J. of Plant Production, Mansoura Univ., Vol. 11 (11):1097-1104, 2020

Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www.jpp.journals.ekb.eg

Splitting of Nitrogen Fertilizer and Planting Method Effects on Rice Productivity

Abd El-Megeed, T. M. and Howida B. I. El-Habet*

Rice Research and Training Center, Field Crops Research Institute, Agricultural Research Center, Kafrelsheikh, Egypt.

ABSTRACT

The present study was carried out at the farm of Agricultural Research Station, Sakha, Kafrelsheikh, Egypt during two rice growing seasons. This study aimed to identify the effect of nitrogen (N) splitting application different growth stage i.e. T1: basal (B) + Mid- tillering (MT) + panicle initiation (PI) and late booting (LB), T2 (- + MT + PI + LB), T3: (B + - + PI + LB), T4: (B + MT + - + LB), T5: (B + MT + PI + -) and T6 :(2/3 B+ 1/PI) on yield and yield components of Sakha 108 rice variety under two planting methods (transplanting and drill seeded methods. The experiment was laid out in strip plot design with four replications. The results showed the planting methods have significant effects on growth parameters, grain yield and yield components. The results indicated that the chlorophyll content, leaf area index, dry matter production, plant height (cm), number of tillers/m^2, number of panicles/m^2, panicle weight (g), number of filled grain/panicle, yields (grain and straw) an nitrogen uptake by grain (kg/ha) were significantly superior with the application of T1: (B + MT + PI + LB followed by T3 :(B + - + PI + LB), T4: (B + MT + - + LB) and T5: (B + MT + PI + -) which eliminate N-at MT PI and LB, respectively as compared to rest of the treatment T2 (absent of N-as basal). Application of N-as four splits at tested stages (T1) gave the highest N-uptake as compared with the other nitrogen treatments.

Keywords: splitting nitrogen, planting methods, productivity, rice

INTRODUCTION

Rice (Oryza sativa L.) is the staple food for almost two-thirds of the world's population, but its sustainable production is threatened by several challenges including decreasing irrigation water availability, increasing costs of energy and other inputs, environmental degradation due to pollution and instability of cropping systems due to erratic climatic variations (Ullah, Mohammadi, and Datta *et al.*, 2018 and Maneepitak *et al.*, 2019). Transplanting is the most common method in rice production. It is reported that direct seeding is increasing in worldwide. The yield of rice under direct seeding is reported to be lower than transplanting. Reasons for this low yield include the uneven distribution of seeds, poor seedling emergence, and high competition of weeds Sorour *et al.*, (2016). Competition against weeds could be solved by high seed density or by the use of high tillering genotypes that could cover the soil surface more rapidly. Even when the planting density and geometric shape are the same, the plant growth rate and till capacity of directly planted rice in the vegetative stage is higher than that of transplanted rice. Rice is a harmonious and complementary crop. To some extent, the loss of yield due to reduced planting density can be compensated by increasing individual plant growth and growth, especially when they are grown under optimal nitrogen conditions. (Lin *et al.*, 2009 and Dendup *et al.*, 2018).

Nitrogen fertilization is the major agronomic practice that affects the yield and quality of rice crop, which requires as much as possible at early and mid tillering stages to maximize panicle number and during the reproductive stage to produce the optimum spikelet's per panicle and percentage filled spikelet's (Sathiya and Ramesh, 2009). Proper fertilizer management, especially nitrogen (N), is another important strategy for maximizing yield in crop production systems (Datta, *et al.*, 2018).

Applying nitrogen fertilizer at an appropriate dose and time helps to enhance the photosynthetic activity of rice plants, improve resistance to pests, improve dry matter accumulation, promote better nutrient absorption, and thereby increase grain yield (Zhao *et al.*, 2020).

In rice cultivation, it is also necessary to change the split-dose according to the needs of the crop. Therefore, it is more important to optimize the nitrogen level and the divided doses for different growth stages of rice to increase grain yield. The purpose of this study was to find the optimal nitrogen distribution application for the Sakha108 rice variety under transplantation and seeding methods.

MATERIALS AND METHODS

A dual season field experiment was conducted at the Experimental Farm of Sakha Agriculture Research Station, Kafrelsheikh, Egypt, during rice growing season 2018 and 2019,, to estimate the cultivation methods and nitrogen splitting application at different growth stages on growth and production of Sakha 108 rice variety. The experiment was laid out in strip plot design with four replications. The planting methods were located in horizontal plot and nitrogen splitting applications were placed in vertical plots.

The seedbed of transplanting method was prepared and well ploughed; dry leveled, submerged by water then water leveled. Calcium mono phosphate (15.5% P_2O_5) at the rate of 36 kg P_2O_5/ha was added during dry land preparation. Nitrogen in the form of urea (46.5%) was added into the dry soil then incorporated just before flooding at the rate of 80 kg N/ha, and $ZnSO_4$ at the rate 57 kg/ha.

* **Corresponding author.**
E-mail address: howidaelnamaky@gmail.com
DOI: 10.21608/jpp.2020.130924

The permanent field was prepared as mentioned in nursery. Calcium mono phosphate (15.5% P_2O_5) was added at the rate of 36.9 kg P_2O_5 kg/ha during land preparation. Nitrogen fertilizer at the rate of 165.6 kg N/ha in the form of urea (46.5% N) was added according to the time scheduled of application (Table 1). After the application of fertilizers the experimental was irrigated and wet leveled slightly. Thirty days old seedlings were uprooted from the nursery and well distributed through the plots. Seedlings were manually transplanted into 12 m^2 sub plots in 20 x 20 cm spacing as a distance between hills and rows. Herbicides application was used as recommended (4.8 litter/ha Saturn 50%), well mixed with enough sand to make it easily for homogenous distribution and broadcast in the 2-3 cm depth water of the field.

