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EFFECT OF SPLIT APPLICATION OF NITROGEN AND POTASSIUM TO SK2047 HYBRID RICE

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ABSTRACT

Two field experiments were conduced at Rice Research and Training Center, Sakha Kafr El-Sheikh, Egypt in 2007 and 2008 summer seasons to study the effect of split application of N and K to SK2047 hybrid rice [IR70368A/Giza 178R]. One level of N fertilization was used, 165 kg N/ha in the form of urea applied in three different times (N_1) as two splits [2/3 incorporated into dry soil before transplanting + 1/3 before panicle initiation), (N_2) as three equal splits [1/3 incorporated into dry soil before transplanting + 1/3 at mid tillering + 1/3 before panicle initiation], (N_3) as three splits [1/2 incorporated into dry soil before transplanting + 1/4 at mid-tillering + 1/4 at panicle initiation]. One level of potassium (60 kg K_2O/ha) was applied. All amount was applied as follow: (K_1) without potassium (control), (K_2) the total amount was applied as basal (100% B), (K_3) one half as basal and one half at panicle initiation (50% B + 50% PI), (K_4) one half as basal and other half in two equal splits; at mid-tillering and at panicle initiation (50% B + 25% T + 25% PI) and (K_5) in four equal splits: basal, mid-tillering, panicle initiation and heading (25% B + 25% MT + 25% PI and 25% at heading). The main results could be summarized as follows:

Three equal split applications of nitrogen (N_2); [1/3 B + 1/3 MT + 1/3 PI) was superior in dry matter (DM), flag leaf area (FLA), leaf area index (LAI), N and K shoot content, panicle number, % of filled grains/panicle, panicle weight, 1000-grain weight, harvest index (HI) and grain yield.

Potassium applications increased growth characters, grain yield and its components and N and K shoot content compared with the control. While, split-applied potassium with three doses (K_4); 50% B + 25% MT + 25% PI, gave the highest values of studied parameters without any significant differences with those produced by (K_5); 25% B + 25% MT + 25% PI + 25% heading in rice grain yield.

The interaction between split application of N and K was significant for filled grains percentage and K shoot content in 2007 season.

It could be concluded that for raising hybrid rice productivity, both nitrogen and potassium should be applied in the following formulas; 1/3 basal (B) + 1/3 at mid tillering stage (MT) + 1/3 at panicle initiation (PI) and 50% basal (B) + 25% at mid tillering stage (MT) + 25% at panicle initiation (PI) for nitrogen and potassium respectively.

INTRODUCTION

Rice is the most important food crop in Egypt, contributing over 20% of cereal consumption. It is raised an area of 1.4 million feddans covering about 22% of the total cultivated area in Egypt.

Hybrid rice technology is one such innovative break through that can further increase rice production leading to food security in Egypt. Rice hybrids produce about 14-28% higher grain yield than inbred cultivars (Siddiq, 1993).

The farmer generally fertilized the rice either with nitrogen or with nitrogen and phosphorous only, though potassium is equally important as it stabilizes yield and is a quality nutrient. Application of potassium has become very necessary due to intensified agriculture with high-yielding varieties and introduction hybrid rice in Egypt. Whereas hybrid rice is highly fertilizer responsive. Agronomic management of hybrid rice differs considerably the conventional varieties. So, adequate fertilization at a right time in a proper manner is essential to achieve potential yield of rice hybrids.

