other growth stages. They also found that grain protein content was highest when N was applied at the anthesis stage.

Patra and Misra (1990) concluded that the highest yield was obtained with split dressings of nitrogen as 15 kg N into dry soil and 30 kg N at tillering stage.

Singh *et al.* (1990) showed that grain yields were: **a)** 1.44 t/ha without N, **b)** 2.3 t/ha with 60 kg N/ha as basal prilled urea, and **c)** 2.59 t/ha with 60 kg N/ha drilled urea in 3 split applications (60% basal + 20% top-dressed at tillering + 20% top-dressing at panicle initiation).

Badawi *et al.* (1991) reported that nitrogen in two equal split dressings ($^1/_2$ at 20 days after transplanting + $^1/_2$ at panicle initiation) gave the highest grain yield compared to other treatments.

Ganai *et al.* (1991) noticed that the rice yield was highest when half of the N dose was applied as basal at transplanting and the rest at 33 DAT.

Sahu *et al.* (1991) found that yields were higher when N was given in 3 split applications (transplanting + maximum tillering + panicle initiation) than all at transplanting.

Ali *et al.* (1992) studied the effect of N application splitting on grain quality of rice. They showed that 3 equal splits of N fertilizer ($^1/_3$ basal, and 30 and 60 days after transplanting) produced higher 1000-grain weight and percentage head rice recovery, while total percentage milling recovery and protein content were not affected.

Assey *et al.* (1992 b) compared 3 times of N application (at transplanting, 15 days after transplanting, and $^1/_2$ at transplanting + $^1/_2$ at 15 days after transplanting). They found that the third treatment significantly increased plant height, number of panicles/m^2, number of grains/panicle, rice grain and straw yields and percentage of crude protein.

Mongia (1992) evaluated yields of rice under four N application at 60 or 120 kg N/ha : (50% basal + 50% at tillering), (50% basal + 50% at flowering initiation) (50% basal + 25% at tillering + 25% at flowering) and (25% basal + 25% at tillering + 25% at flowering + 25% at the flag leaf stage). The grain yield was highest with 60 kg N applied in three splits while total N uptake was highest with 120 kg N applied in three splits.

Robinson (1992) observed that among 12 different split applications of nitrogen, grain yield was highest with application of nitroge in 4 equal splits; basal, tillering, panicle initiation and heading.

Savithri *et al.* (1992) found that applying 50% of the N basally and 25% each at 40 and 60 days after transplanting (DAT) or applying N in 4 equal splits; basally, 20, 40 and 60 DAT produced similar yields (2.64 and 2.65 t/ha, respectively) compared to the application of 50% of the N basally and 25% at 20 DAT and 25% at 40 DAT (2.47 t/ha).

Vijayalakshmi *et al.* (1992) found that rice grain yield ranged from 453 g/m^2 in the normal method (50% of N applied at 21 days after sowing (DAS) + 25% each at 35 and 50 DAS) to 529 g/m^2 with 4 equal applications; 20, 35, 50 and 65 DAS.

Abd El-Wahab *et al.* (1993) indicated that deep placement of nitrogen fertilizer in transplanted rice was superior to the other treatments. The crop yield, % recovery of the added N by plant and that retained in the soil were higher in the deep placement compared to the other method ($^2/_3$ of nitrogen 15 days after transplanting and $^1/_3$ at panicle initiation).

Avasthe *et al.* (1993) reported that the highest grain yield was obtained when N was applied in 2 equal splits at transplanting and 7 days before panicle initiation or half of the N at transplanting + $^1/_4$ of the N each at late tillering and panicle initiation.

Dalel Singh and Om (1993) reported that the highest rice grain yield was obtained from applying 50% of the N at puddling + 25% 21 days after transplanting (DAT) + 25% 42 DAT. The high yields were related to maximum tillering and panicle initiation coinciding at these application dates.

Attia *et al.* (1994) indicated that adding nitrogen in two equal doses ($^1/_2$ N on dry soil before transplanting + $^1/_2$ N at 20 days after transplanting) significantly increased plant height, number of tillers, panicle/m^2, panicle length, number of grains/panicle, panicle weight, 1000-grain weight and grain yield.

Pandey and Tripathi (1994) reported that rice grain yield was slightly higher with split as 2/3 basal and 1/3 at panicle initiation than with basal application.

Porwal *et al.* (1994) showed that the grain yield increased with adding nitrogen in 3 equal splits (basal + tillering + panicle initiation) as compared with basally or in 2 equal doses.

Daniel and Wahab (1994) applied the amount of nitrogen as 50% at sowing + 50% at tillering, 50% at sowing + 25% at tillering + 25% at panicle initiation, 50% at tillering + 50% at panicle initiation or 33% at each of sowing, tillering and panicle initiation. They found that rice grain yield was highest when nitrogen was applied up to 100 kg/ha in 3 equal splits.

Paul (1994) showed that grain yield of rice cv. IET 8002 was higher with up to 80 kg N/ha in 3 equal split application (basal + maximum tillering + panicle initiation) than in 2 splits.

Sharma *et al.* (1994) reported that application of 45 kg N/ha as urea to rice cv. HPU 741 at 14 days after transplanting gave the highest grain yield as compared with its application before or after this date.

Dutta *et al.* (1995) indicated that application of urea in two equal splits (basal and at tillering) caused the highest grain yield (3.7 t/ha) followed by basally application (3.3 t/ha). They also found that foliar application of urea as a 4% spray either once or twice recorded higher grain yields (2.9 and 3.2 t/ha, respectively) than did as soil application of urea as a single basal dose (2.4 t/ha) or in splits (2.7 t/ha).

Ghanem *et al.* (1995) reported that rice yield, number of panicles and panicle weight were highest when nitrogen was applied as triple split ($^1/_3$ basal + $^1/_3$ at tillering + $^1/_3$ 7 days before panicle initiation) .

Abd Alla (1996) pointed out that splitting of nitrogen into two doses ($^2/_3$ or $^1/_2$ incorporated into dry soil immediately before planting and the rest of the amount at PI) caused a significant increase in N-uptake and increased the rice yield. This treatment reduced hulling and head rice %, but milling output increased.

Hamissa *et al.* (1996) revealed the superiority of working the fertilizer in the soil might be due to placing the fertilizer N for the oxidative layer on the surface of the soil and not being susceptible to chemical reactions which lead to N losses through volatilization and denitrification.

El-Refaee (1997) found that splitting nitrogen into two doses ($^2/_3$ basal + $^1/_3$ at panicle initiation) or three ($^1/_3$ basal + $^1/_3$ at tillering + $^1/_3$ at panicle initiation) gave higher number of tillers/m^2, number of panicles/m^2, panicle weight, 1000-grain weight and grain yield than single dose of nitrogen as basal. He also found that hulling, milling, head rice percentages and protein content of milled rice increased with nitrogen splits.

Kalboch (1997) found that, in different Egyptian rice cultivars, N application as $^2/_3$ basal and $^1/_3$ as top-dressing at panicle initiation proved to be the most effective in getting highest values of plant height, number of tillers/hill, and grain yield and its attributes.

Sorour *et al.* (1998) found that the splitting of nitrogen dose into two or three splits was superior to single dose application.

El-Kady and Abd El-Wahab (1999) indicated that two split applications of 50, 100 and 150 kg N/ha ($^2/_3$ basal + $^1/_3$ at PI) increased plant height, number of tillers/hill, leaf area index, dry matter content, nitrogen uptake, grain yield and its components as compared to triple split application of N ($^1/_3$ basal + $^1/_3$ at mid-tillering + $^1/_3$ at PI) or when all N was applied as basal.

3. Interaction Effect Between Rice Cultivars and Nitrogen Application :

Patil *et al.* (1987) found that the transplanted rice cv. IET 3232 responded more to split application of urea than to the basal application.

Om *et al.* (1988) found that PR 106 cultivar produced higher yield than Pusa 33 cultivar. Grain yield significantly increased by increasing nitrogen up to 150 kg N/ha, and split nitrogen application was superior to basal application.

Babalad *et al.* (1989) found that Gama-318 rice cv. gave the highest grain yield when N was applied in 3 equal splits than when applied in a single dose at sowing or 40 days after sowing.

Hamissa and Mahrous (1989) studied the response of traditional (Giza 172) and improved (IR 1626 and IR 28) rice cultivars to different rates and methods of nitrogen application. They found that the grain yields of the three cultivars increased with increasing N up to 144 kg/ha when N fertilizer was applied as a single dry application. The short-statured cultivars (IR 1626 and IR 28) responded better to nitrogen than long-statured cultivar (Giza 172). Split application of 96 kg N/ha to IR 28 ($^2/_3$ basal + $^1/_3$ at PI) was more productive than 144 kg N/ha applied as a single basal dry application.

Leilah and El-Kalla (1989) reported that split application of nitrogen fertilizer in two or three equal portions slightly increased grain yield, especially in Giza 171, compared to a single dose on dry soil before transplanting.

Sharma *et al.* (1990) reported that yields of IR 50 and Pusa 169 rice cultivars were higher when nitrogen was applied in 2 or 3 split dressings than when applied in a single dressing 10 days after transplanting.

Bhagat *et al.* (1991) studied the effect of NPK fertilizers on the yield of IET-1410 (short duration), PC-9 (medium) and Jaya (long). They concluded that application of PK+50% N as basal, 25% N at tillering + 25% N at panicle initiation gave the highest grain yield. However, Jaya gave the highest grain yield and IET-1410 gave the lowest.

Paul (1994) recorded an increase in yield of rice v. IET 8002 by increasing N application up to 80 kg/ha. The yield was higher when N was applied in 3 equal splits (basal + maximum tillering + panicle initiation) than in 2 splits.

Sharma *et al.* (1994) reported that the rice cv. HPU 741 gave the highest grain yield with the application of 45 kg N/ha as urea 14 days after transplanting compared to application of N before or after this date.

Lopes *et al.* (1996) studied the response of rice cultivars and lines IRGA 416, IRGA 417, IRGA 370-38-1-1F and IRGA 284-18-2-2-2 to 0, 30, 60, 90, 120 and 150 kg N/ha with 50% of the amount applied at tillering and 50% at panicle initiation. They reported that IRGA 370-38-1-1F gave the highest yield.

Abd El-Rahman (1997) applied nitrogen in two equal doses; $^1/_2$ at 20 days after transplanting and $^1/_2$ at PI to Giza 178, Sakha 101 and Sakha 102 rice cultivars planted in a saline soil. He found that Giza 178 produced the highest values of filled grains, panicle length, panicles/m^2 and grain and straw yields, while Sakha 101 produced the heaviest panicles, and Sakha 102 produced the heaviest 1000-grain weight, and tallest plants.

Abd El-Wahab (1998) investigated the response of short (Giza 177), medium (Giza 175, Giza 178 and Giza 181), and long (Giza 171) duration rice cultivars to different levels of nitrogen. Two thirds of the nitrogen was applied basal, and the other third top-dressed at panicle initiation. The results revealed that the response of the medium duration cultivars to nitrogen was superior compared to the short or long ones due to the higher sink capacity and spikelets-leaf ratio. However, yields of all rice cultivars gradually increased with increasing N levels up to 200 kg N/ha.

El-Kady and Abd El-Wahab (1999) found that the rice cultivar Giza 181 gave better growth and absorbed more nitrogen compared to Giza 178 or Sakha 101. Physical characters of grains (length, width and shape) were not significantly influenced by levels and methods of nitrogen application. Giza 178 had higher hulling, milling and head rice % than Giza 181 or Sakha 101. Sakha 101 and Giza 178 had lower amylose content than Giza 181.

MATERIALS AND METHODS

MATERIALS AND METHODS

Field experiments on transplanted and broadcast-seeded rice systems were conducted at Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh during 1996 and 1997 rice seasons. The experiments aimed to investigate the performance of certain rice varieties under different times and methods of nitrogen application. Also, the effect of interaction between rice varieties and nitrogen application on growth attributes, yield, yield components and grain quality were considered.

To clarify the effect of nitrogenous fertilizer on the studied traits, the experimental field was selected as grown to barley in the winter season, because baeley is usually grown in a poor-nitrogen soil.

Monthly average temperature and relative humidity are shown in Table (1) according to Sakha Meteorological Station. Mechanical and chemical properties and soil structure of the experimental field are given in Table (2). .

Table (1): Monthly temperature (°C) and relative humidity (%) at Sakha during 1996 and 1997 rice seasons.

Month	Temperature (°C)						Relative humidity % (Mean)	
	1996		1997		Mean			
	Max.	Min.	Max.	Min.	1996	1997	1996	1997
May	29.5	13.6	29.0	15.4	21.5	22.2	53.2	61.0
June	31.5	17.0	32.0	17.8	24.3	24.9	55.3	48.0
July	29.4	18.0	30.0	19.1	23.7	24.5	57.3	51.5
August	31.4	20.0	33.5	17.8	25.7	25.7	63.3	66.5
September	32.3	18.8	35.0	19.2	25.5	27.1	66.7	70.2
October	30.0	15.0	34.0	17.0	22.5	20.5	57.7	55.5

Table (2): Mechanical and chemical analysis and soil structure of the experimental field.

Season	Mechanical analysis			Chemical analysis					Soil texture class
	Sand	Silt	Clay	EC	pH	Organic matter (%)	$CaCO_3$ (%)	N (%)	
1996	24.80	21.00	54.20	1.5	7.8	2.20	1.48	0.32	Clay
1997	18.30	22.00	59.70	1.4	8.4	1.83	1.20	0.14	Clay

Experimental design :

A split-plot design with four replications was used in this study. The main plots were devoted to five rice cultivars i.e. Giza 181, Giza 177, Giza 178, Sakha 101 and Sakha 102. The characteristics of these cultivars are shown in Table (3). Four times and methods of nitrogen application were assigned in the sub-plots, 96 kg N/ha as urea 46% N was applied. These applications were: (T_1) two splits, $^2/_3$ as basal and incorporated into dry soil + $^1/_3$ as top-dressing at panicle initiation, (T_2) three equal splits, $^1/_3$ as basal and incorporated into dry soil + $^1/_3$ as top-dressing at maximum tillering stage + $^1/_3$ as top-dressing at panicle initiation, (T_3) three splits, $^1/_2$ as basal and incorporated into dry soil + $^1/_4$ as top-dressing at panicle initiation + $^1/_4$ as top-dressing after complete flowering, and (T_4) all the nitrogen amount was incorporated into the dry soil.

Table (3) : Characteristics of rice cultivars used in the study (after Annual Report of RRTC, 1998).

Cultivars	Parents	Duration /day	Rice blast	Stem borer	Soil condition	Productivity (t/ha)
Giza 181	IR 22 / IR 24	145	Resistant	Moderately susceptible	Normal soil	10.10
Giza 177	Giza 171/Yomji No. 1// Pi No. 4	125	Resistant	Resistant	Normal soil	9.00
Giza 178	Giza 175 / Milyang 49	135	Resistant	Susceptible	Normal and saline soils	10.70
Sakha 101	Giza 176 / Milyang 79	140	Resistant	Resistant	Normal soil	10.50
Sakha 102	Giza 4096-7-1/Giza 177	125	Resistant	Resistant	Normal soil	9.50

Both nursery and permanent fields were well ploughed twice and followed by wet levelling. Nitrogen, phosphorus (P_2O_5) and zinc ($ZnSO_4$) were applied as recommended to the nursery.

All rice cultivars were planted either in the nursery or in broadcast-seeded rice at the rate of 144 kg seeds/ha on 25 May in both seasons. The seeds of transplanting and broadcasting were soaked in sufficient water for 24 hours and incubated for another 48 hours to enhance germination. Pre-germinated seeds were broadcasted to the nursery or to seeded plots. Thirty days old seedling were transplanted at 20x20 cm distance. The plot size measured 18 m^2 (3x6 m). All other cultural practices for both transplanting and broadcasting rice were undertaken as recommended.

At harvest, the inner 10 m^2 were manually harvested, left for 5 days for air and sun drying and then threshed by an experimental threshing machine.

Studied characters :

1- Growth characters :

1.1. Plant height at harvest (cm) :

Ten random rice plants in each plot were measured from soil surface up to panicle tips.

1.2. Panicle length (cm) :

Ten random panicles were measured from the collar to the top of panicle .

1.3. Number of tillers at different growth stages :

1.3.1) Transplanting :

Number of tillers of five random hills were counted in each plot at 30 days after transplanting, panicle initiation at complete flowering, and at harvest.

1.3.2) Broadcasting :

The number of tillers per $^{1}/_{16}$ m^2 were counted at the same growth stages of transplanting.