For drill seeded method field were prepared by plough and harrowing. The drilled plots were fertilized with 36.9 kg P_2O_5/ha (mono Super Phosphate 15.5% P_2O_5) added during land preparation. Nitrogen fertilizer at the rate of 165.6 kg N/ha in the form of urea (46.5% N) was added according to the time scheduled of application. After the application of fertilizers the experiments were irrigated and wet leveled slightly. Seeds of Sakha108 rice cultivar at seed rate 95 kg/ha were mechanically drilled at row spaces of 17 cm and 1cm below soil surface in 2018 and 2019 seasons. The drilled plots were irrigated every six days intervals after sowing for one month, then continuously flooded. Weed were chemically controlled using Saturn 50% at the rate of 7.5 liters/ha. Dissolved in 350 liters of water/ha and sprayed four days after sowing. Zinc fertilizer (24 kg $ZnSo_4$/ha) was applied before the permanent flooding.

Table 1. Amount of nitrogen fertilizer applied at different growth stages in six treatments in the two experiments.

Nitrogen schedules	Time and methods of nitrogen application				
	Basal (B)	**Mid-tillering (MT)**	**Panicle initiation (PI)**	**Late Booting (LB)**	**Total input kg N/ha**
T_1	26%	26%	26%	22%	165.6
T_2	0	39%	39%	22%	165.6
T_3	39%	0	39%	22%	165.6
T_4	39%	39%	0	39%	165.6
T_5	33.3%	33.3%	33.3%	0	165.6
T_6	66.7%	0	33.3%	0	165.6

T_1 = All (B + MT + PI + LB), T_2 = (- + MT + PI + LB), T_3 = (B + - + PI + LB), T_4 = (B + MT + - + LB), T_5 = (B + MT + PI + -) and T_6 = $^2/_3$ (B) +$^1/_3$ (PI)

The studied characters

Chlorophyll content of flag leaf (SPAD) measured by chlorophyll meter Minolta camera Co. Ltd, Japan, leaf area index and dry matter accumulation were taken at 60 days after transplanting. Plant height (cm), number of tillers/m^2, number of panicles/m^2, panicle weight (g), number of filled grains per panicle, 1000- grain weight (g), straw yield (t/ha), grain yield (t/ha), nitrogen uptake in rice grains were estimated at harvest. All traits were measured according to the standard's evaluation system used by the International Rice Research Institute (IRRI, 2002). Representative soil samples were taken from the experimental sites at (0-30 cm) depth from soil Surface. Some chemical analyses of the experimental soil site were determined in soil past extract before experiments according to Richards (1969), are presented in Table 2. All the collected data were subjected to statistical analysis according to procedure described by Gomez and Gomez (1984). Means were compared at $p < 0.05$ by the revised least significant differences (LSD), which adapted by Duncan (1955).

Table 2. Some chemical analyses of the experimental soil before planting in 2018 and 2019 seasons.

Soil chemical properties	2018 season	2019 season
pH(1:2.5)	8.12	8.35
Ec (ds.m^{-1})	3.09	2.90
Total N (ppm)	585.60	593.50
Available P (ppm)	5.70	6.00
Available K (ppm)	440.50	455.10
Anions(meq.L^{-1})		
CO_3^{--}	--	--
HCO_3^-	6.50	5.77
Cl^-	8.80	8.30
SO_4^{--}	15.63	14.90
Cations(meq.L^{-1})		
Ca^{++}	6.30	5.80
Mg^{++}	4.10	3.70
Na^{++}	19.13	17.70
K^+	1.40	1.70
Available micronutrients (ppm)		
Fe	6.00	6.50
Mn	3.70	3.60
Zn	1.00	1.12

RESULTS AND DISCUSSION

Chlorophyll content of flag leaf, leaf area index and dry matter accumulation

There are significant differences in chlorophyll content, leaf area index and dry matter accumulation between transplanting and drill seeded methods (Table 3). The transplanting method has the highest chlorophyll content while, the drill seeded method has the highest leaf area index and dry matter accumulation in both seasons. The increase of mention traits under drill seeded method might be due to the increase in number of tillers consequently increase number and area of leaves resulted in increase in photosynthesis which accumulate higher amount of dry matter production. The application of T1 (B + MT + PI + LB) or T6 (2/3 B +1/3 PI) produced the highest value of chlorophyll content and leaf area index followed by T4 (B + MT + - + LB) and T5 (B + MT + PI + -). These results are harmony with those obtained by Sorour *et al*., (2016) and Zhou *et al*., (2019).

Data also, reveal that there were highly significant differences in chlorophyll content, leaf area index and dry matter accumulation among all tested nitrogen applications. The application of T1 (B + MT + PI + LB) treatment surpassed the rest nitrogen splitting applications and reached its peak in both seasons. The other multiple way splitting recorded the second rank of dry matter production. Otherwise, the treatment without nitrogen application as basal (T2) recorded the lowest dry matter production in both seasons of study. These results are mainly attributed to the fact that nitrogen application along at proper time paralleled with plant demand at physiological growth stages increase photosynthesis rate which led finally to raise dry weight accumulation. These results are in harmony with those obtained by Singh and Singh (1998); Abd El-Hamed (2005) and Hirzel *et al*., (2011). It means that application of N as basal before planting and mid-tillering (MT) or panicle initiation (PI) is necessary for rice to increase the viability of flag leaf and increase its content from chlorophyll and Leaf area index (LAI) of rice plants. This is as a result of increasing both numbers of tillers and leaves as well as leaf area. These results are in harmony with those obtained by Arafat (2007), Hirzel *et al.*, (2011), Abdel megeed (2012) and Howida Elhabet *et al.*,(2013).

Table 3. Chlorophyll content of flag leaf, leaf area index and dry matter accumulation of Sakha108 rice variety as affected by planting methods and nitrogen splitting applications at different growth stages in 2018 and 2019 seasons.