Yang and Sun (1991) found that N application at heading stage increased leaf chlorophyll content, photosynthetic rate and translocation of carbohydrates to panicle and leading to higher ripening percentage and considerable grain yield. Peng *et al.* (1996) in Philippines stated that late N application at flowering for hybrid rice increased filled grain percentage, filled spikelets number/panicle, panicle weight, 1000-grain weight and grain yield. Kumar *et al.* (1999) stated that N application at various physiological stages of hybrid rice (basal, maximum tillering and panicle initiation stage) involving small dose at flowering stage exerted higher grain and straw yields. That mainly due to improving yield attributes characters. Surekha *et al.* (1999) in India, found that nitrogen applied in four splits (basal + tillering + panicle initiation + flowering) improved panicle weight filled grains/panicle, 1000-grain weight single grain weight and resulted in higher grain yield owing to increased photosynthetic rate and delayed leaf senescence for hybrid rice. Balasubramanian (2002) tested the response of hybrid rice to various timing of nitrogen application. He found that applying N in four equal splits at basal + active tillering + panicle initiation + panicle emergence gave the highest value of dry matter production, tallest plant as well as high values of productive tillers/hill, grain panicle, heaviest 1000-grain and panicle weights, grain and straw yields. Edwin *et al.* (2004) in India, studied the effect of the strategy of applying the recommended dose of nitrogen (150 kg N/ha) as 17, 33, 33 and 17% at basal, active tillering, panicle initiation and first flowering, respectively gave the high values of panicles/m^2, spikelets/m^2, filled grain/m^2, grain yield as well as harvest index for hybrid rice. Ebaid and El-Mowafi (2005) studied the effect of N splitting. They found that nitrogen splitting into equal four doses was better whereas, it gave higher growth parameters and yield attributing traits as well as grain yield.

In fact continuous application of K improves all soil properties and perhaps the use of higher rats of N. Potassium exerts a favourable influence on tillering, size and weight of grain, stimulates build-up and translocation of carbohydrates to grain by strengthening the plant cell wall, renders the crop more resistant to diseases and adverse weather (Roy, 1981). Ebaid and Ghanem (2001) and Zayed (2002) found that potassium application had positive effects on growth, yield components, grain yield and N and K content. Velayutham *et al.* (1992), Ghosh *et al.* (1995); Devasenapathy (1997) and Mutanal *et al.* (1997) reported that the potassium application at 50% basal + 25% at tillering + 25% at panicle flowering or 50% basal + 50% at tillering stage of rice were more efficient for adequate rice growth, yield and yield attributes compared to one dose application. Also, they found that split application of K (3 equal splits) increase seed grain yield as compared with a single basal dose. They added that panicles/m^2, filled grains/panicle and 1000-grain weight were also positively influenced by split application. In the same time.

Venkitaswamy *et al.* (1997) found that hybrid rice cv. CORHI gave the highest grain yield when fertilizer (150 kg N + 50 kg K/ha) was applied in 3 splits (basal, tillering and panicle initiation).

The current study aimed to find out the proper time and splitting of nitrogen and potassium application to SK2047 hybrid rice.

MATERIALS AND METHODS

Two fields experiments were carried out at the Experimental Farm of Rice Research and Training Center (RRTC). Sakha, Kafr El-Sheikh, Governorate Egypt, during the two successive summer seasons of 2007 and 2008. The field experiments were conducted to study the effect of split application of nitrogen and potassium to SK2047 Hybrid rice (IR70368A/Giza 178R). The chemical analysis and physical properties of experimental soil were documented in Table 1.

Table 1: Some physical and chemical properties of the experimental sites.

Seasons	Properties										
	Soil texture	Sandy %	Clay %	Silt %	O.M %	pH	EC (dS/m)	Available (ppm)			
								N	P	K	Zn
2007	Clay	12.30	56.0	31.70	1.4	8.1	2.81	19	18	330	0.81
2008	Clay	13.67	54.33	32.0	1.5	7.9	2.70	17	13	298	0.90

One level of nitrogen fertilization (165 kg N/ha) in form of urea applied in three different times (N_1) as two splits [2/3 incorporated into dry soil before transplanting + 1/3 at panicle initiation (PI)], (N_2) as three equal splits [1/3 incorporated into dry soil before transplanting + 1/3 at mid tillering + 1/3 before PI] and (N_3) as three splits [1/2 incorporated into dry soil before transplanting + 1/4 at tillering + 1/4 at PI].

One level of potassium (60 kg K_2O/ha) was applied consisting of the treatments, viz.

K_1: Absolute control (0 kg K/ha).

K_2: 60 kg K_2O/ha [all amount was applied as basal (100% B)].

K_3: 60 kg K_2O/ha [two equal splits; one half as basal and one half at panicle initiation, (50% B + 50% PI)].

K_4: 60 kg K_2O/ha [three splits; one half as basal and other half in two equal splits; at mid tillering and panicle initiation (50% B + 25% MT + 25% PI)].