1.4. Heading date :

Number of days from sowing to 50% heading was recorded in each plot.

2. Yield and yield components :

At harvest, the following data were collected :

2.1. Number of panicles/m^2 :

Panicles of ten random hills and $^{1}/_{16}$ m^2 from each plot were counted for transplanted and broadcasted rice, respectively.

2.2. Panicle weight (g) :

It was estimated by weighing ten random panicles per plot.

2.3. 1000-grain weight (g) :

Weight of 1000 rough grains was taken from the grain obtained from each sub-plot after threshing.

2.4. Number of filled and unfilled grains/panicle :

Average numbers of filled or unfilled grains of ten random panicles were assessed.

2.5. Grain yield (ton/ha) :

Grain yield of each treatment was adjusted to 14% moisture, and converted into tons per hectare.

2.6. Straw yield (t/ha) :

It was estimated using the same steps for grain yield estimation.

2.7. Harvest index (as a percentage) :

It was estimated according to Yoshida (1981) as follows :

$$\text{Harvest index (\%)} = \frac{\text{Grain yield / ha}}{\text{Grain yield/ha + Straw yield/ha}} \times 100$$

3. Grain quality :

At the Grain Quality Lab of RRTC, random samples of 500 grams of rough rice per plot were taken to determine grain quality characters as described by Khush *et al.* (1979).

3.1. Hulling recovery percentage :

$$\text{Huling recovery \%} = \frac{\text{Weight of brown rice (g)}}{\text{Weight of rough rice (g)}} \times 100$$

3.2. Milling percentage :

$$\text{Milling \%} = \frac{\text{Weight of milled rice (g)}}{\text{Weight of rough rice (g)}} \times 100$$

3.3. Head rice percentage :

$$\text{Head rice \%} = \frac{\text{Weight of whole milled grains (g)}}{\text{Weight of milled rice (g)}} \times 100$$

3.4. Grain length :

Grain length of brown rice grain was measure from the base to top of the grain in mm. Grain length was classified using the standard evaluation system for rice, IRRI (1996) as follows:

Scale	Grain type	Length (mm)
1	Very long (VL)	More than 7.50
3	Long (L)	6.61 - 7.50
5	Medium (M)	5.51 - 6.60
7	Short (S)	5.50 mm or less

3.5. Grain width :

Width of brown rice grain was measured in millimeters from the ventral to the dorsal side at widest point of the grain.

3.6. Grain shape :

The shape of brown rice grain was determined by length (L), width (W) ratio according to the standard evaluation system for rice, IRRI (1996):

Scale	Grain shape	Length:Width ratio
1	Slender	Over 3.0
3	Medium	2.1 to 3.0
5	Bold	1.1 to 2.0
7	Round	Less than 1.1

Chemical determinations :

1. Protein content :

The method of microkjeldahl was used to determine the nitrogen content. The obtained values were multiplied by 5.95 to obtain the protein content in paddy rice (Black, 1965).

2. Amylose content :

The simplified procedure of Juliano (1971) to determine amylose content in milled rice was followed.

Statistical analysis :

Data of the two experiments were subjected to proper statistical analysis of variance according to Snedecor and Cochran (1971). The combined analysis was conducted for the data of the two experiments (broadcasting or transplanting in both seasons) according to Cochran and Cox (1968). Duncan's multiple range test (Duncan, 1955) was used for comparison among means. In the tables, means followed by the same letters are not significantly at the 5% level of significance.


RESULTS
AND
DISCUSSION

RESULTS AND DISCUSSION

1. Broadcasting Method :

1.1. Growth measurements :

1.1.1. Effect of season :

Results in Table (4) present averages of the two seasons of the study. It is evident that all studied characters significantly differed from 1996 than 1997. Higher values for number of tillers/m^2 at all growth stages, and heading date (in days) were detected in 1996, but the situation was reversed for plant height and panicle length which were higher in the second season than in the first one. These results might be attributed to difference in temperature between the two considered seasons.

1.1.2. Effect of nitrogen application :

Table (5) shows the combined data for the averages of number of tillers/m^2 at various growth stages, heading date, plant height and panicle length as affected by nitrogen application in 1996 and 1997 rice seasons.

All studied characters, except number of tillers at the third growth stage, were significantly affected by nitrogen application. Nitrogen applied as $^2/_3$ basal and $^1/_3$ at panicle initiation (T_1) gave higher values of tillers/m^2 at the first growth stage (1635.33 tillers) and second growth stage (1711.30 tillers) and fourth stage (926.83) followed by T_4 (all amount of nitrogen as basal) and T_3 ($^1/_2$ basal + $^1/_4$ at panicle initiation (PI) + $^1/_4$ at complete flowering) at the first stage, T_4 and T_2 (3 equal splits) at the second growth stage, and T_2 and T_3 at fourth growth stage. However, the differences among the previous treatments were not significant. On the other hand, the lowest numbers of tillers/m^2 were obtained by T_2 treatment at 1st growth stage, T_3 at 2nd growth stage and T_4 at 4th stage.

Concerning the heading date (Table 5), the highest value (88.95 days) was obtained at T_3, while the lowest one (88.15 days) was recorded with T_2 treatment. The longest rice plants (87.97 cm) were obtained when nitrogen was applied as $^2/_3$ basal + $^1/_3$ at PI (T_1), while the shortest ones (85.50 cm) were obtained in case of T_4 (all nitrogen as basal, Table 5).

As for panicle length, the values could be descendingly ordered as 20.12 cm for T_2, 19.79 cm for T_1, 19.64 cm for T_4, and then 19.63 cm for T_3.

It is clear that the superiority of growth characters by treatment one (T_1) may be due to that early nitrogen application stimulates the plant growth. Similar results were obtained by Lei *et al* (1971), Islam *et al* (1990), Ali *et al* (1992), El-Refaee (1997) and El-Kady and Abd El-Wahab (1999).

1.1.3. Effect of cultivar :

The effects of tested rice cultivars on number of tillers/m^2 at various growth stages, heading date, plant height and panicle length combined over 1996 and 1997 rice seasons are presented in Table (6).

Table (4): Seasonal effects on the average values of growth attributes in broadcasting method

Season	Number of tillers/m^2 (indicated by growth stages)				Heading date (days)	Plant height (cm)	Panicle length (cm)
	No. 1	No. 2	No. 3	No. 4			
1996	1799.51 a	1965.49 a	1667.10 a	912.20 a	89.56 a	86.26 b	19.45 b
1997	1310.55 b	1333.13 b	943.95 b	851.74 b	87.29 b	87.84 a	20.13 a

No. 1: 30 days after sowing, No. 2: Panicle initiation, No. 3: Complete flowering, No. 4: Harvest

Table (5): Effect of nitrogen application on growth attributes in broadcasting method (Combined data of 1996 & 1997).

Nitrogen application	Number of tillers/m^2 (indicated by growth stages)				Heading date (days)	Plant height (cm)	Panicle length (cm)
	No. 1	No. 2	No. 3	No. 4			
T_1	1635.33 a	1711.30 a	1366.50 a	926.83 a	88.25 b	87.97 a	19.79 ab
T_2	1492.35 b	1643.15 ab	1290.68 a	883.20 ab	88.15 b	87.44 ab	20.12 a
T_3	1515.33 ab	1558.25 b	1273.58 a	870.40 ab	88.95 a	87.30 b	19.63 b
T_4	1577.13 ab	1684.53 a	1291.35 a	847.45 b	88.35 b	85.50 c	19.64 b
F. test T x S	*	*	ns	ns	**	ns	ns

$T_1 = {}^2/_3$ basal + ${}^1/_3$ at panicle initiation (PI). $T_2 = {}^1/_3$ basal + ${}^1/_3$ at maximum tillering (MT) + ${}^1/_3$ at PI.
$T_3 = {}^1/_2$ basal + ${}^1/_4$ at PI + ${}^1/_4$ at complete flowering. T_4 = All amount as basal.

No. 1: 30 days after sowing, No. 2: Panicle initiation, No. 3: Complete flowering No. 4: Harvest

Differences among cultivars were significant in all characters except for number of tillers at 3rd growth stage. Giza 178 produced the highest number of tillers at first (1625.03 tillers), second (1779.91), and fourth stages (949.75). However, these values had no significant superiority over Giza 181 and Sakha 101 at the same aforementioned stages, or over Sakha 102 at 1st growth stage. However, Giza 177 significantly tillered less than Giza 178 in 1st, 2nd and 4th growth stages.

The earliest heading was recorded for Sakha 102 (80.50 days), followed by Giza 177 (80.69), Giza 178 (87.31), and then Sakha 101 (96.44 days), while the latest variety in heading was Giza 181 (97.19 days).

As for plant height, Sakha 102 appeared as the longest variety (88.98 cm) and significantly differed from all other varieties, followed by Giza 177 (87.31 cm), Giza 181 (86.86 cm), Sakha 101 (86.58 cm), while Giza 178 appeared as the shortest one (85.52 cm).

The longest panicles were obtained in case of Giza 181 (20.89 cm) which significantly differed from all other varieties. The second rank of panicle length was occupied by Giza 178 (20.12 cm), and then Sakha 101 (19.91 cm), while Sakha 102 came in the fourth rank (19.51 cm). However, the shortest panicles were measured in case of Giza 177 (18.55 cm).

El-Kalla *et al* (1990), El-Kasaby *et al* (1991), Assy *et al* (1992) and El-Kady and Abd El-Wahab (1999) found differences between the rice cultivars.

Table (6): Growth attributes as affected by rice cultivars in broadcasting method (Combined data of 1996 & 1997).

Cultivar	Number of tillers/m² (indicated by growth stages)				Heading date (days)	Plant height (cm)	Panicle length (cm)
	No. 1	No. 2	No. 3	No. 4			
Giza 181	1605.00 a	1702.94 ab	1340.09 a	914.63 a	97.19 a	86.86 bc	20.89 a
Giza 177	1427.75 b	1452.53 c	1240.75 a	818.34 b	80.69 c	87.31 b	18.55 d
Giza 178	1625.03 a	1779.91 a	1304.75 a	949.75 a	87.31 b	85.52 d	20.12 b
Sakha 101	1575.91 ab	1739.97 a	1290.66 a	910.34 a	96.44 a	86.58 c	19.91 bc
Sakha 102	1541.47 ab	1571.19 bc	1351.41 a	816.78 b	80.50 c	88.98 a	19.51 c
F. test V x S	ns	**	**	ns	**	**	ns

No. 1: 30 days after sowing, No. 2: Panicle initiation, No. 3: Complete flowering, No. 4: Harvest

1.1.4. Interaction effect between cultivars and seasons :

Results in Table (6) show that the interactions between cultivars and seasons differed significantly for all measurements except for number of tillers/m^2 in both first and fourth growth stages, and panicle length. This interaction could be attributed to changes in climatic conditions from one season to another.

1.1.5. Interaction effect between cultivars and N application :

Table (7) shows the average numbers of tillers/m^2 at different growth stages, heading date, plant height and panicle length as affected by interaction between rice cultivars and N application as combined data for 1996 and 1997 rice seasons. It was found that the interaction were significant for all studied characters. At the 1st growth stage, the highest number of tillers (1761.75 tillers/m^2) was obtained with Giza 178 under T_1 treatment, meanwhile the lowest value (1402.63 tillers/m^2) was recorded for Giza 177 under the same treatment. At the 2nd growth stage, Sakha 101 proved to be superior in tillering (1925.25 tillers/m^2) but Giza 177 was minimum (1356.38 tillers/m^2) at T_3 treatment. At the 3rd growth stage, Sakha 101 produced the highest number of tiller at T_1 (1491.88 tillers/m^2), and the same variety was the most affected by N application, exhibiting the lowest number of tillers (1138.50) in case of T_3 treatment. At the 4th growth stage, Giza 178 gave the highest tillers (1039.75 tillers/m^2) at T_1, while Giza 177 gave the lowest value (722.25 tillers/m^2) at T_4 treatment.

As for heading date, Giza 177 was the earliest cultivar (80.00 days) in T_2 treatment, followed by Sakha 102 (80.13) for the same N application, both values were statistically the same. The latest cultivar for heading was Giza 181 for all of N applications.

Table (7) : Growth attributes as affected by interaction between time of nitrogen application and rice cultivars in broadcasting method (Combined data of 1996 & 1997).

Time of N application	Cultivars	Number of tillers/m^2 (indicated by growth stages)				Heading date (days)	Plant height (cm)	Panicle length (cm)
		No. 1	No. 2	No. 3	No. 4			
T_1	Giza 181	1742.75 a	1779.75 c	1453.13 ab	950.38 b	97.13 b	86.65 f	21.03 b
	Giza 177	1402.63 g	1400.00 Lm	1212.38 h	910.63 cde	80.25 k	87.49 d	17.83 j
	Giza 178	1761.75 a	1914.25 ab	1440.38 ab	1039.75 a	87.50 f	87.75 d	20.36 c
	Sakha 101	1746.00 a	1925.25 a	1491.88 a	963.62 b	95.63 d	89.10 bc	20.43 c
	Sakha 102	1523.50 de	1537.25 jk	1234.75 gh	769.75 g	80.75 g	88.88 c	19.31 g
T_2	Giza 181	1665.00 b	1788.25 c	1304.13 ef	880.25 ef	97.13 b	86.45 fg	21.48 a
	Giza 177	1381.75 def	1540.75 jk	1220.50 h	877.13 ef	80.00 k	87.96 d	18.49 h
	Giza 178	1530.88 cde	1698.13 def	1249.25 fgh	893.00 de	86.38 g	83.96 j	20.46 c
	Sakha 101	1466.50 efg	1618.50 ghi	1217.25 h	915.63 cd	97.13 b	87.14 e	19.69 ef
	Sakha 102	1417.63 fg	1570.13 ijk	1462.25 ab	850.00 f	80.13 k	91.68 a	20.48 c
T_3	Giza 181	1489.50 def	1600.50 hij	1401.50 bc	891.00 de	98.00 a	87.70 d	19.88 de
	Giza 177	1437.50 fg	1356.38 m	1242.50 fgh	763.38 g	81.38 h	89.39 b	19.73 ef
	Giza 178	1604.00 bc	1648.25 fgh	1206.00 h	962.00 b	88.00 e	85.69 h	19.87 de
	Sakha 101	1556.50 cd	1742.50 cd	1138.50 i	855.63 f	97.13 b	84.56 i	19.55 f
	Sakha 102	1489.13 def	1443.63 L	1379.38 cd	880.00 ef	80.25 k	89.14 bc	19.15 g
T_4	Giza 181	1522.75 de	1643.25 fgh	1201.63 h	936.88 bc	96.50 c	86.62 f	21.19 b
	Giza 177	1489.13 def	1513.00 k	1287.63 efg	722.25 h	81.13 hi	84.40 i	18.15 i
	Giza 178	1603.50 bc	1859.00 b	1323.25 de	904.25 cde	87.38 f	84.69 i	19.79 de
	Sakha 101	1534.63 cde	1673.63 efg	1315.00 e	906.53 cde	95.88 d	85.53 h	19.96 d
	Sakha 102	1735.63 a	1733.75 cde	1329.25 de	767.38 g	80.88 ij	86.25 g	19.09 g
F. test T x V x S		ns	ns	ns	ns	ns	**	**

$T_1 = {}^2/_3$ basal + ${}^1/_3$ at panicle initiation (PI). $T_2 = {}^1/_3$ basal + ${}^1/_3$ at maximum tillering (MT) + ${}^1/_3$ at PI.
$T_3 = {}^1/_2$ basal + ${}^1/_4$ at PI + ${}^1/_4$ at complete flowering. T_4 = All amount as basal.

No. 1: 30 days after sowing, No. 2: Panicle initiation, No. 3: Complete flowering, No. 4: Harvest

The tallest plants were observed in T_2 treatment with Sakha 102 (91.68 cm), while the shortest ones were recorded in case of Giza 177 at T_4 treatment (84.40 cm).

With regard to panicle length, the highest value was obtained by Giza 181 under T_2 treatment, whereas Giza 177 under T_1 treatment had the shortest panicles (17.83 cm).

Similar results were obtained by El-Kady and Abd El-Wahab (1999).

1.1.6. Interaction effect between nitrogen application and season :

Data in Table (5) reveal the interactions between N applications and seasons. Interactions were significant for number of tillers/m^2 at first and second growth stages as well as for heading date. However, the interactions were insignificant in case of third and fourth growth stages, plant height and panicle length.