Treatment	Chlorophyll content (SPAD)		leaf area index (LAI)		Dry matter accumulation g/m^2	
	2018	2019	2018	2019		
Planting method (A)						
Transplanting	40.01a	39.45a	4.161b	3.80b	1321.32b	1250.83b
Drill seeded	37.97b	36.23b	5.113a	4.57a	1820.50a	1657.51a
F Test	**	**	*	*	**	**
Nitrogen Schedule(B)						
T1	40.34a	39.21a	6.930a	5.96a	1731.50a	1583.06a
T2	37.06f	36.09e	3.245e	2.79d	1383.50f	1341.51f
T3	38.15e	37.05d	5.165b	4.74b	1556.00d	1442.86d
T4	38.81d	38.03c	3.705de	3.58cd	1475.00e	1375.41e
T5	39.49c	38.26b	4.230cd	3.89bc	1652.95b	1492.81b
T6	40.10b	38.44b	4.548bc	4.15bc	1626.50c	1489.36c
F Test	**	**	**	**	**	**
Interaction: A x B	**	**	*	*	**	**

T_1 = All (B + MT + PI + LB), T_2 = (- + MT + PI + LB), T_3 = (B + - + PI + LB), T_4 = (B + MT + - + LB), T_5 = (B + MT + PI + -) and T_6 = ⅔ (B) +⅓ (PI).

The interaction effect between planting methods and time of nitrogen application at different growth stages on chlorophyll content, leaf area index and dry matter accumulation are presented in Table 4. Results clear that nitrogen application as basal (B), MT, PI and LB (T1) was considered the greatest SPAD reading of chlorophyll content for both seasons under transplanting method followed by T5 and T6 in both seasons. On the other hand, the lowest value of chlorophyll content was recorded by the drill seeded method under the treatment without nitrogen application as the basal (T2). Leaf area index was improved and reached to highest value when rice received all nitrogen does at all tested growth stages (T_1) under drill seeded method during the two studied seasons without any significant difference with T_1 under transplanted method in 2018 seasons followed by the treatments T_5, (B + MT + PI + -) and T_6 (2/3 B + 1/3 at PI) under drill seeded method, while the lowest LAI was observed in T_2 under transplanted in 2018 and drill seeded method in 2019 seasons. However, significant differences were observed for LAI with different application of splits N-fertilizer treatments with in the two methods of planting, e.g. in case of T_4, T_3 and T_6 in 2019 season. These results are in agreement with that obtained by JinLiu *et al.*, (2000), Omar *et al.*, (2006), Kaushal *et al.*, (2010) and Howida El habet *et al.*, (2018).

Data in Table 4 also, clear that under drill seeded method, nitrogen application at all growth stages (T1) recorded the highest values of dry matter production followed by nitrogen application at three splits (T5) and two splitting 2/3 as basal, 1/3 at panicle initiation (T6). On the other hand, the T2 (- + MT + PI + LB), treatment produced the lowest dry matter accumulation in the both seasons. These results are mainly attributed to that nitrogen application as basal improved seedling vigor in term of number of tillers and application of N at different growth stages were favorable for increase LAI, photosynthesis rate and consequently more dry matter production especially under drill seeded methods which has more tillers and leaf area than transplanting method. These results are in harmony with those obtained by Arafat (2007) and Kumar *et al.*, (2017)

Table 4. Chlorophyll content, leaf area index (LAI) and dry matter accumulation as affected by the interaction between planting methods and nitrogen splitting application at different growth stages in 2018 and 2019 seasons

Treatment N application	Chlorophyll content of flag leaf			
	2018 season		2019 season	
	Transplanting	Drill seeded	Transplanting	Drill seeded
T_1	41.38a	39.30ef	40.81a	37.60e
T_2	38.67g	35.45j	38.06d	34.12i
T_3	39.11f	37.18i	39.11c	34.98h
T_4	39.84d	37.78h	39.31c	36.74g
T_5	40.26c	38.71g	39.69b	36.83g
T_6	40.77b	39.42e	39.74b	37.13f
	Leaf area index (LAI)			
T_1	6.730ab	7.130a	5.09b	6.84a
T_2	3.090g	3.400g	2.71e	2.86de
T_3	4.420ef	5.910bc	4.23b-d	5.25b
T_4	3.450fg	3.960e-g	3.27c-e	3.89b-e
T_5	3.670fg	4.790de	3.64c-e	4.13b-d
T_6	3.607fg	5.490cd	3.86b-e	4.43bc
	Dry matter accumulation (g/m^2)			
T_1	1410.00g	2053.00a	1322.16g	1843.96a
T_2	1232.00l	1535.00f	1162.76l	1520.26f
T_3	1310.00j	1802.00d	1239.96j	1645.76d
T_4	1263.00k	1687.00e	1220.46k	1530.36e
T_5	1363.90h	1942.00b	1292.36h	1693.26b
T_6	1349.00i	1904.00c	1267.26i	1711.46c

T_1 = All (B + MT + PI + LB), T_2 = (- + MT + PI + LB), T_3 = (B + - + PI + LB), T_4 = (B +MT + - + LB), T_5 = (B + MT + PI + -) and T_6 = ⅔ (B) +⅓ (PI)

Plant height (cm), number of tiller/m^2 and panicle/m^2:

There are significant differences between the plant height, number of tillers/m^2 and the number panicles/m^2 between transplantation and drill seeded methods (Table 5). The transplanting method has the highest value of plant height in both seasons. While, number of tillers/m^2 and number of panicles/m^2 were significantly higher under drill seeded. (Dingkuhn *et al.*, 1990 and Wiangsamut *et al.*, 2006). Data indicated that application of N as the four tested splits (T1) produced the highest values plant height, number of tillers/m^2 and number panicles/m^2 whereas, the lowest values were obtained with treatment which did not receive nitrogen as basal (T2).

The treatments without nitrogen as basal application (T1) produced the lowest values in this aspect. These might be due to the encouraging of more number of tillers from up ground nodes when the nitrogen was applied as basal before planting or at mid tillering. There results could be mainly attributed to the fact that nitrogen application at different growth stages improved the number of tillers/m^2. These results are in agreed with those obtained by Singh and Singh (1998) and Song *et al*., (2014).