K_5: 60 kg K_2O/ha [four equal splits; at basal, mid tillering, panicle initiation and heading (25% B + 25% MT + 25% PI + 25% at heading)].

The current study was performed in split plot design with four replications. The three splitting of N were distributed in the main plots. The sub plots were devoted to the five splitting of potassium. Phosphorous (P_2O_5)

and zinc (Zn SO_4) as well as all other cultural practices were undertaken as a recommended under normal soil. The sub-plot area was 15 m^2 and rice hybrid SK2047 was planted at 20 x 20 cm spacing with two seedling/hill. Egyptian clover was the previous crop in the two seasons.

At heading 7 days later, plant samples (5 hills) were collected from each plot to determine the following: dry matter production (g/m^2)-leaf area was measured using leaf are meter and leaf area index (LAI) was calculated. Flag leaf area (cm^2) and chlorophyll content, using chlorophyll meter (Model-SPAD-502), degree of lodging using the following scale: [1 = no lodging and 9 = total lodging (flat) and total nitrogen and potassium were determined in dry shoots as follows: Total nitrogen (mg/g) was determined by the Microkjeldahl Method (Black, 1965) and potassium, by using atomic absorption method of Yoshida *et al.* (1972).

At harvest, ten random hills from sub plot were collected to determine the number of panicles/m^2 and ten panicles characters estimate (number of grains/panicle, % of filled grains/panicle, panicle weight and 1000-grain weight). Ten square meter of each sub-plot was harvest, dried and threshed to estimate the grain yield. The grain yield was adjusted to 14% moisture content and converted into ton/ha. Harvest index was estimated according to the following equation.

HI = Economic yield (t/ha)/biological yield (t/ha) where economic yield is the actual grain yield and biological yield is the total yield of grain plus straw yield.

All the collected data was conducted with IRRISTAT and the difference among the treatments means were computerized by M-STAT (Duncan, 1955 multiple range test at 5% level) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

A. Growth characters:

A.1. Dry mater weight (DM), flag leaf area (FLA), leaf area index (LAI), chlorophyll content and degree of lodging:

As for times of nitrogen application, significant differences were existed in dry matter (DM), flag leaf area (FLA), leaf area index (LAI) degree of lodging and chlorophyll content due to various time of N application in both seasons Tables (2 and 3). It was obviously that splitting N more than two times had a positive effect in growth parameters. The highest values of DM, flag leaf area, LAI and chlorophyll content were obtained when N applied in three equal splits (N_2) 1/3 incorporated into dry soil before transplanting (B) + 1/3 at mid tillering + 1/3 at panicle initiation (PI). Moreover nitrogen splits (N_2) treatment associated with important stage such node elongation might be encouraged the cell elongation leading to more dry matter production and leaf area index. It was detected that nitrogen splitting up to PI stage of rice had a high ability to increase its photosynthetic rate, and growth, which enhanced high grain yield resulted from stored assimilates pre-heading. Also, three nitrogen splits (N_2) gave the highest values of chlorophyll content without any significant differences with those produced by (N_3). The highest values of chlorophyll content delayed the early senescence of leaves during filling period, leading to a high current photosoynthesis. Similar data were obtained by Peng *et al.* (2003) and Edwin *et al.* (2004). Also, (N_2) treatment decrease in the degree of lodging for plants, Table (3).

Table 2: Dry matter weight (g/m²), flag leaf area (cm²), and leaf area index (LAI) as affected by time of both nitrogen and potassium split application during 2007 and 2008 seasons.

Characters / Treatments	Dry matter (g/m²)		Flag leaf area (cm²)		Leaf area index (LAI)	
	2007	2008	2007	2008	2007	2008
Time of N application						
N_1	1250.04 b	1347.90 b	31.29 b	31.81 b	6.51 c	7.14 c
N_2	1326.43 a	1428.20 a	31.86 a	32.42 a	7.09 a	7.66 a
N_3	1266.74 b	1364.60 b	31.65 ab	32.28 ab	6.80 b	7.32 b
F-test	*	**	*	*	**	**
Time of K application						
K_1	1162.58 c	1236.60 c	30.53 c	30.25 c	5.87 d	6.67 d
K_2	1271.48 b	1372.40 b	31.63 b	32.47 b	6.69 c	7.21 c
K_3	1276.22 b	1382.00 b	31.70 b	32.42 b	6.91 bc	7.44 bc
K_4	1359.50 a	1468.90 a	32.23 a	33.29 a	7.34 a	7.87 a
K_5	1335.58 a	1441.20 a	31.89 ab	32.56 b	7.18 ab	7.68 ab
F-test	**	**	**	**	**	**
Interaction: N x K	NS	NS	NS	NS	NS	NS

In each column, means followed by a common letter are not significantly different at 5% level according to DMRT.