1.1.7. Interaction effect among cultivars, N applications and seasons :

Results in Table (7) revealed that the interaction effect among cultivars, N applications and seasons was not significant in number of tillers/m^2 for all growth stages and heading date, whereas significant interaction effects were detected for both plant height and panicle length.

1.2. Yield and its components :

1.2.1. Effect of seasons :

Table (8) prsents the average values of seasonal effect on yield and its components as combined data for 1996 and 1997 seasons. The results show that all studied characters were significantly variable from one season to another. Higher values of number of panicles/m^2, panicle weight and 1000-grain weight were detected in the first season, while values of filled and unfilled grains/panicle, straw and grain yield and harvest index were higher in the second season. It could be concluded that the increase in grain yield in the second season is due to the significant increase in number of filled grains/panicle and panicle length (Tables 4 and 8). Also, the climatic conditions in the second season may have favoured grain production for all the tested rice cultivars, which is explained by a higher harvest index (Table 8).

1.2.2. Effect of nitrogen applications :

Results in Table (9) present the means of yield and yield components as affected by nitrogen fertilizer applications expressed in combined data for 1996 and 1997 seasons.

Results indicated that grain yield and yield components were significantly affected by nitrogen fertilizer applications, while straw yield did not exhibit significance with these applications.

Number of panicles and panicle weight exhibited highest values being 792.2/m^2 and 2.79 g, respectively, when nitrogen dose was applied in two splits as $^1/_2$ basal, $^1/_4$ at panicle initiation and $^1/_4$ at complete flowering (T_3). The lowest number of panicle (698.0/m^2) as well as weight of panicle (2.35 g) were obtained by applying all nitrogen as basal (T_4).

The highest value of number of filled grains/panicle (103.00) was obtained when nitrogen was applied in two equal splits as basal, at maximum tillering and at panicle initiation (T_2), but the difference between this treatment and T_1 ($^2/_3$ basal + $^1/_3$ at PI) was not significant. However, the lowest number of filled grains/panicle (90.10) was followed the application of all nitrogen as basal (T_4).

Adding nitrogen in three split doses; $^1/_2$ basal, $^1/_4$ at panicle initiation and $^1/_4$ at complete flowering (T_3), markedly gave the highest number of unfilled grains/panicle (8.35). The lowest number was recorded by applying nitrogen in two split doses (T_1), being 5.97 unfilled grains/panicle.

The highest average of 1000-grain weight (27.28 g) was obtained when nitrogen was applied in three split doses (T_2), but with no significant superiority over T_1 and T_4. However, the lowest value was recorded by adding nitrogen in three split doses (T_3), being 26.40 g per 1000 grains.

Concerning grain yield (t/ha), results showed that the highest grain yield/ha followed N application in three split doses (T_3) being 8.15 t/ha, while the lowest average was recorded when all nitrogen was applied as basal (T_4), being 7.17 t/ha.

Table (8): Seasonal effects on the average of yield and yield components in broadcasting method.

Season	Number of panicle/m^2	Panicle weight (g)	Filled grains/ panicle	Unfilled grains/ panicle	1000-grain weight	Straw yield (t/ha)	Grain yield (t/ha)	Harvest index
1996	820.9 a	2.62 a	91.61 b	4.30 b	27.60 a	9.69 b	7.36 b	42.93 b
1997	687.7 b	2.51 b	104.95 a	9.46 a	26.15 b	10.06 a	8.13 a	44.60 a

Table (9): Effect of time of nitrogen application on yield and yield components in broadcasting method (Combined data of 1996 & 1997).

Treatments Time of N application	Number of panicle/m^2	Panicle weight (g)	Filled grains/ panicle	Unfilled grains/ panicle	1000-grain weight	Straw yield (t/ha)	Grain yield (t/ha)	Harvest index
T_1	775.5 ab	2.55 b	101.13 ab	5.97 c	26.93 a	9.95 a	7.73 c	43.79 b
T_2	751.6 b	2.57 b	103.00 a	6.95 b	27.28 a	9.94 a	7.94 b	44.54 ab
T_3	792.2 a	2.79 a	98.90 b	8.35 a	26.40 b	9.88 a	8.15 a	45.07 a
T_4	698.0 c	2.35 c	90.10 c	6.25 c	26.90 a	9.74 a	7.17 c	41.66 c
F. test T x S	ns	**	*	**	ns	**	ns	ns

$T_1 = {}^2/_3$ basal + ${}^1/_3$ at panicle initiation (PI).
$T_2 = {}^1/_3$ basal + ${}^1/_3$ at maximum tillering (MT) + ${}^1/_3$ at PI.
$T_3 = {}^1/_2$ basal + ${}^1/_4$ at PI + ${}^1/_4$ at complete flowering.
T_4 = All amount as basal.

Splitting nitrogen as $^1/_2$ basal, $^1/_4$ at panicle initiation and $^1/_4$ at complete flowering (T_3) or as $^1/_3$ basal, $^1/_3$ at maximum tillering and $^1/_3$ at panicle initiation (T_2) gave the highest harvest index, being 45.07 and 44.54, respectively. While the lowest value (41.66) was recorded by adding all nitrogen basally (T_4).

It could be concluded that the highest values of grain yield and yield components (number of panicles/m^2 and panicle weight) were obtained when nitrogen dose was applied in three splits into $^1/_2$ basally, $^1/_4$ at panicle initiation and $^1/_4$ at complete flowering (T_3).

The highest values of grain yield, number of panicles/m^2, and panicle weight in case of T_3 could be explained on the basis that adding $^1/_2$ of nitrogen activated the tillering at tillering stage, $^1/_4$ produced more effective tiller, while the last $^1/_4$ increased the panicle weight. Thus, this method of application encouraged the building of metabolites and this in turn resulted in a high yield.

These findings are in a close agreement with the results of Gorgy (1988), Salam *et al* (1988), Sahu *et al* (1991) and Porwal *et al* (1994).

1.2.3. Effect of cultivars :

Results of the effect of the tested rice cultivars on yield and yield components combined over 1996 and 1997 seasons are presented in Table (10).

Highly significant differences were observed among the five cultivars in all studied characters.

Giza 178 cultivar significantly produced the highest number of panicle/m^2, being 827.5, while the lowest number was detected by Giza 177 being 703.2 .

Sakha 101 cultivar had the highest panicle weight (2.84 g), but the lowest value was recorded for Giza 181 (2.41 g).

Giza 181 and Giza 178 cultivars had the highest number of filled grains/panicle, being 108.47 and 107.94, respectively, while the lowest number of filled grains/panicle (91.13) was obtained by Sakha 102 cultivar.

The results of unfilled grains/panicle as influenced by cultivars were similar to those of the filled grains number, whereas Giza 181 cultivar, gave the highest number of unfilled grains/panicle (11.34). While the lowest number was detected by Sakha 102 cultivar (5.13).

Sakha 102 cultivar markedly produced the highest 1000-grain weight (28.88 g), followed by Sakha 101 cultivar (28.78 g), while the lowest value was recorded by Giza 178 cultivar being (22.84 g).

The highest values of straw yield were 10.17 and 10.02 t/ha were obtained by Giza 181 and Sakha 101, respectively. On the other hand, Giza 177 cultivar gave the lowest value for straw yield, being 9.59 t/ha.

As for the grain yield, Giza 178 cultivar produced the highest value (8.25 t/ha), but without significant superiority over Sakha 101 cultivar (8.05 t/ha), whereas Sakha 102 cultivar had the minimum grain yield, being 7.28 t/ha.

Table (10) : Yield and yield components as affected by rice cultivars in broadcasting method (Combined data of 1996 & 1997).

Cultivars	Number of panicle/m²	Panicle weight (g)	Filled grains/ panicle	Unfilled grains/ panicle	1000-grain weight	Straw yield (t/ha)	Grain yield (t/ha)	Harvest index
Giza 181	718.8 cd	2.41 c	108.47 a	11.34 a	25.59 c	10.17 a	7.45 bc	42.45 b
Giza 177	703.2 d	2.53 b	91.69 b	5.56 cd	28.28 b	9.59 c	7.70 b	44.39 a
Giza 178	827.5 a	2.53 b	107.94 a	6.44 b	22.84 d	9.91 b	8.25 a	45.11 a
Sakha 101	775.4 b	2.84 a	92.19 b	5.94 bc	28.78 a	10.02 ab	8.05 a	44.34 a
Sakha 102	746.8 bc	2.51 b	91.13 b	5.13 d	28.88 a	9.68 c	7.28 c	42.54 b
F. test V x S	**	**	**	**	**	**	*	**

Giza 178 cultivar had the highest harvest index followed by Giza 177 and Sakha 101 cultivars, which were 45.11, 44.39 and 44.34, respectively. The lowest value was recorded by Giza 181 cultivar, being 42.45.

It is evident that the increase in the grain yield of Giza 178 cultivar primarily due to the increase in number of panicles/m^2 and filled grains/panicle, whereas the increase in yield of Sakha 101 cultivar could be attributed to the increase in weight of panicle and 1000-grain weight.

It could be concluded that differential performance of the tested cultivars may be attributed to differences in constitution of these cultivars.

These results are in accordance with those obtained by Aly *et al* (1984), Mahgoub *et al* (1986), Badawi *et al* (1990) and El-Kalla (1990).

1.2.4. Interaction effect between cultivars and seasons :

Table (10) shows that the effects of interaction between cultivars and seasons were highly significant for all parameters, but only significant for grain yield.

This interaction with seasons resulted mainly from different ranking of cultivars from season to season.

1.2.5. Effect of the interaction between nitrogen application and seasons :

Table (9) shows that the effect of interaction between nitrogen application and seasons was significant for panicle weight, filled grains (panicle, unfilled grains/panicle and straw yield). However, insignificant effect of interaction between nitrogen application and seasons was detected for other yield and yield components.

1.2.6. Effect of the interaction between cultivars and nitrogen application :

Means of yield and yield components as affected by the interaction between rice cultivars and nitrogen application as combined data for 1996 and 1997 seasons are shown in Table (11).

Results showed that the effect of interaction between rice cultivars and nitrogen application significantly influenced yield and yield components.

Adding nitrogen in three split doses (T_3); $^1/_2$ basal and $^1/_4$ at panicle initiation and $^1/_4$ at complete flowering with Giza 178 cultivar gave the highest values for number of panicles/m^2 (916.0) and grain yield (8.83 t/ha). The same N application resulted in the highest panicle weight (3.56 g) and harvest index (46.46) with Sakha 101 cultivar, as well as unfilled grains/panicle (14.5) and straw yield (10.46 t/ha) with Giza 181 cultivar. However, Giza 178 had the highest value for filled grains/panicle (118.75) under T_1 treatment while the highest 1000-grain weight (29.25 g) was obtained with Sakha 102 under T_2 treatment .

On the contrary, application of all nitrogen as basal (T_4) gave the lowest values for panicle weight (2.14 g) and harvest index (40.21) with Giza 181 cultivar, filled grains (79.88) and unfilled grains (4.38) per panicle with Sakha 101 cultivar as well as number of panicles/m^2 (628.1) with Giza 177 cultivar. While, the lowest value for 1000-grain weight (22.63 g) and grain yield (6.85 t/ha) were recorded by applying

Table (11) : Grain yield and yield components as affected by interaction between time of nitrogen application and rice cultivars in broadcasting method (Combined data of 1996 & 1997).

Time of N application	Cultivars	Number of panicle/m²	Panicle weight (g)	Filled grains/ panicle	Unfilled grains/ panicle	1000-grain weight (g)	Straw yield (t/ha)	Grain yield (t/ha)	Harvest index
T_1	Giza 181	758.8 fg	2.42 i	107.38 de	9.38 c	26.00 i	10.37 a	7.30 j	42.27 i
	Giza 177	706.0 i	2.43 hi	91.38 ij	4.98 i	28.50 e	9.81 fg	7.63 g	43.39 gh
	Giza 178	844.5 b	2.51 f	118.75 a	4.75 i	22.63 m	9.99 cd	8.29 d	45.30 cd
	Sakha 101	816.3 c	2.79 b	97.13 h	5.75 h	28.75 d	9.92 de	8.55 b	46.40 a
	Sakha 102	752.1 g	2.61 e	91.00 ij	5.00 i	28.79 cd	9.64 h	6.85 m	41.61 j
T_2	Giza 181	721.8 hi	2.59 e	115.50 b	12.00 b	26.63 h	10.00 cd	7.54 gh	42.65 i
	Giza 177	727.3 h	2.57 e	92.00 i	5.50 h	28.38 ef	9.62 h	7.77 f	45.50 cd
	Giza 178	730.1 h	2.51 fg	106.13 e	6.00 g	23.00 L	10.27 b	8.42 c	45.54 cd
	Sakha 101	796.0 d	2.68 c	101.63 f	6.50 f	29.13 ab	10.19 b	7.96 c	43.81 f
	Sakha 102	782.6 de	2.48 fg	99.75 g	4.75 i	29.25 a	9.61 h	7.99 e	45.20 d
T_3	Giza 181	719.3 hi	2.49 fg	111.13 c	14.50 a	24.75 k	10.46 a	8.07 e	44.68 e
	Giza 177	751.3 g	2.65 cd	99.00 g	5.50 h	27.50 g	9.30 j	7.99 e	45.63 bc
	Giza 178	916.0 a	2.66 c	108.38 d	8.88 d	23.00 L	9.97 cd	8.83 a	45.95 b
	Sakha 101	853.5 b	3.56 a	90.13 j	7.13 c	28.25 f	9.93 de	8.55 b	46.46 a
	Sakha 102	720.8 hi	2.61 de	85.88 L	5.75 h	28.50 e	9.71 gh	7.28 j	42.63 i
T_4	Giza 181	675.4 j	2.14 k	99.88 g	9.50 c	25.00 j	9.85 ef	6.88 Lm	40.21 L
	Giza 177	628.1 k	2.48 fg	84.38 L	6.25 g	28.75 d	9.63 h	7.39 ij	43.04 h
	Giza 178	819.4 c	2.46 gh	98.50 gh	6.13 g	22.75 m	9.42 i	6.46 hi	43.64 fg
	Sakha 101	635.8 k	2.35 j	79.88 m	4.38 j	29.00 bc	10.05 c	7.14 k	40.70 k
	Sakha 102	731.5 ef	2.33 j	87.88 k	5.00 i	29.00 bc	9.75 fg	6.99 L	40.73 k
F. test T x V x S		**	**	**	**	ns	ns	ns	ns

T_1 = $^2/_3$ basal + $^1/_3$ at panicle initiation (PI).
T_2 = $^1/_3$ basal + $^1/_3$ at maximum tillering (MT) + $^1/_3$ at PI.
T_3 = $^1/_2$ basal + $^1/_4$ at PI + $^1/_4$ at complete flowering.
T_4 = All amount as basal.

nitrogen in two split doses (T_1) with Giza 178 and Sakha 102, respectively. Concerning straw yield, the lowest value was obtained by Giza 177 (9.30 t/ha) under T_3 treatment.

It could be concluded that applying nitrogen as $^1/_2$ basal and $^1/_4$ at panicle initiation and $^1/_4$ at complete flowering (T_3) favourably affected grain yield of Giza 178 cultivar and significantly increased grain yield compared to other treatments. The superiority of Giza 178 cultivar in grain yield under T_3 treatment might be ascribed to some components of yield, especially number of panicle/m^2.

These results are in harmony with those obtained by Om *et al* (1988), Lopez *et al* (1996), Abd El-Wahab (1998) and El-Kady and Abd El-Wahab (1999).

1.2.7. Effect of interaction between cultivars, nitrogen application and seasons :

Results revealed significant effects of cultivars, nitrogen applications and seasons for number of panicles/m^2, panicle weight, filled grains/panicle and unfilled grains/panicle (Table 11). These results indicated into the unstable effect of interaction between cultivars and nitrogen applications.

1.3. Quality attributes :

1.3.1. Effect of seasons :

Table (12) shows the average values of seasonal effect on some quality attributes as combined data for 1996 and 1997 seasons.

The results indicated that only hulling, milling, head rice and protein percentage were significantly affected by seasons. Higher hulling and protein percentages were deteted in the first season, but values of milling and head rice percentages were higher in the second one.