Table 5. plant height, number of tiller/m^2 and panicle/m^2 at harvest of Sakha108 as affected by planting methods and nitrogen splitting application at different growth stages in both seasons

Treatment	Plant height (cm)		Number of tillers/m^2		Number of panicles/m^2	
	2018	2019	2018	2019	2018	2019
Planting method (A)						
Transplanting	108.18a	104.97a	469.82b	413.80b	423.4b	372.31b
Drill seeded	102.12b	97.58b	618.51a	577.92a	585.8a	540.45a
F Test	**	**	**	**	**	**
Nitrogen Schedule(B)						
T1	108.82a	102.78bc	594.19a	563.67a	585.6a	532.21a
T2	99.50d	94.17e	473.36f	425.60f	426.1e	364.83e
T3	100.27d	98.78d	515.99e	464.67e	464.5d	411.84d
T4	105.58c	101.93c	537.84d	480.61d	473.0d	444.56c
T5	107.63b	103.59b	583.70b	533.40b	558.4b	502.53b
T6	109.09a	106.38a	559.92c	507.20c	519.8c	482.33b
F Test	**	**	**	**	**	**
Interaction: A*B	*	*	**	**	**	**

T_1 = All (B + MT + PI + LB), T_2 = (- + MT + PI + LB), T_3 = (B + - + PI + LB), T_4 = (B + MT + - + LB), T5 = (B + MT + PI + -) and T_6 = $^2/_3$ (B) +$^1/_3$ (PI)

The interaction between planting methods and nitrogen splitting applications for plant height, number of tillers/m^2 and panicles/m^2 in both seasons are presented in Table 6. Under transplanting method applying nitrogen in two splits, two thirds as basal in dry soil before flooding and 1/3 before panicle initiation (T6) recorded the highest value of plant height compared with drill seeded while the treatment without nitrogen application at basal before flooding (T2) or at mid tillering (T3) recorded the lowest values of plant height under the two methods of planting. These results are in coincidence with that obtained by Abd El-Megeed, (2012) and Liu *et al*, (2019).

Data also, demonstrated that under drill seeded method, nitrogen application at all growth stages (T1) recorded the highest values of number of tillers/m^2 and panicles/m^2 followed by nitrogen application at three splits (T5) and two splitting 2/3 as basal, 1/3 at panicle initiation (T6). On the other hand, the T2 (- + MT + PI + LB), treatment produced the number of tillers/m^2 and panicles/m^2 in the both seasons. It could be attributed to nitrogen application as basal increase number of tillers and application of N at different growth stages raise photosynthesis rate, dry matter production especially under drill seeded methods which has more tillers and leaf area than transplanting method. Kumar *et al.*, (2017). The content of NH_4^+-N in the soil solution is positively correlated with tillering ability.

Also the amount of nitrogen applied basally before transplanting largely determines when the soil reaches this threshold **(**Luikhan *et al*., 2004 and Abd El-megeed, 2012). These results might be due to the continuous supply of nitrogen during tillering stage up to more effective tillers. These results are in agreement with that reported by Luikhan *et al*., (2004); Wiangsamut *et al*., (2006) and Sathiya and Ramesh (2009).

Table 6. plant height, number of tillers/m^2 and panicles/m^2 as affected by the interaction between planting methods and nitrogen splitting application at different growth stages in 2018 and 2019 seasons.

Treatment N-application	Plant height (cm)			
	2018		2019	
	Trans planting	Drill seeded	Trans planting	Drill seeded
T_1	110.03b	107.62cd	107.58b	97.99e
T_2	101.73f	97.28g	91.43f	96.91e
T_3	106.88d	93.66h	104.92c	92.65f
T_4	108.43c	102.73f	105.73c	98.14e
T_5	108.36cd	106.91d	107.65b	99.54d
T_6	113.65a	104.54e	112.51a	100.25d
	Number of tillers/m^2			
T_1	512.69g	675.69a	461.46g	665.89a
T_2	417.89l	528.82f	373.72l	477.49f
T_3	443.39k	588.59e	394.96k	534.39e
T_4	455.09j	620.59d	396.63j	564.59d
T_5	503.29h	664.12b	432.92h	633.89b
T_6	486.59i	633.26c	423.12i	591.29c
	Number of panicles/m^2			
T_1	504.4d	666.9a	436.19de	628.22a
T_2	353.9h	498.4d	302.39i	427.26ef
T_3	388.6g	540.3c	350.99h	472.69d
T_4	390.5g	555.6c	362.09gh	527.02c
T_5	465.6e	651.3a	397.79efg	607.26ab
T_6	437.2f	602.4b	384.39fgh	580.26b

T_1 = All (B + MT + PI + LB), T_2 = (- + MT + PI + LB), T_3 = (B + - + PI + LB), T_4 = (B + MT + - + LB),
T_5 = (B + MT + PI + -) and T_6 = $^2/_3$ (B) +$^1/_3$ (PI)

Panicle weight, number of filled grain/panicle and 1000-grain weight:

Transplanting method recorded the highest value of panicle weight (g), number of filled grain/panicle and 1000-grain weight compared with drill seeded method (Table 7). Data also, revealed that application of N as the four tested splits (T1) produced the highest values of value of panicle weight (g) and number of filled grain/panicle, followed by T3 while, the lowest values were obtained with treatment which did not receive nitrogen as basal (T2). Moreover, the other treatments (T4, T5 and T6) came in the last rank without any significant differences among them. These results could be discriminated that basal nitrogen application increased total sink size because of increases in number of panicles and spikelet number per panicle. Nitrogen applied at flowering stage significantly increased nitrogen content in flag leaf and leaves besides the flag leaf which led to improve the viability of leaves and late its senescence resulted in increase of photosynthesis rate and its products (assimilates). Thereby, Rubisco (Ribulose-1, 5- Bisphosphate Carboxylase) activity in the flag leaves was higher for the plants that received nitrogen at panicle inition (PI) and late booting (LB). These results are in harmony with those recorded by Arafat (2007) and Wang, *et al*., (2017). The application of N as basal (B), Mid-tillering (MT), panicle initiation (PI) and late booting (LB) is necessary for optimum photosynthesis during growth stage to produce great number of filled grains as improve in sink size and capacity of rice. Similar results were obtained by Singh and Singh (1998); Luikhan *et al*., (2004) and Zhao *et al*., (2020). However there is no significant difference observed for 1000 grain weight under different split of nitrogen fertilizer. It could be attributed to continuous supply of nitrogen for rice plant during both growth and filling periods consequently increase photosynthesis rate along growth stages and the viability of flag leaf resulted in more photosynthesis products and metabolism stream from source directly to sink which produce heavy grain weight. These data are in coincidence with that recorded by Abd El-Hamed (2005); Arafat (2007) and Dendupg *et al*., (2018).