Table 3: Chlorophyll content, degree of lodging and N and K shoot contents (mg/g) as affected by times of both nitrogen and potassium split application during 2007 and 2008 seasons.

Characters / Treatments	Chlorophyll content		Degree of lodging (means)		N content (mg/g)		K content (mg/g)	
	2007	2008	2007	2008	2007	2008	2007	2008
Time of N application								
N_1	40.69 b	40.59 b	4	3	7.63 c	12.02 c	11.46 c	14.52 c
N_2	41.82 a	41.89 a	2	3	9.33 a	13.35 a	12.78 a	15.85 a
N_3	41.64 a	41.59 a	3	4	8.90 b	13.23 b	12.69 b	15.76 b
F-test	*	*			**	**	**	**
Time of K application								
K_1	39.94 b	39.74 b	6	7	7.768 b	11.62 c	9.28 d	11.0 d
K_2	41.38 a	41.35 a	4	4	8.639 a	12.74 b	11.26 c	15.16 c
K_3	41.59 a	41.55 a	3	3	8.873 a	13.15 a	12.80 b	16.48 b
K_4	42.11 a	42.21 a	1	3	8.913 a	13.48 a	14.14 a	17.08 a
K_5	41.90 a	41.92 a	1	2	8.904 a	13.33 a	14.08 a	17.17 a
F-test	*	**			**	**	**	**
Interaction: N x K	NS	NS			NS	NS	*	NS

In each column, means followed by a common letter are not significantly different at 5% level according to DMRT.

Regarding times of potassium application effect, data in Tables 2 and 3 show the times of K application had a great effect on growth parameters in both seasons. Significantly more effective of DM production, FLA, LAI and chlorophyll content were obtained with the application of K through three splits (K_4), (50% B + 25% MT + 25% PI), K_4 treatment, and gave the highest values of these growth parameters and ranked first, while, four equal splits (K_5) treatment ranked second. Numerous authors came to similar results such as Velayuthan *et al.* (1992), Devasenapathy (1997) and Mutanal *et al.* (1997). Also, K_4 and K_5 treatments were the best to reduce the lodging of rice plants. May be, potassium increased the standing ability of plants by increasing the culms diameter and strengthen its wall.

Data did not show any significant effect due to the interaction between splitting of N and K on these studied characters. This results means that each factor affected on these characters independently.

B. Yield and its attributes:

B.1. Panicles number/m^2, number of grains/panicle and percentage of filled grains/panicle:

Regarding times of N application effect, data in Table 4 claimed that times of N application had a significant effect on panicles number/m^2, no. of grains/panicle and % of filled grains/panicle in both seasons. Splitting N into three equal splits (N_2) treatment was found to be effective in raising panicles number/m^2 in both seasons. Also, (N_2) treatment gave the highest values of filled grains percentage. Nitrogen supply at much needed growth stages i.e. early growth stage is more important for increasing panicles number/m^2 which is considered as main components of grain yield. As it well known, N application beef up cell division of stem bud to produced more fertile tillers that mainly became clearly at panicle initiation (PI) stages which affected the number of panicles/hill. Also, nitrogen splits might be due to increased N uptake efficiency and reduction in N loss by volatilization and leaching. Similar finding have been claimed by Balasubramnain (2002) and Peng *et al.* (2003).

Table 4: Panicles number/m^2, number of grains/panicle and percentage of filled grains/panicle as affected by time of both nitrogen and potassium split application during 2007 and 2008 seasons.