1.3.2. Effect of nitrogen application :

Data in Table (13) present the average values of some grain quality attributes as affected by time of nitrogen application expressed as combined data for 1996 and 1997 rice seasons. Milling, head rice and protein percentages responded significantly to time of nitrogen application, while the other attributes were statistically the same with different nitrogen application times. When nitrogen was applied as two split doses; $^2/_3$ basal and $^1/_3$ at panicle initiation (T_1), the highest significant values of milling (71.47%) and head rice (62.41%) were obtained. The lowest values of milling (69.46%) as well as head rice (59.16%) were detected when nitrogen was applied as T_3 ($^1/_2$ basal + $^1/_4$ at panicle initiation (PI) + $^1/_4$ at complete flowering) and as T_4 (all amount as basal), respectively. The highest protein content was assessed in rice grains (8.68) when N was applied as T_3, followed by T_1 (8.16%), T_2 (7.83%), while the lowest value was assessed in T_4 (6.98%).

Similar results were obtained by Lei *et al* (1971), Islam *et al* (1990) and El-Refaee (1997).

Table (12): Seasonal effects on the average values of some grain quality in broadcasting method.

Season	Grain length (mm)	Grain width (mm)	Grain shape	Hulling %	Milling %	Head rice %	Protein %	Amylose %
1996	8.10 a	3.16 a	2.62 a	78.98 a	69.23 b	59.99 b	8.41 a	19.04 a
1997	7.96 a	3.14 a	2.62 a	77.94 b	71.11 a	62.23 a	7.42 b	19.59 a

Table (13): Effect of time of nitrogen application on some grain quality in broadcasting method (Combined data of 1996 & 1997).

Treatments / Time of N appl.	Grain length (mm)	Grain width (mm)	Grain shape	Hulling %	Milling %	Head rice %	Protein %	Amylose %
T_1	7.94 a	3.13 a	2.63 a	78.77 a	71.47 a	62.41 a	8.16 b	19.37 a
T_2	8.09 a	3.15 a	2.65 a	78.32 a	70.07 b	61.29 b	7.83 c	19.28 a
T_3	8.03 a	3.15 a	2.59 a	78.32 a	69.46 b	61.58 b	8.68 a	19.31 a
T_4	8.04 a	3.16 a	2.61 a	78.41 a	69.67 b	59.16 c	6.98 d	19.30 a
F. test (T x S)	ns	ns	ns	ns	*	**	**	ns

$T_1 = {}^2/_3$ basal + ${}^1/_3$ at panicle initiation (PI). $T_2 = {}^1/_3$ basal + ${}^1/_3$ at maximum tillering (MT) + ${}^1/_3$ at PI.
$T_3 = {}^1/_2$ basal + ${}^1/_4$ at PI + ${}^1/_4$ at complete flowering. T_4 = All amount as basal.

1.3.3. Effect of cultivars :

Data presented in Table (14) show the performance of rice cultivars in terms of combined data of grain quality in 1996 and 1997 seasons.

Results indicated that the five tested cultivars significantly affected all studied quality attributes. Giza 181 cultivar gave the highest values of grain length (9.13 mm), grain shape (3.46) and amylose content (20.31%). The highest hulling, milling, head rice and protein percentages (80.57, 72.62, 65.23 and 8.26, respectively) were recorded for Giza 177 cultivar which had also the lowest grain shape (2.29). The lowest values of grain length (7.42 mm), hulling (76.85%) and milling (67.91%), head rice (57.74%) and amylose (17.91%) were recorded by Giza 178 cultivar. Sakha 101 cultivar had the highest value of grain width (3.42 mm) and the lowest value of protein content (7.69%).

It could be concluded that the five tested cultivars differed with regard to grain quality attributes, that may be mainly due to differences in growth patterns and genetic constitutions.

El-Kalla *et al* (1990) and El-Kady and Abd El-Wahab (1999) found differences between rice cultivars.

1.3.4. Interaction effect between cultivars and seasons :

Data presented in Table (14) clarify the interaction effect between cultivars and seasons. Significant interactions were calculated for milling, head rice, protein and amylose percentages. These significant interactions reveal that performance of such cultivars varied from one season to another concerning these traits.

Table (14): Some grain quality as affected by rice cultivars in broadcasting method (Combined data of 1996 & 1997).

Cultivars	Grain length (mm)	Grain width (mm)	Grain shape	Hulling %	Milling %	Head rice %	Protein %	Amylose %
Giza 181	9.13 a	2.70 c	3.46 a	75.67 d	67.96 c	57.71 d	7.74 c	20.31 a
Giza 177	7.82 b	3.41 a	2.29 c	80.57 a	72.62 a	65.23 a	8.26 a	19.91 c
Giza 178	7.42 c	2.85 b	2.64 b	76.85 c	67.91 c	57.74 d	7.91 b	17.91 d
Sakha 101	7.93 b	3.42 a	2.33 c	79.62 b	71.11 b	61.85 c	7.69 c	19.74 b
Sakha 102	7.83 b	3.35 a	2.37 c	79.58 b	71.25 b	63.03 b	7.95 b	19.59 b
F. test (V x S)	ns	ns	ns	ns	**	**	**	**

1.3.5. Interaction effect between cultivars and nitrogen application :

Data in Table (15) revealed significant interaction between the tested cultivars and time of nitrogen applications.

Giza 177 cultivars had the highest values for hulling (80.95%) and head rice (66.57%) under T_2 treatment, protein (9.34%) under T_1 treatment as well as milling (73.60%) under T_3. While, Giza 181 cultivar had the highest values for grain length (9.42), grain shape (3.57) and amylose (20.6%) under T_2, T_4 and T_1 treatments, respectively.

For grain width, the highest mean value was obtained by Sakha 101 with T_2 treatment being 3.50 mm. On the other hand, the lowest values for grain length (7.28 mm), grain width (2.65 mm), milling (66.02%) and amylose content (17.62%) were produced by Giza 178 cultivar with T_4, T_2, T_3 and T_1, respectively. The lowest values for hulling (75.53%) and head rice (55.55%) were obtained by adding all nitrogen dose as basal (T_4) with Giza 181 while the same treatment of N application resulted in the lowest value of protein (6.84%) with Sakha 102. As for grain shape, the lowest value was produced by Giza 177 under T_3 and T_4 treatments.

Similar results were obtained by El-Kady and Abd El-Wahab (1999).

1.3.6. Interaction effect between nitrogen application and season :

The interaction effect between N applications and seasons is shown in Table (13). Significant effects were found for milling, head

Table (15) : Some grain quality as affected by interaction between time of nitrogen application and rice cultivars in broadcasting method (Combined data of 1996 & 1997).

Time of N application	Cultivars	Grain length (mm)	Grain width (mm)	Grain shape	Hulling %	Milling %	Head rice %	Protein %	Amylose %
T_1	Giza 181	8.33 d	2.65 i	3.50 b	76.02 h	69.50 i	60.43 h	8.13 e	20.60 a
	Giza 177	7.90 f	3.38 cd	2.35 h	80.47 b	72.13 c	66.38 a	9.34 a	18.63 h
	Giza 178	7.53 g	2.93 f	2.57 f	77.02 g	70.70 g	58.23 j	7.72 h	17.62 L
	Sakha 101	8.08 e	3.40 bc	2.36 gh	80.40 b	71.77 d	62.15 g	7.63 i	20.42 b
	Sakha 102	7.83 f	3.30 e	2.37 gh	79.95 c	73.27 b	64.87 c	8.00 f	19.57 d
T_2	Giza 181	9.42 a	2.73 h	3.43 c	75.53 i	67.40 L	57.40 k	7.79 g	20.20 c
	Giza 177	7.83 f	3.43 bc	2.28 j	80.95 a	73.57 a	66.57 a	7.97 f	19.32 e
	Giza 178	7.52 g	2.65 i	2.85 e	77.13 g	67.95 k	59.83 i	7.97 f	17.80 k
	Sakha 101	7.88 f	3.50 a	2.30 ij	78.05 f	69.88 h	60.52 h	7.44 j	19.70 d
	Sakha 102	7.82 f	3.42 bc	2.37 gh	79.93 c	71.53 e	62.13 g	7.95 f	19.37 e
T_3	Giza 181	9.27 c	2.77 h	3.35 d	75.58 i	66.07 n	57.47 k	8.10 e	20.27 c
	Giza 177	7.77 f	3.45 b	2.27 j	80.92 a	73.60 a	65.00 bc	8.54 d	19.00 g
	Giza 178	7.33 h	2.88 g	2.58 f	77.23 g	66.02 n	56.70 L	8.95 b	18.22 i
	Sakha 101	7.91 f	3.35 d	2.33 hi	79.43 d	72.22 c	64.15 e	8.79 c	19.43 e
	Sakha 102	7.88 f	3.28 e	2.40 g	78.43 e	69.40 i	64.60 d	9.01 b	19.63 d
T_4	Giza 181	9.52 b	2.67 i	3.57 a	75.53 i	68.87 j	55.55 m	6.94 m	20.17 c
	Giza 177	7.78 f	3.38 cd	2.27 j	79.95 c	71.18 f	62.95 f	7.19 k	19.15 f
	Giza 178	7.28 h	2.92 fg	2.55 f	76.00 h	66.95 m	56.20 b	7.01 L	18.00 j
	Sakha 101	7.85 f	3.41 bc	2.33 hi	80.58 b	70.58 g	60.67 h	6.91 mn	19.42 e
	Sakha 102	7.78 f	3.42 bc	2.35 h	79.98 c	70.78 g	60.53 h	6.84 n	19.78 e
F. test T x V x S		ns	ns	ns	**	**	**	**	**

T_1 = $^2/_3$ basal + $^1/_3$ at panicle initiation (PI). T_2 = $^1/_3$ basal + $^1/_3$ at maximum tillering (MT) + $^1/_3$ at PI.

T_3 = $^1/_2$ basal + $^1/_4$ at PI + $^1/_4$ at complete flowering. T_4 = All amount as basal.

rice and protein percentages that mean that the effect of time of nitrogen application on some grain quality attributes was not constant in both years of study.

1.3.7. Interaction effect among cultivars, nitrogen applications and season :

With the exception of grain length, grain width and grain shape, all attributes showed significant differences due to the interaction effect between cultivars, nitrogen application and seasons (Table 15). This result may be due to the fluctuated effect of the interaction of cultivars and nitrogen application from one season to another.

2. Transplanting Method :

2.1. Growth attributes :

2.1.1. Effect of season :

The effect of season on growth attributes presented in Table (16) showed that the seasonal effects were clear on most of growth attributes. Numbers of tillers/m^2 in the first, second and third stages were significantly higher in the first season than in the second one. However, plant height and heading date gave significantly higher values in the second season than in the first one. On the other hand, panicle length didn't differ significantly in 1996 than 1997 rice season.

2.1.2. Effect of nitrogen application :

Data in Table (17) show the effect of N-fertilizer application on number of tillers/m^2 at different growth stages, heading date and plant height as combined data of the two seasons.

Table (16) : Seasonal effect on the average values of growth attributes of transplanted rice.

Season	Number of tillers/m^2 (indicated by growth stages)				Heading date (days)	Plant height (cm)	Panicle length (cm)
	No. 1	No. 2	No. 3	No. 4			
1996	526.81 a	637.81 a	662.50 a	630.31 a	93.75 b	87.66 b	19.78 a
1997	424.38 b	475.23 b	572.81 b	640.69 a	102.83 a	97.84 a	19.58 a

No. 1: 30 days after sowing, No. 2: Panicle initiation, No. 3: Complete flowering, No. 4: Harvest

Table (17) : Effect of time of nitrogen application on growth attributes of transplanted rice (Combined data of 1996 & 1997).

Treatments Time of N application	Number of tillers/m^2 (indicated by growth stages)				Heading date (days)	Plant height (cm)	Panicle length (cm)
	No. 1	No. 2	No. 3	No. 4			
T_1	469.25 a	561.00 a	635.63 a	652.38 a	98.78 a	93.38 a	19.77 a
T_2	471.88 a	563.30 a	605.63 b	635.00 b	98.55 ab	93.47 a	19.81 a
T_3	473.75 a	555.35 a	615.00 b	634.00 b	98.00 bc	92.37 b	19.71 a
T_4	487.50 a	546.43 a	614.38 b	620.63 b	97.83 c	91.78 b	19.43 a
F. test T x S	**	ns	**	ns	**	**	*

$T_1 = {}^2/_3$ basal + ${}^1/_3$ at panicle initiation (PI). $T_2 = {}^1/_3$ basal + ${}^1/_3$ at maximum tillering (MT) + ${}^1/_3$ at PI.
$T_3 = {}^1/_2$ basal + ${}^1/_4$ at PI + ${}^1/_4$ at complete flowering. T_4 = All amount as basal.
No. 1: 30 days after sowing, No. 2: Panicle initiation, No. 3: Complete flowering, No. 4: Harvest

It was observed that N-fertilizer application gave significant effect on number of tillers/m^2 in the third and fourth stages, heading date, plant height and panicle length. The highest values of number of tillers/m^2 in the third and fourth stages, heading date and plant height were obtained by T_1 ($^2/_3$ basal + $^1/_3$ at panicle initiation), followed by T_2 ($^1/_3$ basal + $^1/_3$ at maximum tillering + $^1/_3$ at panicle initiation). The superiority of the split application of nitrogen may be attributed to the availability of nitrogen in the critical rice growth stages as well as to the decrease in nitrogen losses due to volatilization, nitrification and denitrifiation. These results are in agreement with those obtained by Lai *et al.* (1977). Reddy *et al.* (1985), El-Bably (1990), Attia *et al.* (1994), El-Refaee (1997) and El-Kady and Abd El-Wahab (1999).

2.1.3. Effect of cultivars :

Results in Table (18) revealed that tested cultivars performed significantly for all the considered growth attributes.

Giza 178 produced the highest number of tillers in the first and second growth stages (510.94 & 591.78 tillers/m^2, respectively). However, Giza 177 and Sakha 102 at the first growth stage and Sakha 102 at the second stage gave the lowest tillers/m^2. Giza 177 was superior (670.31 tillers/m^2) in the third stage, while Giza 181 gave the highest number of tillers in stage four (663.44 tillers/m^2) followed by Giza 178 (662.50) and then Giza 177 (652.66), however Sakha 101 came last in this stage (603.13 tillers/m^2).

Concerning the heading date, Giza 177 and Sakha 102 were the earliest cultivars (91.03 and 90.78 days, respectively), but Giza 181 was the latest heading cultivar (108.50 days).

Table (18): Growth attributes of transplanted rice as affected by rice cultivars (Combined data of 1996 & 1997).

Cultivars	Number of tillers/m^2 (indicated by growth stages)				Heading date (days)	Plant height (cm)	Panicle length (cm)
	No. 1	No. 2	No. 3	No. 4			
Giza 181	485.16 b	549.22 b	623.44 c	663.44 a	108.50 a	89.48 d	20.40 a
Giza 177	450.78 c	563.81 b	670.31 a	652.66 a	91.03 d	93.23 b	17.86 b
Giza 178	510.94 a	591.78 a	647.66 b	662.50 a	101.59 b	91.10 c	19.89 a
Sakha 101	472.66 bc	554.16 b	578.91 d	603.13 c	99.53 c	89.16 d	20.02 a
Sakha 102	458.44 c	523.63 c	567.97 d	625.78 b	90.78 d	100.78 a	20.22 a
F. test V x S	**	*	**	**	**	**	*

No. 1: 30 days after sowing, No. 2: Panicle initiation, No. 3: Complete flowering, No. 4: Harvest

Sakha 102 gave the highest value of plant height (100.78 cm) followed by Giza 177 (93.23 cm), while the shortest cultivars were Sakha 101 and Giza 181; 89.16 and 89.48 cm, respectively.

As for panicle length, Giza 177 had significantly the shortest panicles (17.86 cm), but the other cultivars had almost the same panicle length, with Giza 181 having the longest panicles (20.40 cm).

Differences in number of tillers and other rice growth attribute in various cultivars were recorded by several authors; Zeidan *et al.* (1980), Assey *et al.* (1992) and Gorgy (1995).

2.1.4. Interaction effect between cultivars and seasons :

Table (18) shows that the effect of interaction between cultivars and seasons was statistically significant for all growth attributes. This interaction with season were caused mainly by different ranking of cultivars from season to season.

2.1.5. Interaction effect between cultivars and nitrogen application :

The cultivars and N-application interaction showed a significant effect on all growth attributes (Table 19). The highest values for number of tillers at the first growth stages were obtained by T_4 with Giza 178 (562.50 tillers/m^2) followed by T_3 (518.75) and T_2 (503.13) with the same cultivar. Meanwhile, the lowest value of tillers (406.25) was recorded by T_1 with Giza 177 in the first stage.