Table 7. Panicle weight, number of filled grain/panicle and 1000-grain weight of Sakha108 as affected by planting methods and nitrogen splitting application at different growth stages in 2018 and 2019 seasons.

Treatment	Panicle weight (g)		Number of filled grain /panicle		1000-grain weight (g)	
	2018	2019	2018	2019	2018	2019
Planting method (A)						
Transplanting	4.463a	4.273a	147.51a	139.86a	28.42a	27.84a
Drill seeded	3.642b	3.512b	120.00b	116.85b	25.99b	27.09b
F Test	**	**	**	**	**	*
Nitrogen Schedule(B)						
T1	4.415a	4.285a	141.83a	138.16a	26.88	27.97
T2	3.685d	3.495e	122.58f	113.66e	27.20	27.04
T3	4.230ab	4.030b	136.86b	132.36b	27.22	27.57
T4	3.965c	3.770d	135.67c	130.47c	27.17	27.32
T5	4.065bc	3.945bc	133.82d	128.07d	27.46	27.48
T6	3.955c	3.830cd	131.78e	127.42d	27.29	27.39
F Test	**	**	**	**	Ns	Ns
Interaction: A*B	**	**	**	**	Ns	Ns

T_1 = All (B + MT + PI + LB), T_2 = (- + MT + PI + LB), T_3 = (B + - + PI + LB), T_4 = (B + MT + - + LB), T_5 = (B + MT + PI + -) and T_6 = ⅔ (B) +⅓ (PI)

Highly significant differences in panicle weight and number of filled grain/panicle as affected by the interaction between planting methods and different time of nitrogen application at different growth stages in both seasons (Table 8).

Table 8. Panicle weight (g) and number of filled grain/panicle as affected by the interaction between planting method and nitrogen splitting application at different growth stages in 2018 and 2019 seasons.

Treatment N application	Panicle weight (g)			
	2018		2019	
	Transplanting	Drill seeded	Transplanting	Drill seeded
T_1	4.860a	3.970ef	4.710a	3.860c
T_2	4.120de	3.250i	3.920c	3.070e
T_3	4.630ab	3.830ef	4.290b	3.770c
T_4	4.290cd	3.640gh	4.180b	3.360d
T_5	4.490bc	3.640gh	4.340b	3.550d
T_6	4.390bcd	3.520h	4.200b	3.460d
	Number of filled grain/panicle			
T_1	155.33a	128.33e	150.11a	126.21d
T_2	134.43d	110.73j	126.46d	100.86h
T_3	149.73b	123.98f	142.88b	121.83e
T_4	149.33b	122.01g	140.11c	120.83e
T_5	148.63bc	119.00h	139.20c	116.93f
T_6	147.63c	115.93i	140.42c	114.42g

T_1 = All (B + MT + PI + LB), T_2 = (- + MT + PI + LB), T_3 = (B + - + PI + LB), T_4 = (B + MT + - + LB), T_5 = (B + MT + PI + -) and T_6 = ⅔ (B) +⅓ (PI)

Data revealed that application of N as the four tested splits (T1) significantly produced the heaviest panicles and maximum number of filled grain/panicle in both seasons and T3 in 2018 only under transplanting method. While the lowest panicles weight and number of filled grain/panicle were obtained from the treatments which received nitrogen as T2 (all the tested splits except basal application) under drill seeded method. Moreover, the other treatments T4 (elimination of N-application at PI), T5 (elimination of N-application at LB) and T6 (2/3 as Basal + 1/3 at PI) came in the lasted rank recording nearly the same values among them under both planting methods in this study. It means that application of nitrogen as basal before planting or through the thirty days from transplanting is necessary for increase the panicle weight and number of filled grains/panicle, due to the increase in photosynthesis resulted in increase in metabolites streamed translocate from source to sink which increase filling processes during period. These results are in concurrent with that recorded by Sathiy and Ramesh (2009) and Abid *et al*., (2015).

Grain yield, straw yield and N-uptake of rice grains:

The transplanting method gave the highest grain yield, straw yield and N-uptake of rice grains (Table 9). These results could be attributed to the geometric structure of transplanting method which proper for penetrate light through rows and hills of rice resulted in excess of photosynthesis rate and consequently, increase number of filled grains, panicle weight and grain yield but the reduction in grain yield with drill seeded method may be due to uneven distribution of seeds and high competition of weeds.

Data in Table 9 indicate that the application of N into the four tested splits (T1) markedly surpassed the other nitrogen splits for highest grain yield, straw yield and N-uptake of rice grains, followed by T3, T4 and T5 in both seasons. On the other hand, both T2 produced the lowest grain yield, straw yield and N-uptake of rice grains. It means that the application of N into four splits is necessary for continuous N supplying for rice by nitrogen which increase N-content in rice leaves including flag leaf resulted in increased photosynthesis rate during growth stage and filling period of rice spikelets which received more metabolize stream from big canopy of translocated rice (big source) to great sink result in high filling and panicle weight consequently great grain yield. These results are in harmony with those reported by Wiangsamut *et al*., (2006) and Gang *et al*., (2012) who found that nitrogen applied at different growth stages could enhance the dry weight of the culm-sheath and the redistribution of dry matter at heading stage. Also, improves the conversion of carbon photosynthetic products into sucrose and output of sucrose along with causing a delay in leaf senescence.