The highest number of tillers in the second stage was obtained by T_2 and T_1 with Giza 178; 607.00 and 603.00 tillers/m^2, respectively, Table (19): Growth attributes of transplanted rice as affected by interaction between time of nitrogen application and rice cultivars (Combined data of 1996 & 1997).

Time of N application	Cultivars	Number of tillers/m^2 (indicated by growth stages) No. 1	No. 2	No. 3	No. 4	Heading date (days)	Plant height (cm)	Panicle length (cm)
T_1	Giza 181	518.75 b	562.50 fg	628.13 de	658.75 cde	108.25 b	90.30 k	19.58 e
	Giza 177	406.25 n	561.38 fg	650.00 c	653.13 c	92.13 j	95.15 d	17.96 g
	Giza 178	459.38 jk	603.00 a	684.38 b	709.38 a	102.38 c	90.06 kL	20.05 cd
	Sakha 101	475.00 ghi	554.38 gh	618.75 e	578.13 j	99.88 g	90.65 j	20.48 b
	Sakha 102	486.88 def	523.75 j	596.88 g	662.50 cd	91.25 k	100.71 b	20.79 a
T_2	Giza 181	490.63 de	537.50 i	634.38 d	621.88 g	109.13 a	87.64 n	20.25 bc
	Giza 177	465.65 ij	567.00 ef	646.88 c	656.25 de	90.50 L	94.79 e	18.01 g
	Giza 178	503.13 c	607.00 a	625.00 e	637.50 f	101.88 d	92.59 f	19.80 de
	Sakha 101	446.88 Lm	549.38 h	578.13 b	631.25 f	100.13 g	90.66 j	20.79 a
	Sakha 102	453.13 kL	555.63 gh	543.75 j	628.13 fg	91.13 k	101.68 a	20.18 c
T_3	Giza 181	453.13 kL	593.75 b	621.88 e	656.25 de	108.25 b	89.80 L	20.99 a
	Giza 177	484.38 efg	578.13 cd	703.13 a	629.38 fg	90.38 L	91.93 g	18.03 g
	Giza 178	518.75 b	572.13 de	606.25 f	637.50 f	101.50 e	90.18 k	20.14 c
	Sakha 101	471.88 hi	537.50 i	575.00 h	609.38 h	99.38 h	88.33 m	19.13 f
	Sakha 102	440.63 m	495.25 k	568.75 hi	637.50 f	90.50 L	101.64 a	20.26 bc
T_4	Giza 181	478.13 fgh	503.13 k	609.38 f	596.88 L	108.38 b	90.20 k	20.79 a
	Giza 177	446.88 Lm	548.75 h	681.25 b	671.88 b	91.13 k	91.06 i	17.44 h
	Giza 178	562.50 a	585.00 bc	675.00 b	665.63 bc	100.63 f	91.58 h	19.58 e
	Sakha 101	496.88 cd	575.38 de	543.75 i	593.75 i	98.75 i	86.99 o	19.69 e
	Sakha 102	453.13 kL	519.88 j	575.00 j	575.00 j	90.25 L	99.09 c	19.65 e
F. test T x V x S		**	**	**	**	ns	**	**

No. 1: 30 days after sowing, No. 2: Panicle initiation, No. 3: Complete flowering, No. 4: Harvest

while the lowest number of tillers (495.25) was recorded by Sakha 102 with T_3. Markedly, increases in tillering were recorded in the third growth stage, as Giza 177 produced the highest number of tillers with T_3 (703.13), followed by Giza 178 with T_1 (684.38) and again Giza 177 in T_4 (681.25) and T_1 (650.00 tillers). However, the lowest values were detected for Sakha 102 at T_2 (543.75) and Sakha 101 at T_4 (543.75 tillers). At the fourth growth stage, the highest tillers were recorded by Giza 178 at T_1 (709.38), while the lowest ones were those of Sakha 101 with T_1 (578.13) and Sakha 102 with T_4 (575.00 tillers/m^2).

It could be concluded that number of tillers per m^2 differed from one cultivar to another due to their tillering ability, and from one growth stage to another due to tillering patterns of each cultivar.

The earliest heading occurred with Sakha 102 at T_4 (90.25 days), followed by Giza 177 at T_3 (90.38) and Sakha 102 at T3 (90.50) and T_2 (91.13) and the Giza 177 at T_4 (91.13 days).

The longest plants were always recorded by Sakha 102 at all times of nitrogen application, as the heights ranged between 99.09 and 101.68 cm. The shortest cultivar was Sakha 101 exhibiting 86.99 and 88.33 cm at T_4 and T_3 nitrogen applications, respectively. A similar result was obtained by El-Kady and Abd El-Wahab (1991).

2.1.6. Interaction effect between nitrogen application and season :

Table (17) revealed that the interaction between times of nitrogen application and seasons of study was significant for all growth attributes with the exception of interaction effect at the second and fourth growth stages which revealed insignificance.

2.1.7. <u>Interaction effect among seasons, nitrogen application and cultivars</u> :

With the exception of heading date, all growth attributes showed highly significant differences due to the effect of interaction among cultivars, N-applications and seasons (Table 19). This result may be due to fluctuating effect of the interaction of cultivars and N-applications from one season to another.

2.2. <u>Yield and yield components</u> :

2.2.1. <u>Effect of season</u> :

Results in Table (20) present averages of yield and yield components in the two seasons of the study. From the results, it is evident that all yield and yield components except grain yield were significantly different from one season to another. Higher mean values for panicle weight, filled grains/panicle, 1000-grain weight and harvest index were detected in the first season compared to the second one. However, number of panicles/m^2, unfilled grains and straw yield were found to be higher in 1997 rice season than in 1996 one. However, grain yields for both seasons were very close. These results could be attributed to variations in temperature relative humidity and soil between 1996 and 1997.

2.2.2. <u>Effect of nitrogen ferilizer application</u> :

Table (21) shows the combined analysis of the two seasons for yield and yield components as affected by time of nitrogen application. Data revealed that the differences between the

Table (20): Seasonal effects on the average of yield and yield components of transplanted rice.

Season	Number of panicle/m²	Panicle weight (g)	Filled grains/ panicle	Unfilled grains/ panicle	1000-grain weight	Straw yield (t/ha)	Grain yield (t/ha)	Harvest index
1996	430.94 b	2.86 a	93.64 a	3.86 b	27.84 a	9.74 b	8.15 a	45.60 a
1997	596.81 a	2.44 b	88.90 b	6.63 a	26.14 b	10.24 a	8.18 a	44.28 b

Table (21): Effect of time of nitrogen application on yield and yield components of transplanted rice (Combined data of 1996 & 1997)

Treatments Time of N application	Number of panicle/m²	Panicle weight (g)	Filled grains/ panicle	Unfilled grains/ panicle	1000-grain weight	Straw yield (t/ha)	Grain yield (t/ha)	Harvest index
T_1	551.58 a	2.78 a	91.63 b	4.88 b	26.53 b	10.14 a	8.62 a	45.92 a
T_2	511.43 b	2.65 b	91.28 b	5.43 ab	27.05 ab	9.98 ab	7.99 bc	44.46 b
T_3	501.25 b	2.60 b	94.20 a	5.68 a	27.35 a	10.00 ab	8.17 b	45.04 ab
T_4	491.25 b	2.57 b	87.98 c	5.00 b	27.03 ab	9.86 b	7.89 c	44.35 b
F. test T x S	ns	**	**	ns	ns	ns	*	*

$T_1 = {}^2/_3$ basal + $^1/_3$ at panicle initiation (PI). $T_2 = {}^1/_3$ basal + $^1/_3$ at maximum tillering (MT) + $^1/_3$ at PI.
$T_3 = {}^1/_2$ basal + $^1/_4$ at PI + $^1/_4$ at complete flowering. T_4 = All amount as basal.

averages of all characters under study were significantly affected by N-fertilizer application. The results showed that, the highest number of paniles/m^2, panicle weight, straw and grain yields and harvest index were obtained when plants received nitrogen as $^2/_3$ basal and $^1/_3$ at panicle initiation (T_2). The same N-fertilizer treatment resulted in the lowest mean value for unfilled grains/panicle. This result might be attributed to the fact that splitting the nitrogen dose minimized the losses and met the needs of rice plants. The highest nitrogen losses take place during the wetting and drying period before the permanent floodig. In this period, nitrification-denitrification processes is the common reason of losses. Similar results were reported by Salam *et al.* (1988), Badawi *et al.* (1990), Pandey and Tripathi (1994), El-Refaee (1997) and Sorour *et al.* (1998). However, T_4 (all nitrogen amount applied as basal) resulted in the minimum value of all traits except for unfilled grains/panicle and 1000-grain weight which gave the lowest values due to T_1 treatment ($^2/_3$ basal + $^1/_3$ at PI). These findings are in a close agreement with the results of Gorgy (1988), Salam *et al.* (1988), Sahu *et al.* (1991), Pandey and Tripathi (1994) and Porwal *et al.* (1994).

2.2.3. Effect of cultivars :

The differences in yield and yield components as affected by considered rice cultivars were highly significant (Table 22).

Giza 181 gave the highest values for panicle weight and unfilled grains/panicle. While Giza 178 had the highest values for number of panicles/m^2 (564.06), filled grains/panicle (102.63) and straw yield (10.43 t/ha) and came second for grain yield (8.38 t/ha). Sakha 101

Table (22) : Yield and yield components as affected by rice cultivars of transplanted rice (Combined data of 1996 & 1997).

Cultivars	Number of panicle/m²	Panicle weight (g)	Filled grains/ panicle	Unfilled grains/ panicle	1000-grain weight	Straw yield (t/ha)	Grain yield (t/ha)	Harvest index
Giza 181	519.16 b	2.78 ab	99.81 b	8.16 a	26.13 c	9.82 c	7.82 d	44.21 c
Giza 177	489.28 c	2.54 a	80.81 d	4.25 c	28.50 b	9.89 bc	7.96 cd	44.52 c
Giza 178	564.06 a	2.61 b	102.63 a	5.66 b	22.44 d	10.43 a	8.38 b	44.48 c
Sakha 101	497.66 c	2.76 b	87.47 c	4.00 c	29.06 a	10.02 b	8.63 a	46.26 a
Sakha 102	499.22 c	2.57 ab	85.63 c	4.16 c	28.81 ab	9.81 c	8.04 c	45.24 b
F. test V x S	**	**	**	**	**	**	**	**

produced the highest values for panicle weight, 1000-grain weight, grain yield and harvest index. Sakha 101 had highest grain yield (8.63 t/ha), followed by Giza 178 and Sakha 102, while Giza 177 yielded lowest. The superiority of Sakha 101 in yield could be attributed to the high values of panicle weight, 1000-grain weight and seed index. Ranking Giza 178 as second in grain yield may be due to high number of panicles/m^2 and number of filled grains/panicle. Similar findings were reported by Aly *et al.* (1984) Mahgoub *et al.* (1986), Badawi *et al.* (1990) and El-Kalla *et al.* (1990).

2.2.4. Interaction effect between cultivars and seasons :

Table (22) shows that the effect of interaction between cultivars and seasons was statistically highly significant for all traits under study. This interaction with seasons was caused mainly by different ranking of cultivars from one season to another.

2.2.5. Interaction effect between cultivars and nitrogen application :

The cultivars and N-applications interaction showed a significant effect on all yield and its components (Table 23).

The highest values for number of panicles/m^2 were obtained by T_1 with Giza 178 followed by T_1 with Giza 181 and T_3 with Giza 178. However, the lowest number of panicles was detected by T_4 with Sakha 101.

The highest value of panicle weight was obtained by T_1 with Sakha 101 followed by T_3 with Giza 181. On the other hand, the lowest panicle weight was obtained by T_4 with Giza 177.

Table (23) : Grain yield and yield components as affected by interaction between time of nitrogen application and rice cultivars of transplanted rice (Combined data of 1996 & 1997).

Time of N application	Cultivars	Number of panicle/m^2	Panicle weight (g)	Filled grains/ panicle	Unfilled grains/ panicle	1000-grain weight (g)	Straw yield (t/ha)	Grain yield (t/ha)	Harvest index
T_1	Giza 181	563.25 b	2.81 c	93.13 f	7.25 c	25.63 i	10.18 d	8.48 d	45.30 e
	Giza 177	500.80 g	2.55 hi	76.38 k	4.00 jk	28.63 d	9.88 i	8.08 g	44.88 f
	Giza 178	593.75 a	2.77 cd	104.38 c	5.00 f	21.75 L	10.67 b	8.99 b	45.80 cd
	Sakha 101	553.13 c	3.09 a	100.13 d	4.88 f	28.63 d	9.89 hi	9.08 a	47.88 a
	Sakha 102	546.88 c	2.66 ef	84.13 gh	3.25 L	28.00 f	10.08 e	8.48 d	45.74 cd
T_2	Giza 181	532.13 d	2.72 de	100.38 d	8.00 b	26.13 h	9.96 gh	7.91 hi	44.19 hi
	Giza 177	462.50 k	2.60 fgh	82.50 i	4.50 gh	28.25 e	9.60 L	7.47 L	43.58 k
	Giza 178	562.50 b	2.61 fgh	107.00 a	6.13 c	22.50 k	10.30 c	8.08 g	43.74 jk
	Sakha 101	509.38 f	2.77 cd	85.00 g	4.00 jk	29.38 b	10.33 c	8.51 d	44.86 f
	Sakha 102	490.63 h	2.55 hi	81.50 g	4.50 gh	29.00 c	9.71 k	7.96 h	45.93 c
T_3	Giza 181	518.75 e	2.99 b	105.88 b	9.63 a	27.25 g	9.56 L	7.85 i	45.30 e
	Giza 177	478.13 i	2.59 gh	83.38 hi	4.13 ij	28.50 d	10.05 ef	7.94 h	44.05 ij
	Giza 178	565.63 b	2.50 ij	104.88 c	6.50 d	22.75 j	10.78 a	8.68 c	44.44 gh
	Sakha 101	475.00 ij	2.46 jk	84.25 gh	3.38 L	29.63 a	10.08 e	8.73 c	46.79 b
	Sakha 102	468.75 jk	2.47 jk	92.63 f	4.75 fg	28.63 d	9.54 L	7.66 k	44.64 fg
T_4	Giza 181	462.50 k	2.59 gh	99.88 d	7.75 b	25.50 i	9.56 L	7.04 m	42.04 L
	Giza 177	515.63 e	2.42 k	81.00 j	4.38 hi	28.63 d	10.03 efg	8.36 e	45.56 de
	Giza 178	534.38 d	2.56 hi	94.25 e	5.00 f	22.75 j	9.99 fg	7.76 j	43.96 ij
	Sakha 101	453.13 L	2.73 fg	80.50 j	3.75 k	28.63 d	9.80 j	8.23 f	45.53 de
	Sakha 102	490.63 h	2.58 gh	84.25 gh	4.13 j	29.63 a	9.90 hi	8.06 g	44.66 fg
F. test T x V x S		**	ns	**	**	**	**	*	**

The highest value of filled grains/panicle was obtained by T_2 with Giza 178 followed by T_3 with Giza 181. Whereas, the lowest value was obtained by T_1 with Giza 177. T_1 with Sakha 102 and T_3 with Sakha 101 gave the lowest unfilled grains/panicle. However, T_3 with Giza 181 gave the highest one.

The highest values of 1000-grain wight were recorded by each of T_3 with Sakha 101 and T_4 with Sakha 102, followed by T_2 with Sakha 101. However, T_1 with Giza 178 gave the lowest one.

For straw yield, the highest value was recordd by T_3 with Giza 178, whereas T_3 and T_4 with Giza 181 gave the lowest one. Concerning grain yield, the highest value was recorded by T_1 with Sakha 101 followed by T_1 with Giza 178 and then by T_3 with each of Giza 178 and Sakha 101. The high grain yield of T_1 with Sakha 101 could be attributed to the high panicle weight and harvest index, while, the highest grain yield of T_1 and T_3 with Giza 178 may be attributed to high number of panicles/m^2.

It could be concluded that T_1 is the optimal combination for each of Sakha 101 and Giza 178 to produce the highest grain yield. The highest value of harvest index was detected by T_1 with Sakha 101. However, T_4 with Giza 181 had the lowest one.

Generally, T_1 with all cultivars gave the highest mean values for yield and most of yield components. These results are in harmony with those obtained by Om *et al.* (1988), Lopes *et al.* (1996), Abd El-Wahab (1998) and El-Kady and Abd El-Wahab (1999).

2.2.6. Interaction effect of nitrogen application and seasons :

Table (21) shows that the effect of interaction between time of nitrogen fertilizer application and seasons was statistically significant for panicle weight, filled grains/panicle, grain yield and harvest index, revealing that this effect differed from one season to another. However, insignificant effect of interaction between nitrogen fertilizer application and seasons was detected for other characters.

2.2.7. Interaction effect among varieties, N-application and seasons :

Results in Table (23) indicated that the effect of cultivars, N-application and seasons was significant for yield and yield components except for panicle weight. This result indicates that the effect of interaction between cultivars, N-applications changed from one season to another.

2.3. Quality attributes :

2.3.1. Effect of season :

Results in Table (24) present averages of the two seasons for quality attributes. It is evident that hulling, head rice and protein percentages were significantly different from one season to another. Higher mean values for hulling and protein percentages were detected in the first season, but the situation was reversed in the second season. However, seasonal effect was not significant on the other grain quality attributes.

2.3.2. Effect of nitrogen fertilizer application :

With regard to time of N application, results showed that time of nitrogen application significantly affected all grain quality attributes except for hulling percentage in the combined analysis over both seasons (Table 25).

Grain length reached its maximum value (8.33 mm) by T_3 ($^1/_3$ basal + $^1/_3$ at maximum tillering + $^1/_3$ at panicle initiation), followed by T_1 (8.04 mm), but the minimum value (7.90 mm) was obtained by T_3.

The highest grain width (3.27 mm) was recorded by T_4, followed by T_2 treatment (3.25 mm). On the other hand, T_1 gave the highest grain shape (2.63), followed by T_2 and T_3, while the treatments were statistically the same, but T_4 (all basal) gave the lowest value of grain shape.

T_2 treatment (3 equal splits) resulted in the highest values of milling and head rice percentages, while T_4 (all nitrogen amount as basal) resulted in the lowest values of both traits. T_3 gave the highest protein percentage, and T_4 gave the highest amylose percentage.

The superiority of the split application of nitrogen may be attributed to the occurrence of nitrogen in the critical rice growth stages as well as the decrease in lossing nitrogen to ammonia volatilization, nitrification and denitrification. Similar results were obtained by Lei *et al.* (1971), Islam *et al.* (1990), Ali *et al.* (1992), El-Refaee (1997) and El-Kady and Abd El-Wahab (1999).

Table (24) : Seasonal effects on the average values of some grain quality of transplanted rice.

Season	Grain length (mm)	Grain width (mm)	Grain shape	Hulling %	Milling %	Head rice %	Protein %	Amylose %
1996 (S_1)	8.18 a	3.25 a	2.57 a	80.63 a	70.25 a	62.11 b	7.43 a	18.33 a
1997 (S_2)	8.02 a	3.18 a	2.60 a	79.21 b	70.40 a	64.50 a	6.77 b	18.53 a

Table (25) : Effect of time of nitrogen application on some grain quality of transplanted rice (Combined data of 1996 & 1997).

Treatments / Time of N appl.	Grain length (mm)	Grain width (mm)	Grain shape	Hulling %	Milling %	Head rice %	Protein %	Amylose %
T_1	8.04 b	3.16 b	2.63 a	80.29 a	70.14 b	62.78 b	7.19 b	18.44 a
T_2	8.33 a	3.25 a	2.58 ab	79.75 a	71.03 a	64.69 a	7.14 b	18.09 b
T_3	7.90 c	3.18 b	2.59 ab	79.73 a	70.41 b	62.66 b	7.56 a	18.48 a
T_4	8.13 b	3.27 a	2.54 b	79.90 a	69.71 c	62.18 b	6.52 c	18.71 a
F. test (T x S)	**	*	*	ns	**	**	*	*

$T_1 = {}^2/_3$ basal + $^1/_3$ at panicle initiation (PI). $T_2 = {}^1/_3$ basal + $^1/_3$ at maximum tillering (MT) + $^1/_3$ at PI.
$T_3 = {}^1/_2$ basal + $^1/_4$ at PI + $^1/_4$ at complete flowering. T_4 = All amount as basal.

2.3.3. Effect of cultivars :

Table (26) shows the means of quality properties of the rice grains for the five cultivars under study. The grain length of cultivars ranged between 7.58 mm (Giza 178) and 9.14 mm (Giza 181) and grain width from 2.55 mm (Giza 181) to 3.49 mm (Sakha 102). These measurements in turn affected the grain shape (length/width ratio) which varied from 2.25 (Sakha 102) to 3.65 (Giza 181). The highest values of hulling, milling, head rice and protein content were recorded for Giza 177. Sakha 102 gave the highest value of amylose content followed by Giza 181 and then Giza 177. It could be concluded that Giza 177 is considered the best cultivar for grain quality properties followed by Sakha 102 and 101. Similar results were obtained by El-Kalla *et al.* (1990), El-Kassaby *et al.* (1991), Assey *et al.* (1992) and El-Kady and Abd El-Wahab (1999).

2.3.4. Interaction effect between cultivars and seasons :

Table (26) shows that the effect of interaction between cultivars and seasons was statistically significant for all properties except grain width and grain shape. This interaction with seasons resulted mainly by different ranking of cultivars from one season to another.

2.3.5. Interaction effect between cultivars and nitrogen application :

The differences between the averages of all properties were significant due to the interaction effect between N-application and cultivars (Table 27). This interaction is mainly due to the different ranking of cultivars from one application of nitrogen to another. The highest values of grain length were obtained by T_2 with Giza 181

Table (26): Some grain quality as affected by rice cultivars of transplanted rice (Combined data of 1996 & 1997).

Cultivars	Grain length (mm)	Grain width (mm)	Grain shape	Hulling %	Milling %	Head rice %	Protein %	Amylose %
Giza 181	9.14 a	2.55 c	3.65 a	77.95 c	66.96 c	60.95 c	7.32 b	18.91 b
Giza 177	7.75 d	3.41 a	2.31 c	81.64 a	71.97 a	64.31 a	7.53 a	18.26 c
Giza 178	7.58 e	3.14 b	2.40 b	78.43 c	70.37 b	62.70 b	6.73 d	17.65 d
Sakha 101	7.94 c	3.48 a	2.30 c	80.47 b	70.58 b	63.46 ab	7.07 c	18.11 c
Sakha 102	8.09 b	3.49 a	2.25 c	81.11 ab	71.75 a	63.98 a	6.86 d	19.23 a
F. test (V x S)	**	ns	ns	**	**	**	**	**

Table (27): Some grain quality as affected by interaction between time of nitrogen application and rice cultivars of transplanted rice (Combined data of 1996 & 1997).

Time of N application	Cultivars	Grain length (mm)	Grain width (mm)	Grain shape	Hulling %	Milling %	Head rice %	Protein %	Amylose %
T_1	Giza 181	9.20 b	2.42 n	3.78 a	79.20 g	67.22 m	58.53 m	7.94 b	18.58 f
	Giza 177	7.80 h	3.38 g	2.35 gh	82.12 a	71.38 f	63.05 h	8.09 a	18.23 gh
	Giza 178	7.55 k	3.10 j	2.43 f	77.68 j	70.48 h	64.60 de	6.47 k	17.60 k
	Sakha 101	7.93 f	3.50 bc	2.28 i	81.05 c	70.83 g	63.47 fg	6.96 h	18.30 g
	Sakha 102	7.70 i	3.40 fg	2.28 i	81.47 b	70.78 g	64.23 e	6.50 k	19.48 b
T_2	Giza 181	9.53 a	2.55 m	3.73 b	77.32 k	66.15 n	61.28 j	7.41 e	18.80 e
	Giza 177	7.68 i	3.45 de	2.25 ij	81.37 b	74.42 a	68.92 a	7.23 f	17.92 i
	Giza 178	7.67 ij	3.18 i	2.33 h	78.15 i	70.42 h	62.87 h	6.79 i	17.37 L
	Sakha 101	7.85 g	3.53 ab	2.28 i	81.35 b	71.98 e	65.40 c	7.23 f	17.78 j
	Sakha 102	8.92 c	3.52 ab	2.28 i	80.58 d	72.20 d	64.97 d	7.05 g	18.57 f
T_3	Giza 181	8.38 d	2.60 L	3.53 d	78.70 h	65.58 o	61.12 j	7.46 e	19.10 d
	Giza 177	7.67 ij	3.40 fg	2.32 h	80.92 c	73.62 b	66.33 b	7.69 d	18.18 h
	Giza 178	7.47 L	2.95 k	2.52 e	78.12 i	69.68 i	59.67 k	7.39 e	17.65 k
	Sakha 101	8.15 e	3.42 ef	2.38 g	79.97 c	70.37 h	62.97 h	7.45 e	17.88 ij
	Sakha 102	7.85 g	3.55 a	2.22 j	80.93 c	72.80 c	63.23 gh	7.79 c	19.60 a
T_4	Giza 181	9.45 a	2.63 L	3.57 c	76.57 L	68.90 k	62.87 h	6.47 k	19.15 d
	Giza 177	7.85 g	3.40 fg	2.32 h	82.17 a	68.45 L	58.93 L	7.12 g	18.70 e
	Giza 178	7.63 j	3.32 h	2.32 h	79.75 ef	70.88 g	63.65 f	6.28 L	17.97 i
	Sakha 101	7.82 gh	3.47 cd	2.25 ij	79.52 f	69.12 j	62.00 i	6.64 j	18.47 f
	Sakha 102	7.90 f	3.52 ab	2.23 j	81.50 b	71.22 f	63.47 fg	6.09 m	19.28 c
F. test T x V x S		**	ns	ns	ns	**	**	**	**

(9.53 mm) and T_4 with the same cultivar (9.45 mm). On the other hand, the lowest value was detected by T_3 ($^1/_2$ basal + $^1/_4$ at panicle initiation + $^1/_4$ at complete flowering) with Giza 178.

For grain width, the highest values were recorded by T_2 with Sakha 101 and Sakha 102, T_3 with Sakha 102 and T_4 with Sakha 102. However, the lowest one was recorded by T_1 with Giza 181.

For grain shape the highest value was detected by T_1 with Giza 181 cv., while the lowest values were obtained by T_3 and T_4 with Sakha 102.

The highest values of hulling percentage were recorded by T_1 and T_4 with Giza 177, followed by T_1 and T_4 with Sakha 102, T_2 with Giza 177 and Sakha 101. However, T_4 with Giza 181 gave the lowest hulling percentage.

For milling and head rice percentages, the highest values were recorded for Giza 177 with both T_2 and T_3, while T_1 and T_2 with Giza 181 gave lowest one for milling and head rice percentages, respectively. Both Giza 177 and Giza 181 produced the highest levels of grain protein; 8.09 and 7.94%, respectively, as a result to T_1, while Sakha 102 produced the lowest value (6.09%) due to T_4, preceded by Giza 178 due to T4 (6.28%).

For amylose percentage, the highest value was obtained by T_3 with Sakha 102 followed by T_1 with Sakha 102. Similar results were obtained by El-Kady and Abd El-Wahab (1999).

2.3.6. Interaction effect between nitrogen application and seasons :

Table (25) shows that the interaction between nitrogen fertilizer levels and seasons was statistically significant for all quality attributes except hulling %, revealing that the effect of nitrogen fertilizer application was unconstant from season to another. These results might be attributed to fluctuated of temperature in both seasons.

2.3.7. Interaction effect among cultivars, nitrogen application and seasons :

With the exception of grain width, grain shape and hulling percentage, all quality traits showed significant differences due to the effect of interaction between cultivars, N-applications and seasons (Table 27). This result may be due to the fluctuated effect of the interaction of cultivars and N-application from one season to another.

Comparison between planting methods :

The averages of the studied characters for the two planting methods are presented in Table (28). The statistical analysis (t-test) revealed that the differences were significant for heading date, plant height, unfilled grains/panicle, grain yield, and percentages of head rice, protein and amylose. However, the remaining traits gave significantly the same values under the two methods of planting. It was found that broadcasting method gave higher significant values than transplanting for unfilled grains, and protein and amylose percentages; while transplanting gave higher significant values for heading date, plant height, grain yield, and head rice.

Table (28) : Effect of planting methods on :
a) Growth attributes

Planting method	Heading date	Plant height (cm)	Panicle length (cm)
Broadcasting	88.43 b	87.05 b	19.79 a
Transplanting	98.29 a	92.75 a	19.68 a

b) Yield and its components

Planting method	Panicle weight (g)	Filled grains/ panicle	Unfilled grains/ panicle	1000-grain weight	Straw yield t/ha	Grain yield t/ha	Harvest index
Broadcasting	2.57 a	98.28 a	6.88 a	26.88 a	9.88 a	7.75 b	43.77 a
Transplanting	2.65 a	91.27 a	5.25 b	26.99 a	9.99 a	8.17 a	44.94 a

c) Grain quality

Planting method	Grain length (mm)	Grain width (mm)	Grain shape	Hulling %	Milling %	Head rice %	Protein %	Amylose %
Broadcasting	8.03 a	3.15 a	2.62 a	78.46 a	70.17 a	61.11 b	7.92 a	19.32 a
Transplanting	8.10 a	3.22 a	2.59 a	78.92 a	70.33 a	63.31 a	7.10 b	18.43 b

Means followed by the same letter are not significantly different according to t-test.


SUMMARY

SUMMARY

Two field experiments for transplanted and broadcast-seeded rice system were conducted at Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt, during 1996 and 1997 seasons to investigate the effect of time and method of nitrogen application on grain yield and grain quality of transplanting and broadcasting methods on rice cultivars; (Giza 181, Giza 177, Giza 178, Sakha 101 and Sakha 102). Four times of N application viz. (T_1) two splits ($^2/_3$ as basal and incorporated into dry soil + $^1/_3$ as top-dressing at panicle initiation), (T_2) three splits ($^1/_3$ as basal and incorporated into dry soil + $^1/_3$ as top-dressing at maximum tillering stage + $^1/_3$ as top-dressing at panicle initiation), (T_3) three splits ($^1/_2$ as basal and incorporated into dry soil + $^1/_4$ as top-dressing at panicle initiation + $^1/_4$ as top-dressing after complete flowering, and (T_4) all amount was incorporated into dry soil were used in this study.

The split -plot design was used, and the main plots were devoted to five rice cultivars and subplots were allocated for the time of nitrogen application.

Studied Characters :

A. Growth characters :

1- Number of tillers at different stages of growth/m^2

2- Heading date (days)

3- Plant height at harvest (cm)

4- Panicle length (cm)

B. Yield and yield attributes :

1- Number of panicles/m^2
2- Panicle weight (g)
3- Filled grains/panicle
4- Unfilled grains/panicle
5- 1000-grain weight (g)
6- Straw yield (t/ha)
7- Grain yield (t/ha)
8- Harvest index

C- Grain quality characters :

1- Grain length (mm)
2- Grain width (mm)
3- Grain shape
4- Hulling %
5- Milling %
6- Head rice %
7- Protein %
8- Amylose %

The most important results obtained from this study could be summarized as follows :

I- Broadcasting Method :

1. Growth measurements :

a) Number of tillers/m^2, plant height, heading date (in days) and panicle length were significantly different from 1996 to 1997. Higher values for number of tillers/m^2 at all growth stages, and heading date (in days) were detected in 1996, but the situation was reversed for plant height and panicle length which were higher in the second season than in the first one.

b) Time of nitrogen application had significant effects on all studied characters except for number of tillers/m^2 at the 3rd growth stage. When nitrogen was applied as $^2/_3$ basal and $^1/_3$ at panicle initiation (PI), T_1 gave higher values of number of tillers/m^2 and longest rice plants. The highest value of heading date (in days) was obtained at T_3 ($^1/_2$ basal + $^1/_4$ at PI + $^1/_4$ at complete flowering) whileT_2 (3 equal splits) gave the longest panicle length.

c) Giza 178 produced the highest number of tillers at 1st, 2nd and 3rd stages, while Giza 177 had significantly lower values of tillers and earliest heading. Sakha 102 appeared as the longest variety and significantly differed from all varieties, while Giza 181 gave the longest panicles compared with the other varieties.

d) The interaction between cultivars and seasons differed significantly for all measurements except for number of tillers/m^2 in both 1st and 4th growth stages and panicle length.

e) Numbers of tillers/m^2 at different growth stages, heading date, plant height and panicle length were significantly affected by the interaction between rice cultivars and times of N application as combined data for 1996 and 1997 rice seasons. The highest number of tillers was obtained with Giza 178 under T_1 treatment, at the 1st and 4th growth stages. Sakha 101 under T_3 treatment gave the highest number of tillers at the 2nd growth stage, while the same variety gave the highest tillers in case of T_3 treatment at the 3rd growth stage. On the other hand, Giza 177 was the earliest for heading date in T_2 treatment and the tallest plants were observed in T_2 treatmet with Sakha 102, while the highest value of panicle length was obtained by Giza 181 by T_2 treatment.

f) The interactions between time of N application and season were significant at first and second growth stages and for heading date.

g) Plant height and panicle length were significantly affected by the interaction among cultivars, time of N application and seasons.