Table 9. Grain yield, straw yield (t/ha) and N-uptake of rice grains (kg/ha) of Sakha108 as affected by planting methods and nitrogen splitting application at different growth stages in 2018 and 2019 seasons.

Treatments	Grain yield t/ha		Straw yield t/ha		N-uptake (kg/ha)	
	2018	2019	2018	2019	2018	2019
Planting methods (A)						
Transplanting	10.937a	10.64a	12.79a	12.62a	119.14a	100.60a
Drill seeded	9.882b	9.32b	11.78b	11.38b	110.22b	89.09b
F Test	**	**	**	**	**	**
Nitrogen Schedule (B)						
T1	11.20a	10.69a	13.10a	12.75a	129.20a	110.060a
T2	9.45d	8.92c	11.27c	11.15c	97.98f	78.320f
T3	10.98ab	10.37ab	12.81ab	12.38ab	123.31b	103.190b
T4	10.68ab	10.17ab	12.44ab	12.12ab	117.48c	99.260c
T5	10.30bc	10.01ab	12.14bc	11.93abc	112.57d	92.985d
T6	9.85cd	9.73b	11.95bc	11.67bc	107.54e	85.245e
F Test	**	**	**	**	**	**
Interaction: A*B	**	**	**	**	**	**

T_1 = All (B + MT + PI + LB), T_2 = (- + MT + PI + LB), T_3 = (B + - + PI + LB), T_4 = (B + MT + - +LB), T_5 = (B + MT + PI + -) and $T_6 = \frac{2}{3}$ (B) $+\frac{1}{3}$ (PI)

A highly significant difference in grain yield and straw yield as affected by the interaction between planting methods and different time of nitrogen application at different growth stages in both seasons (Table 10). The application of nitrogen into four splits application (T1) under transplanted method gave the highest grain yield followed by T3 and T4 without any significant differences among them. On contrast, the lowest value of grain yield was obtained when nitrogen was eliminated at basal application (T2) under both transplanting and drill seeded methods. It could be attributed to continuous supply of nitrogen for rice plants during both growth and filling periods consequently increase photosynthesis rate along growth stage and the viability of flag leaf resulted in more photosynthesis products and metabolic stream from source directly to sink which produce heavy grain weight. These results are in concert with those obtained by Wiangsamut *et al*., (2006); Song, *et al*., (2014) and Yajie, *et al*., (2018) and Xiea *et al*., (2019).

Table 10. Grain yield and straw yield (t/ha) as affected by the interaction between planting methods and nitrogen splitting applications at different growth stages in 2018 and 2019 seasons.

Treatment N-application	Grain yield (t/ha)			
	2018		2019	
	Transplanting	Drill seeded	Transplanting	Drill seeded
T_1	11.870a	10.531cde	11.57a	9.80cde
T_2	9.690def	9.207f	9.34bef	8.50f
T_3	11.700ab	10.251d-f	11.09ab	9.64c-f
T_4	11.360a-c	10.001d-f	10.88abc	9.46def
T_5	10.790b-d	9.810d-f	10.71a-d	9.30ef
T_6	10.210d-f	9.491ef	10.27b-e	9.19ef
	Straw yield (t/ha)			
T_1	13.45a	12.76a-c	13.29a	12.22a-e
T_2	11.83bcd	10.71d	11.78b-f	10.51f
T_3	13.20ab	12.43a-c	13.01ab	11.74b-f
T_4	13.04ab	11.85b-d	12.79a-c	11.45c-f
T_5	12.72a-c	11.57cd	12.62a-d	11.25d-f
T_6	12.51a-c	11.39cd	12.23a-e	11.12ef

T_1 = All (B + MT + PI + LB), T_2 = (- + MT + PI + LB), T_3 = (B + - + PI + LB), T_4 = (B + MT + - + LB), T_5 = (B + MT + PI + -) and $T_6 = \frac{2}{3}$ (B) $+\frac{1}{3}$ (PI)

A highly significant difference in nitrogen uptake (kg/ha) by rice grains as affected by the interaction between planting methods and various schedules of N-application in both seasons (Fig 1).

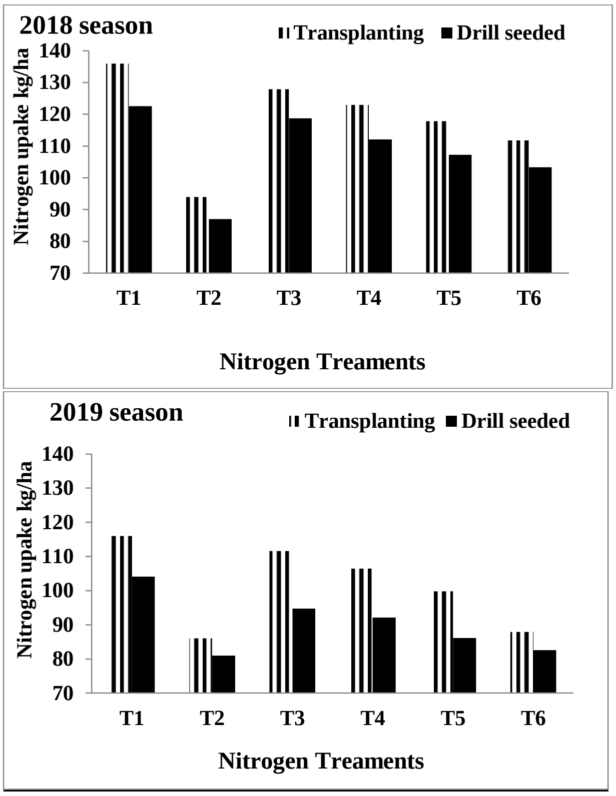

Figure1. N-uptake of rice grains (kg/ha) as affected by the interaction between planting methods and nitrogen splitting application at different growth stages in 2018 and 2019 seasons.