2. Yield and its components :

a) Higher values for number of panicles/m^2, panicle weight and 1000-grain weight were detected in the first season, while values of filled and unfilled grains/panicle, straw and grain yield and harvest index were higher in the second season.

b) Grain yield and yield components were significantly affected by nitrogen fertilizer application. Adding nitrogen in three split doses; $^1/_2$ basal, $^1/_4$ at panicle initiation and $^1/_4$ at complete flowering (T_3) gave the highest number of panicles/m^2, panicle weight, number of unfilled grains/panicle and grain yield. The highest values of filled grains/panicle and 1000-grain weight were obtained when nitrogen was split as; $^1/_3$ basal, $^1/_3$ at maximum tillering and $^1/_3$ at panicle initiation (T_2) with no significant difference over T_1 for number of filled grains/panicle and T_1 and T_4 for 1000-grain weight. Splitting nitrogen in T_3 or T_2 treatment gave the highest harvest index.

c) Highly significant differences were observed among the five cultivars in all studied characters. Giza 178 cultivar had the highest number of panicle/m^2 and harvest index, while Sakha 101 had the highest panicle weight. The highest values of straw yield were obtained by Giza 181 and Sakha 101. The highest 1000-grain was produced by Sakha 102. However, Giza 181 produced the highest number of filled and unfilled grains/panicle. As for the grain yield, Giza 178 cultivar produced the highest value (8.25 t/ha), but without significant superiority over Sakha 101 (8.05 t/ha).

d) The effects of interaction between cultivars and seasons were highly significant for all parameters, but only significant for grain yield.

e) Panicle weight, filled grains/panicle, unfilled grains/panicle and straw yield were significantly affected by the interaction between nitrogen application and seasons.

f) The interaction between rice cultivars and nitrogen application significantly influenced yield and yield components. Adding nitrogen in three split doses (T_3); $^1/_2$ basal, $^1/_4$ at panicle initiation and $^1/_4$ at complete flowering with Giza 178 cultivar gave the highest value for number of panicles/m^2 and grain yield. The same N application resulted in the highest panicle weight and harvest index with Sakha 101 cultivar as well as unfilled grains/panicle and straw yield with Giza 181 cultivar. However, Giza 178 had the highest value for filled grains/panicle under T_1 treatment, while the highest 1000-grain weight under T_2 treatment was obtained with Sakha 102.

g) The interaction between cultivars, nitrogen application and seasons had significant effect on number of panicles/m^2, panicle weight, filled grains/panicle and unfilled grains/panicle.

3. <u>Quality characters</u> :

a) Higher hulling and protein percentages were detected in the first season, but values of milling and head rice percentages were higher in the second one.

b) Milling, head rice and protein percentages responded significantly to time of nitrogen application, while the other attributes were statistically the same with different nitrogen application times.

When nitrogen was applied as two split doses; $^2/_3$ basal and $^1/_3$ at panicle initiation (T_1), the highest significant values of milling and head rice were obtained.

c) Giza 181 cultivar gave the highest values of grain length, grain shape and amylose content. The highest hulling, milling, head rice and protein percentages were recorded for Giza 177 cultivar.

d) Significant interactions between cultivars and seasons were calculated for milling, head rice, protein and amylose percentages.

e) Giza 177 cultivar had the highest values for hulling and head rice under T_2 treatment, protein under T_1 treatment as well as milling under T_3. On the other hand, Giza 181 cultivar had the highest values for grain length, grain shape and amylose content under T_2, T_4 and T_1 treatments, respectively. For grain width, the highest mean value was obtained by Sakha 101 with T_2 treatment.

f) Significant effects were found for milling, head rice and protein percentages which means that the effect of time of nitrogen application on some grain quality attributes was not constant in both years of study.

g) With the exception of grain length, grain width and grain shape, all attributes showed significant differences due to the interaction effect between cultivars, nitrogen application and seasons.

II- Transplanting Method :

1. Growth attributes :

a) Number of tillers/m^2 in the first, second and third stages were significantly higher in the first season than in the second one. However, plant height and heading date gave significantly higher values in the second season than in the first one.

b) N-application gave significant effect on number of tillers/m^2 in the third and fourth stages, heading date, plant height and panicle length. The highest values of number of tillers/m^2 in the third and fourth stages, heading date and plant height were obtained by T_1 ($^2/_3$ basal + $^1/_3$ at panicle initiation).

c) Giza 178 produced the highest number of tillers in the first and second growth stages. Giza 177 was superior in the third stage, while Giza 181 gave the highest number of tillers in stage four. Giza 177 was the earliest cultivar and gave the shortest panicles, while Sakha 102 gave the highest value of plant height.

d) The interaction between cultivars and seasons was statistically significant for all attributes.

e) Giza 178 produced the highest number of tillers at the first growth stage with T_3, and at the second stage with T_1 and T_2 and at the fourth growth stage with T_1. However, Giza 177 produced the highest number of tillers with T_3. The earliest heading occurred with Sakha 102 at T_4, while the longest plants were always recorded for the same cultivar at all times of nitrogen application.

f) The interaction between times of nitrogen application and seasons of study were significant for all growth attributes.

g) With the exception of heading date, all growth attributes showed highly significant differences due to the effect of interaction among cultivars, N-applications and seasons.

2. <u>Yield and yield components</u> :

a) Higher mean values for panicle weight, filled grains/panicle, 1000-grain weight and harvest index were detected in the first season compared to the second one. However, number of panicles/m^2, unfilled grains and straw yield were found to be higher in 1997 rice season than in 1996. However, grain yields for both seasons were very close.

b) Yield and its components were affected by time of nitrogen application. Highest number of panicles/m^2, panicle weight, straw and grain yields and harvest index were obtained by plants received nitrogen as $^2/_3$ basal and $^1/_3$ at panicle initiation (T_1). The same N-fertilizer treatment resulted in the lowest mean value for unfilled grains/panicle.

c) Giza 181 gave the highest values for panicle weight and unfilled grains/panicle. While, Giza 178 had the highest values for number of panicles/m^2 filled grains/panicle and straw yield. Sakha 101 produced the highest values for panicle weight, 1000-grain weight, grain yield (8.63 t/ha) and harvest index.

d) The interaction between cultivars and seasons was statistically highly significant for all traits under study.

e) T_1 with all cultivars gave the highest mean values for yield (with Sakha 101) and most of yield components, number of panicles/m^2 with Giza 178 and panicle weight with sakha 101.

f) The interaction between time of nitrogen application and seasons was statistically significant for panicle weight, filled grains/panicle, grain yield and harvest index, revealing that this effect differed from one season to another.

g) The interaction effect of cultivars, N-application and seasons was significant for yield and yield components except for panicle weight.

3. Quality characters :

a) Higher mean values for hulling and protein percentages were detected in the first season, but the situation was reversed in the second season.

b) Grain length, milling and head rice percentages reached its maximum values by T_2 (3 equal splits), while the highest grain width and protein percentage were recorded for T_4 and T_2, respectively.

c) Giza 181 had the highest grain length, while Sakha 102 gave the highest values for grain width and amylose content. The highest values of hulling, milling, head rice and protein content were recorded for Giza 177.

d) The interaction between cultivars and seasons was statistically significant for all properties except for grain width and grain shape.

e) Highest values of grain length and shape were obtained by Giza 181 with T_2 and T_1, respectively. For grain width, the highest values were recorded by T_2 with Sakha 101 and Sakha 102, while the highest values of hulling percentage were recorded by T_1 and T_2 with Giza 177 and the highest milling and head rice percentages were recorded for the same cultivar with both T_2 and T_3. Both Giza 177 and Giza 181 produced the highest levels of grain protein as a result to T_1. However, for amylose percentage, the highest values were obtained by T_3 with Sakha 102.

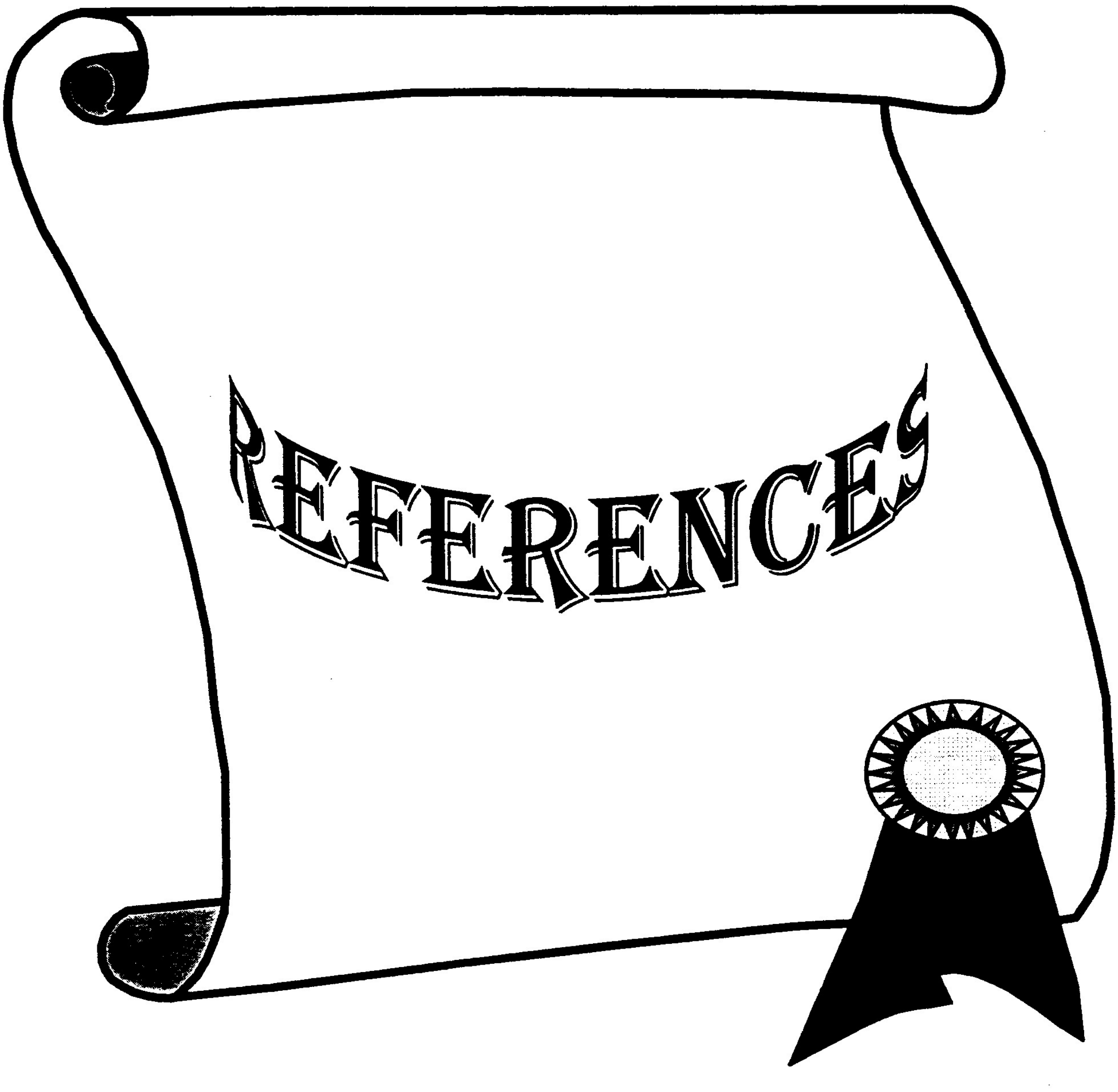
f) The interaction between nitrogen fertilizer and seasons was statistically significant for all quality attributes except for hulling percentage.

g) With the exception of grain width, grain shape and hulling percentage and all quality traits showed significant differences due to the effect of interaction between cultivars, N-applications and seasons.

As a conclusion, transplanting gave higher significant grain yield and head rice compared to broadcasting method.

It could be recommended to obtain high yield and quality to grow Giza 178 and Sakha 101 and to split nitrogen in three splits ($^1/_2$ as basal + $^1/_4$ at panicle initiation + $^1/_4$ at complete flowering) for broadcasting and transplanting methods under conditions similar to the present experiments.

However, T_2 ($^1/_3$ basal + $^1/_3$ at maximum tillering + $^1/_3$ at panicle initiation) and T_1 ($^2/_3$ basal + $^1/_3$ at panicle initiation) were efficient for broadcasting and transplanting methods, respectively.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الملخـــص العربـــى

تأثير ميعاد الإضافة للسماد الأزوتى على المحصول وصفات الجودة فى الأرز الشتل والبدار

أجريت هذه التجربة فى مزرعة مركز البحوث والتدريب فى الأرز - سخا - كفر الشيخ - جمهورية مصر العربية - خلال موسمى ١٩٩٦ و ١٩٩٧ وذلك لدراسة تأثير ميعاد إضافة السماد الأزوتى على المحصول وصفات الجودة فى الأرز الشتل والبدار وذلك مع خمس أصناف من الأرز هى : جيزة ١٨١ ، جيزة ١٧٧ ، جيزة ١٧٨ ، سخا ١٠١ وسخا ١٠٢ . وكان معدل الأزوت المستخدم هو ٩٦ وحدة أزوت/هكتار (فى صورة يوريا ٤٦,٥%) ، وكانت مواعيد إضافة الأزوت هى :

١- دفعتين (٢/٣ خلط بالتربة الجافة قبل الشتل أو البدار + ١/٣ عند بداية تكوين الداليات) .

٢- ثلاث دفعات (١/٣ خلط بالتربة الجافة + ١/٣ عند أقصى تفريع + ١/٣ عند بداية تكوين الداليات) .

٣- ثلاث دفعات (١/٢ خلط بالتربة الجافة + ١/٤ عند بداية تكوين الداليات + ١/٤ عند تمام طرد الداليات) .

٤- دفعة واحدة خلط بالتربة الجافة .

وإستُخدم لتنفيذ التجربة تصميم القطع المنشقة مرة واحدة ذو أربع مكررات ، حيث إحتوت القطع الرئيسية على أصناف الأرز ، بينما إحتوت القطع المنشقة على مواعيد إضافة الأزوت . وقد أُخذت القياسات التالية :

١- تحليل النمو :

عدد الفروع فى مراحل النمو المختلفة (بعد شهرمن الشتل أو البدار ، عند أقصى تفريع ، عند بداية طرد الداليات ، عند تمام طرد الداليات) - تاريخ التزهير - طول النبات - طول السنبلة .

٢- المحصول ومكوناته :

محصول الحبوب (طن/هكتار) - محصول القش (طن/هكتار) - دليل الحصاد - عدد الداليات/م٢ - عدد الحبوب الممتلئة/دالية - عدد الحبوب الفارغة/دالية - وزن الدالية - وزن ١٠٠٠ حبة .

٣- الصفات التكنولوجية :

طول الحبة – عرض الحبة – شكل الحبة – تصافى التقشير – تصافى التبييض – % للحبوب السليمة – % للبروتين فى الحبوب الشعير – % للأميلوز .

ويمكن تلخيص أهم النتائج المتحصل عليها كما يلى :

١- تأثير ميعاد إضافة الأزوت والأصناف والتفاعل بينهم على كل من :

أ- تحليل النمو ب- المحصول ومكوناته ج- الصفات التكنولوجية

تحليل النمــــــو :

أولا : البـــدار :

١- تأثير الأصنـــاف :

١-١- صفـــات النمـــو :

أظهرت النتائج وجود فروق معنوية بين جميع الأصناف تحت الدراسة فى معظم صفات النمو. فقد أعطى الصنف جيزة ١٧٨ أعلى عدد فروع/م^2 فى مرحلة النمو الأولى بالنسبة لبقية الأصناف يليه الصنف جيزة ١٨١ . بينما كان الصنف جيزة ١٧٧ أقل الأصناف فى هذه المرحلة .

وفى المرحلة الثانية والرابعة تفوق الصنف جيزة ١٧٨ فى عدد الفروع/م^2 يليه سخا ١٠١ فى المرحلة الثانية وجيزة ١٨١ فى المرحلة الرابعة ، وكان أقل الأصناف فى المرحلة الثانية الصنف جيزة ١٧٧ .

وفى المرحلة الثالثة لم يكن هناك فروق معنوية بين الأصناف فى عدد الفروع وأعطى الصنف سخا ١٠٢ أقل قيمة فى أيام التزهير يليه جيزة ١٧٧ وأكبر قيمة فى أيام التزهير كان الصنفان جيزة ١٨١ وسخا ١٠١ .

وفى طول النبات تفوق الصنف سخا ١٠٢ على بقية الأصناف ، بينما كان الصنف جيزة ١٧٨ أقل الأصناف فى طول النبات .

وفى طول السنبلة تفوق الصنف جيزة ١٨١ وكان اقل الأصناف جيزة ١٧٧ فى طول السنبلة .

١-٢- المحصول ومكوناتــــــه :

تفوق الصنف جيزة ١٧٨ فى عدد السنابل/م٢ وعدد الحبــوب الممتلئــة ومحصــول الحبوب ودليل الحصاد على بقية الأصناف . بينما تفوق الصنف سخا ١٠١ فى الوزن الجاف للسنبلة ولم يكن بينه وبين الصنف جيزة ١٧٨ فروق معنوية فى محصول الحبــوب ودليــل الحصاد . وأعطى الصنف جيزة ١٨١ أعلى قيم فى عدد الحبوب الفارغة ومحصول القــش مقارنة بالأصناف الأخرى .

١-٣- صفـــات الجـــودة :

تفوق الصنف جيزة ١٨١ فى طول الحبة وشكل الحبة ونسبة الأميلــوز علــى بقيــة الأصناف . بينما تفوق الصنف جيزة ١٧٧ فى تصافى التقشير والتبييض ونســـبة الحبــوب السليمة والبروتين على بقية الأصناف .

٢- تأثير مواعيد إضافة النيتروجين :

٢-١- صفـــــات النمــــو :

أظهرت الدراسة فروق معنوية بين معظم الصفات نتيجة تأثير مواعيـــد إضافــة النيتروجين . فقد تفوقت المعاملة (٢/٣ خلط بالتربة + ١/٣ عند بداية طرد السنابل) فــى عدد الفروع فى المرحلة الأولى والثانية والرابعة وتاريخ التزهير وطول النبات بالمقارنة بالمعاملات الأخرى . بينما لم يكن هناك فرق معنوى بين المعاملات فىمرحلة التفريــع الثالثة ، بينما المعاملة الثانية تفوقت على جميع المعاملات الأخرى فى طول الســـنابل ، والمعاملة الثالثة أعطت أقل طول سنبلة يليها المعاملة الرابعة فى طول السنابل .

٢-٢- المحصول ومكوناتــــه :

تفوقت المعاملة الثالثة على بقية المعاملات فى عدد السنابل /م٢ والوزن الجـــاف للسنبلة وعدد الحبوب الفارغة ومحصول الحبوب وكذلك دليل الحصاد . بينمـــا تفوقــت المعاملة الثانية فى عدد الحبوب الممتلئة ووزن الألف حبة ، ولم يكن هناك فرق معنوى فى محصول القش .

٢-٣- صفـــات الجـــودة :

لم تُظهر النتائج أى معنوية بين المعاملات فى طول الحبة وعرض الحبة وشكل الحبة وتصافى التقشير ونسبة الأميلوز . بينما أعطت المعاملة الأولى أعلى نسبة تبييض وحبـــوب سليمة ، وكانت أقل معاملة فى نسبة الحبوب السليمة هى المعاملة الرابعة .

٣- تأثير التفاعل بين الأصناف ومواعيد إضافة النيتروجين :

٣-١- صفـــات النمـــو :

أوضحت النتائج فروق معنوية فى جميع الصفات تحت الدراسة نتيجة التفاعل بيـن الأصناف ومواعيد إضافة النيتروجين . فقد أعطى الصنف جـيزة ١٧٨ مـع المعاملـة الأولى والرابعة أعلى عدد فروع/م٢ فى مرحلة النمو الأولى مع المعاملة الأولى ، بينمـا كان أقل عدد فروع مع الصنف سخا ١٠٢ مع المعاملة الثانية . وفـى المرحلـة الثانيـة والثالثة أعطى الصنف سخا ١٠١ مع المعاملة الأولى أعلى عـدد فـروع/م٢ والصنـف جيزة ١٧٧ مع المعاملة الثالثة أقل عدد فروع /م٢ تحت نفس المرحلة . بينما فى المرحلـة الثالثة للتفريع أعطى الصنف جيزة ١٧٨ أعلى عدد فروع /م٢ مع المعاملة الثالثة ، وفـى المرحلة الرابعة أعطى الصنف جيزة ١٧٧ مع المعاملة الرابعة أقل عدد فروع /م٢ .

وبالنسبة لتاريخ التزهير فقد أعطى الصنف سخا ١٠٢ مع المعاملة الثالثة أقل قيمة بالمقارنة مع بقية الأصناف والمعاملات . والصنف جيزة ١٨١ أعطى أطول فترة تزهـير مع المعاملة الثالثة .

وتفوق الصنف سخا ١٠٢ مع المعاملة الثانية فى طول النبات ، بينمـا الصنـف جيزة ١٧٨ أعطى أقل طول للنبات .

وتفوق الصنف جيزة ١٨١ مع المعاملة الثانية فى طول السـنبلة بالمقارنـة ببقيـة الأصناف والمعاملات الأخرى . وأعطى الصنف جيزة ١٧٧ أقل طـول للسـنبلة مـع المعاملة الأولى .

٣-٢- المحصـول ومكوناتـه :

أوضحت النتائج أن الصنف جيزة ١٧٨ مع المعاملـة الثالثـة تفـوق فـى عـدد السنابل/م٢ وكذلك فى محصول الحبوب . وأعطى الصنف سخا ١٠١ تحـت المعاملـة الثالثة أعلى وزن جاف للسنبلة ودليل الحصاد .

والصنف جيزة ١٧٨ مع المعاملة الأولى أعطى أعلى قيمـــة فـــى عـــدد الحبـــوب الممتلئة/ سنبلة . وأعطى الصنف جيزة ١٨١ مع المعاملة الثالثة أعلى قيمة فـــــى الحبـــوب الفارغة / سنبلة وكذلك محصول القش . بينما تفوق الصنف سخا ١٠٢ مع المعاملة الثانيـــــة فى وزن الألف حبة .

٣-٣- صفـــــات الجــــودة :

تفوق الصنف جيزة ١٨١ مع المعاملة الثانية فى طول الحبة وفى المعاملة الأولى فـــى نسبة الأميلوز ، بينما تفوق الصنف سخا ١٠١ فى عـــرض الحبـــة مـــع المعاملـــة الثانيـــة وجيزة ١٨١ مع المعاملة الرابعة فى شكل الحبة أيضا . وتفوق الصنـــف جـــيزة ١٧٧ مـــع المعاملة الثالثة فى تصافى التقشير والتبييض ونسبة الحبوب السليمة والبروتين مع المعاملــــة الأولـــــــى .

ثانيا: الشـــــتل :

١- تأثير الأصنـــاف :

١-١-صفـــــات النمـــــو :

أوضحت الدراسة فروق معنوية بين الأصناف تحت الدراســـة فـــى معظـــم الصفات المدروسة . فقد تفوق الصنف جيزة ١٧٨ فى عدد الفروع فـــى مراحـــل النمو المختلفة ماعدا المرحلة الثالثة وكذلك تفوق الصنفان جيزة ١٧٧ ، سـخا ١٠٢ فى تاريخ التزهير مقارنة بالأصناف الأخرى . بينما فى طول النبات تفوق الصنف سخا ١٠٢ وأعطى الصنف جيزة ١٧٧ اقل طول للسنبلة بالمقارنة ببقية الأصناف .

١-٢-المحصول ومكوناتـــــه :

تفوق الصنف جيزة ١٧٨ فى عدد السنابل /م٢ على بقية الأصناف وكذلـــك فى عدد الحبوب الممتلئة ومحصول القش . بينما أعطى الصنف سخا ١٠١ أقـــل قيمة فى عدد الحبوب الفارغة / سنبلة وأعلى قيمة فى وزن الألـــف حبـــة ودليـــل الحصاد ومحصول الحبوب .

١-٣- صفـــــات الجــــودة :

أعطى الصنف جيزة ١٨١ أعلى قيمة فى طول الحبة وشكل الحبة . بينمـــا أعطـــى الصنف جيزة ١٧٧ أعلى قيمة فى تصافى التقشير وتصافى التبييض والبروتين ، بينما أعطى الصنف سخا ١٠٢ أعلى قيمة فى نسبة الأميلوز بالحبوب وعرض الحبة والحبوب السليمة .

٢- تأثير مواعيد إضافة النيتروجين :

٢-١- صفـــات النمـــو :

أعطت المعاملة الأولى (٢/٣ خلط + ١/٣ عند بداية طرد الداليات) أعلى قيم فى عـدد الفروع فى المرحلة الثالثة والرابعة وكذلك فى طول النبات . بينمــا المعاملــة الرابعــة أعطت تفوقاً فى تاريخ التزهير عن بقية المعاملات ، حيث أعطت أقل عـــدد فـــى أيـــام التزهير . بينما لم يكن هناك فرق معنوى بين المعاملات فى طول السنبلة وعدد الفـــروع فى المرحلة الأولى والثانية .

٢-٢- المحصـــول ومكوناتــــه :

تفوقت المعاملة الأولى فى عدد السنابل /م٢ والوزن الجاف للسنبلة ومحصول القش ومحصول الحبوب وكذلك دليل الحصاد . بينما تفوقت المعاملة الثالثة فى عدد الحبـــوب الممتلئة ووزن الألف حبة وعدد الحبوب الفارغة .

٢-٣- صفـــات الجـــودة :

تفوقت المعاملة الأولى فى شكل الحبة وتصافى التقشير ، بينما تفوقـــت المعاملـــة الثانية فى طول الحبة وتصافى التبييض ونسبة الحبوب السليمة . وتفوقت المعاملة الثالثـــة فى نسبة البروتين أما المعاملة الرابعة فقد تفوقت فى عرض الحبة ونسبة الأميلوز .

٣- تأثير التفاعل بين الأصناف ومواعيد إضافة النيتروجين :

٣-١- صفـــات النمـــو :

أظهرت النتائج فروق معنوية واضحة بين جميع الصفات نتيجـــة التفـــاعل بيـــن الأصناف ومواعيد إضافة النيتروجين. فقد أعطى الصنف جيزة ١٧٨ مع المعاملة الرابعة

أعلى عدد فروع /م٢ فى المرحلة الأولى ، بينما كانت أقل فى عدد الفروع /م٢ فى هذه المرحلة مع الصنفان سخا ١٠١ وجيزة ١٧٧ مع المعاملة الثانية والرابعة على التوالى .

وأعطى الصنف جيزة ١٧٨ فى المرحلة الثانية أعلى عدد فروع مع المعاملة الأولى والثانية ، وفى المرحلة الثالثة للتفريع كانت أعلى قيمة لعدد الفروع مع الصنف جيزة ١٧٧ مع المعاملة الثالثة ، والصنف جيزة ١٧٨ أعطى أعلى قيمة فى عدد الفروع /م٢ مع المعاملة الأولى وأقل قيمة مع الصنف سخا ١٠٢ مع المعاملة الرابعة .

وفى تاريخ التزهير تفوق الصنف سخا ١٠٢ مع المعاملة الرابعة ، حيث أعطى أقل عدد أيام للتزهير مقارنة ببقية الأصناف والمعاملات , وكان أطول صنف فى عدد أيام التزهير هو جيزة ١٨١ مع المعاملة الثانية وفى طول النبات تفوق الصنف سخا ١٠٢ مع المعاملة الثانية والثالثة على بقية الأصناف والمعاملات الأخرى .

وفى طول السنبلة تفوق الصنف جيزة ١٨١ مع المعاملة الثالثة على بقية الأصناف والمعاملات ، وكان الصنف جيزة ١٧٧ أقل الأصناف فى طول السنبلة مع المعاملة الرابعة .

٣-٢- المحصول ومكوناته :

تفوق الصنف جيزة ١٧٨ مع المعاملة الأولى على باقى الأصناف والمعاملات فى عدد السنابل /م٢ ، بينما كان أقل الأصناف سخا ١٠٢ مع المعاملة الرابعة . وتفوق الصنف سخا ١٠١ مع المعاملة الأولى فى الوزن الجاف للسنبلة ، بينما الصنف جيزة ١٧٧ مع المعاملة الرابعة كان أقل وزن للسنبلة .

وفى عدد الحبوب الممتلئة كانت أعلى قيمة مع الصنف جيزة ١٧٨ مع المعاملة الثانية وأقل عدد حبوب ممتلئة مع الصنف جيزة ١٧٧مع المعاملة الأولى. وأعطى الصنف جيزة ١٨١ مع المعاملة الثالثة أعلى عدد حبوب فارغة وأقل الأصناف سخا ١٠٢ مع المعاملة الأولى .

وبالنسبة لوزن الألف حبة فقد تفوق الصنفان سخا ١٠١ وسخا ١٠٢ مع المعاملة الثالثة والرابعة على التوالى ، وتفوق الصنف جيزة ١٧٨ مع المعاملة الثالثة فى محصول القش والصنف سخا ١٠١ مع المعاملة الأولى فى محصول الحبوب ودليل الحصاد . وكانت أقل قيمة فى محصول القش والحبوب ودليل الحصاد مع الصنف جيزة ١٨١ مع المعاملة الرابعة .

٣-٣- صفـــات الجـــودة :

تفوق الصنف جيزة ١٨١ مع المعاملة الثانية فى طول الحبة ، بينما أعطى الصنف جيزة ١٧٨ مع المعاملة الثالثة فى طول الحبة أقل طول للحبة وتفوق الصنف سخا ١٠٢ فى عرض الحبة مع المعاملة الثالثة ، وكان الصنف جيزة ١٨١ أقل الأصناف مع المعاملة الأولى وأعلى قيمة فى شكل الحبة ، بينما الصنف سخا ١٠٢ أقل الأصناف فى شكل الحبة .

وقد تفوق الصنف جيزة ١٧٧ فى نسبة تصافى التقشير مع المعاملة الرابعة والأولى على التوالى ، وأعلى قيمة فى تصافى التبييض مع المعاملة الثانية . بينما الصنف جيزة ١٨١ أقل الأصناف فى تصافى التبييض ونسبة الحبوب السليمة مع المعاملة الأولى . بينما تفوق الصنف جيزة ١٧٧ مع المعاملة الثانية فى نسبة الحبوب السليمة وكذلك فى نسبة البروتين مع المعاملة الأولى ، بينما كان الصنف سخا ١٠٢ أقل الأصناف فى نسبة البروتين مع المعاملة الرابعة وأعلى الأصناف فى الأميلوز مع المعاملة الثالثة وأقل الأصناف فى الأميلوز الصنف جيزة ١٧٨ مع المعاملة الثانية .

التوصيــــــات :

تؤدى زراعة الأرز بطريقة الشتل إلى الحصول على إنتاجية أعلى وإرتفاع صفة الجودة عن زراعته بطريقة البدار. وتفوق الصنفان جيزة ١٧٨ وسخا ١٠١ فى المحصول وصفات الجودة عند إضافة الأزوت كما يلى : ١/٢ الكمية خلطاً بالتربة الجافة + ١/٤ الكمية عند بداية طرد الداليات + ١/٤ الكمية عند تمام الطرد سواء فى طريقة الشتل أو طريقة البدار. أو إضافة الأزوت على ثلاث دفعات متساوية : ١/٣ الكمية خلطاً بالتربة الجافة + ١/٣ فى مرحلة أقصى تفريع + ١/٣ عند مرحلة طرد الداليات فى الزراعة البدار ، أو يضاف على دفعتين : ٢/٣ الكمية خلطاً بالتربة الجافة ، ثم ١/٣ الكمية عند مرحلة طرد الداليات فى الزراعة الشتل .

بسم الله الرحمن الرحيم

قالوا سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

البقرة - اية ٣٢

جامعة الزقازيق
كلية الزراعة بمشتهر
قسم المحاصيل

تأثير ميعاد وطرق إضافة السماد الأزوتى على المحصول وصفات الجودة فى الأرز الشتل والبدار

إبراهيم حمدى عمر أبو الدرج
بكالوريوس العلوم الزراعية - جامعة الأزهر (القاهرة) - ١٩٩٠

رسالة مقدمة

للحصول على درجة الماجستير

فى

العلوم الزراعية (محاصيل)

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