Transplanting method with splitting nitrogen into four doses (T1) at the different stages was considered as the best combination which produced the peak nitrogen uptake by rice grains followed by the treatment which did not receive nitrogen at MT (T3) under transplanted methods in both seasons. The lowest value of nitrogen uptake was obtained with T2 (which did not receive nitrogen as basal application before planting). It can be also, observed that the trend of nitrogen treatment under drill was the same under transplanting but the values were less. This may be due to plants grown with wider spacing have more area of land to uptake the nutrient and were exposed more solar radiation which encouraged superior photosynthetic process. These results are in harmony with those obtained by liu, (1991) and Gang *et al*., (2012).

CONCLUSION

It could be concluded that Sakha108 rice variety gave the highest yield with the application of nitrogen into four splits application T1: basal (B), Mid- tillering (MT), panicle initiation (PI) and late booting (LB) (T1) under transplanting method followed by T3: (B + - + PI + LB) and T4: (B + MT + - + LB) without any significant differences among them. Under the same nitrogen treatments, the yields of the drilling method have the same trend, but with low values.

REFERENCES

Abd El-Hamed, N. N. B. (2005). A study on the effect of some agronomic practices on characters and grain quality of rice. M.Sc. Thesis. (Agronomy), Fac. of Agric., Kafrelsheikh, Tanta Univ. Egypt.

Abd El-Megeed, T. M. (2012). Response of hybrid rice and true bred line (GZ6522) to nitrogen application under transplanting and drill seeded methods. Ph.D. (Agronomy), Fac. of Agric. Kafrelsheikh University.

Abid, M., Khan, I. ; Mahmood, F. ; Ashraf, U. ; Imran, M. and Anjum, Sh. (2015). Response of Hybrid Rice to Various Transplanting Dates and Nitrogen Application Rates. PHILIPP AGRIC SCIENTIST. 98 (1): 98–104.

Arafat, S.F. (2007). Effect of some agronomic practices on hybrid rice. M.Sc. Thesis, (Agronomy), Agric., Kafrelsheikh University.

Datta, A. , Ullah, H.; and Ferdous, Z. (2017). Water management in rice. In B. S. Chauhan, K. Jabran, & G. Mahajan (Eds.), Rice production worldwide (pp. 255–277). Dordrecht, The Netherlands: Springer.

Dendupg, Ch. , Chhogyelh, N. and Ngawangg, A. (2018). Effects of different planting methods on rice (Oryza sativa L.) crop performance and cost of production. Bhutanese Journal of Agriculture. 1(1): 13-22.

Dingkuhn, M., Schnier . S., De Datta, H.F.; Dorffling , S.K., Javellana. C. and Pamplona, A. (1990). Nitrogen fertilization of direct-seeded flooded vs. transplanted rice: II. Interactions among canopy properties. Crop Science. 1284-1292.

Djaman, K. V.C.; Mel, F. ; Ametonou, Y.; Namaky R.E.and Diallo. M.D. (2018). Effect of Nitrogen Fertilizer Dose and Application Timing on Yield and Nitrogen Use Efficiency of Irrigated Hybrid Rice under Semi-Arid Conditions. J Agri Sci Food Res 9: 223.

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

Gang, P. S.; Sheng-qi1, H.; Jing, Z.; Jing-ping, W.; Cou-gui1, C.; Ming-li1, C.; Ming Z. and Xiang-ru, T.(2012). Effects of N Management on Yield and N Uptake of Rice in Central China. Journal of Integrative Agriculture. 11(12): 1993-2000.

Gomez, K.A and Gomez, A.A.(1984). Statistical procedures for Agricultural Research, edn2. International Rice research institute, manila, Philippines.

Hirzel, J., pedreros A. and cordero1 K.(2011). Effect of nitrogen rates and split nitrogen fertilization on grain yield and its components in flooded rice. Chilean journal of agricultural research. 71(3).

Howida El-Habet , B. I., Naeem El.S., Abd El-Megeed T. M. and El-Khtyar A.M. (2013). Rice seed rates and nitrogen levels effects on growth and yield of Egyptian hybrid rice1 under drill seeded method. J. Agric. Res. Kafr El-Sheikh Univ.(2): 39.

Howida EL-Habet, B. I., Abd El-Megeed T. M. and Mervat M. A. Osman. (2018). Performance of some Rice Genotypes under Both Different Nitrogen Levels and Plant Spaces. J. Plant Production, Mansoura Univ., Vol. 9 (10):845 - 858

Hussain, S., Cao F., Wu W. and Geng M. (2016). Seed priming alters the production and detoxification of reactive oxygen intermediates in rice seedlings grown under sub-optimal temperature and nutrient supply. Frontiers in Plant Science. 7, 439.

IRRI, (2002). Standard Evaluation System for Rice. International Rice Research Institute.

Islama, S. M., Hasanuzzamanb M., Rokonuzzamanc M. and Nahard K. (2009). Effect of split application of nitrogen fertilizer on morphophysiological parameters of rice genotypes. International Journal of Plant Production 3 (1).

JinLiu, C., GuangMing T., LiTao R.; ZuCong C. and RenHong H. (2000).Ammonia volatilization from urea applied to the field of wheat and rice in southern Jiangsu Province. Journal of Nanjing Agricultural University. 23(4): 51-54.

Kaushal, A.K., Rana Adesh N.; Singh, S.; Neeraj S. and Srivastav A. (2010). Response of levels and splits application of nitrogen in green manure wet land rice (Oryza Sativa L.). Asian Journal of Agricultural Sciences 2(2): 42 -46.

Lin, X., Zhu D., Chen H.and Zhang Y. (2009). Effects of plant density and nitrogen application rate on grain yield and nitrogen uptake of super hybrid rice. Rice Sci. 16,138–142.

Liu, D. (1991). Efficient use of nitrogen in crop production. Ext. Bulletin. 340 Food& Fertilizer Technology Center, Taiwan.

Liu, Z.,. Gao F, Liu Y., Yang J., Zhen, X. Li X., Li Y., Zhao J.; Li J., Qian B., Yang D. and Li X. (2019). Timing and splitting of nitrogen fertilizer supply to increase crop yield and efficiency of nitrogen utilization in a wheat–peanut relay intercropping system in China. The CROPJOURNAL7: 101 – 112.

Luikhan, E.; Krishnarajan J. and Premsekhar M. (2004). Irrigation and nitrogen application schedules for hybrid"ADTRH" rice (*Oryza sativa*, L.) In Tamil Nadu. Indian Journal of Agronomy 49 (11): 37-39.

Omar, S. S., Wilson L.T., Medley J.C., SPinson.R., Meclung A.M. and Lales J.S. (2006). Relationships with grain yield, grain protein and yield related traits in rice. Agron. J. 98: 168-176.

Richards, L.A. (1969). Diagnosis and improvement of saline and alkali soils. city, USA: U. S Dept. Agric. Handbook. p. 60.

Sathiya, K. and Ramesh T. (2009). Effect of split application of nitrogen on growth and yield of aerobic rice. Asian J. Exp. Sci., 23(1): 303 - 306.

Singh, R.S. and Singh S.B. (1998). Response of rice (Oryza sativa) to age of seedlings, and level and time of application of nitrogen under irrigated condition. Indian Journal of Agronomy 43 (4): 632-635.

Song, C., Sheng-guan C., XIN C. and Guo-Ping Z. (2014). Genotypic differences in growth and physiological response to transplanting and direct seeding cultivation in rice. Rice science, 16 (2): 143 -150.

Sorour, F. A., Ragab A. Y., Metwally T. F. and Shafik A. A. (2016). Effect of planting methods and nitrogen fertilizer rates on the productivity of rice (oryza sativa l.). J. Agric. Res. Kafr El-Sheikh Univ. pp: 173-182, Vol. 42(2). https://www.researchgate.net/publication/ 319482802.

Ullah, H., Mohammadi A. and Datta. A. (2018). Growth, yield and water productivity of selected lowland Thai rice varieties under different cultivation methods and alternate wetting and drying irrigation. Annals of Applied Biology, 173, 302–312.

Wang, Y., Lu J., Ren T., Hussain S., Guo C., Wang S., Cong R. and Li X. (2017). Effects of nitrogen and tiller type on grain yield and physiological responses in rice. AoB PLANTS 9: plx012; doi:10.1093/aobpla/plx012.

Wiangsamut, B., Teodoro Mendoza C. and Tanguy Lafarge A. (2006).Growth dynamic and yield of rice genotypes grown in transplanted and direct-seeded fields. Journal of Agricultural Technology 2(2): 299 – 316.

Xiea, X., Shan S., Wangb Y., Caob F., Chenb J., Huangb M. and Zoub Y. (2019). Dense planting with reducing nitrogen rate increased grain yield and nitrogen use efficiency in two hybrid rice varieties across two light conditions. Field Crops Research 236: 24–32.

Yajie, H., Pei W., Hong-cheng Z., Qi-gen D., Zhong-yang H., KeG X., Hui. W. Hai-yan, Bao-wei G. and Pei-yuan C. (2018). Comparison of agronomic performance between inter-sub-specific hybrid and inbred japonica rice under different mechanical transplanting methods. Journal of Integrative Agriculture 2018, 17(4): 806–816.

Zhao, H. ; Mo, Z. ; Lin, Q. ; Pan, S. ; Duan, M. ; Tian, H. ; Wang, S. and Tang, X. (2020). Relationships between grain yield and agronomic traits of rice in southern China. Chilean Journal of Agricultural Research 80(1) January-March.

Zhou, C.; Huang, Y.; Jia, B. ; Wang, S. ; Dou, F. ; Omar, S. ; Samonte, K. ; Chen, K. and Wang, Y. (2019). Optimization of Nitrogen Rate and Planting Density for Improving the Grain Yield of Different Rice Genotypes in Northeast China. Agronomy. 9, 555.

تاثير تقسيم الاسمدة النتروجينية وطرق الزراعة على انتاجية محصول الارز

طاهر محمد عبد المجيد وهويدا بيومى الهابط*

معهد بحوث المحاصيل الحقيله - مركز البحوث والتدريب فى الارز – سخا - كفر الشيخ

أقيمت تجربتان بمزرعة محطة البحوث الزراعية بسخا كفر الشيخ وذلك خلال موسمى 2018 و 2019 لدراسة تاثير تقسيم النتروجين خلال مراحل نمو الارز المختلفة و طرق الزراعة (الشتل والتسطير) على انتاجية الارز صنف سخا 108 وكانت معاملات اضافة السماد كالاتى T1: basal (B) + Mid-tillering (MT) + panicle inition (PI) + late booting (LB) وT2 : (- + MT + PI + LB) و T3: (B + - + PI + LB), T_4: (B + MT + - + LB) و T_5: (B + MT + PI + -) وT_6: (2/3 B+ 1/3 PI) . كان تصميم التجربة Strip وتم عمل اربع مكررات . اظهرت النتائج ان محتوى الكلوروفيل- دليل مساحة ورقة- انتاج المادة الجافة- طول النبات- عدد الفروع/م^2- عدد السنابل/م^2- وزن السنبلة – عدد الحبوب الممتلئة / للسنبلة محصول القش- محصول الحبوب تفوق بشكل ملحوظ عند المعاملة T1 تليها المعاملة T3 و T4 تحت طريقة الزراعة بالشتل. كما اعطت المعاملة T1 اعلى امتصاص للنتروجين بواسطة الحبوب تحت طريقتين الزراعة خلال موسمين الزراعة. كما اوضحت الدراسات ان تحت طريقة الزراعة بالتسطير اخذ محصول الحبوب والقش ومعظم الصفات المدروسة اخذ نفس الاتجاه مع معاملات النتروجين تحت طريقه الزراعة بالشتل ولكن القيم تحت طريقه الزراعة بالشتل كانت اكبر من الزراعة بالتسطير.