Characters / Treatments	Panicles number/m^2		No. of grains/panicle		% of filled grains/panicle	
	2007	2008	2007	2008	2007	2008
Time of N application						
N_1	459.2 c	471.2 b	176.99 c	172.27 b	90.62 c	90.28 c
N_2	499.9 a	506.0 a	180.42 b	176.97 ab	92.78 a	92.61 a
N_3	480.4 b	490.9 a	184.13 a	179.29 a	91.81 b	91.50 b
F-test	**	**	*	*	**	**
Time of K application						
K_1	416.9 d	420.9 c	173.51 d	169.46 d	87.11 d	88.13 d
K_2	486.0 bc	495.7 b	178.99 c	174.70 c	91.87 c	90.98 c
K_3	474.8 c	498.4 b	180.3 bc	175.74 bc	92.04 c	92.20 b
K_4	524.8 a	527.7 a	184.41 ab	179.46 ab	92.96 b	92.80 b
K_5	496.5 b	504.1 b	185.33 a	181.50 a	94.71 a	93.48 a
F-test	**	**	**	**	**	**
Interaction: N x K	NS	NS	NS	NS	*	NS

In each column, means followed by a common letter are not significantly different at 5% level according to DMRT.

In both seasons, three nitrogen splits (N_3); 1/2 incorporated into dry soil before transplanting + 1/4 at mid tillering + 1/4 at panicle initiation gave the maximum no. of grains/panicle (184.13 and 179.28) in the first and second seasons, respectively.

Data presented in Table 4 show that time of potassium application had pronounced effect on studied yield contributing characters i.e. panicles number/m^2, no. of grains/panicle and percentage of filled grains/panicle in both seasons. Splitting K into 3 times (K_4) was found to be effective in raising number of panicles/m^2 in both seasons. While, 3 or 4 times (K_4 or K_5) treatment, gave the highest no. of grains/panicle with insignificant differences existed between them. In the same time, 4 equal splits (K_5) of potassium (25% B + 25% MT + 25% PI and 25% at heading) gave the highest values of percentage of field grains/panicle in both seasons. Some investigator found similar results such as Mutanal *et al.* (1997), Venkitaswamy *et al.* (1997) and Wang Yong Rui and Zou Jie (1997). They found that nitrogen and potassium application at heading increased translocation of C^{14} from the flag leaf to panicle. It is suggested that N + K application at panicle emergence may increase grain yield.

The interaction between the splitting application of N and K showed significant effects on percentage of filled grains/panicle in the first season. Table 6. Four equal splits of potassium (K_5) treatment with 3 equal splits of nitrogen (N_2) treatment gave the highest percentage of filled grains/panicle. On the other hand, the lowest one was obtained when (N_1) treatment was applied with no fertilizer of potassium.

B.2. Panicle weight, 1000-grain weight, grain yield and harvest index:

Regarding times of nitrogen application effect, data in Table 5 show that the times of nitrogen application had a great effect on panicle weight, 1000-grain weight, grain yield and harvest index in both seasons, three equal nitrogen splits (N_2) 1/3 incorporated into dry soil before transplanting + 1/3 at mid tillering + 1/3 at panicle initiation gave the maximum values of these parameters and ranked first followed by (N_3) treatment which ranked second and (N_1) treatment was last. From the obtained results, splitting nitrogen over two times delayed leaf aging and increased activity of root and three active leaves during grain filling period also, improving grain filling rate and reduced the sterility percentage which greatly increased grain yield. Similar results are in a good harmony with those reported by Yang and Sun (1991), Peng *et al.* (1996) and Kumar *et al.* (1999).

Concerning splitting of potassium, data in Table 5 reveal that the different tested times of potassium application had a significant effect on panicle weight, 1000-grain weight, grain yield and harvest index. Panicle weight increased significantly with the application of potassium in four equal splits (K_5) treatment and gave the heaviest panicle weight followed by (K_4) treatment while, the lightest panicle weight was produced when no potassium was applied. Similar results were observed by Kalita *et al.* (1995) and Mutanal *et al.* (1997). Furthermore, both of three potassium splits; (50% B + 25% MT + 25% PI) and four equal potassium splits; (25% B + 25% MT + 25%

PI + 25% at heating) did not significantly vary in their 1000-grain weight, value of grain yield and harvest index (HI) in both seasons. The low values of panicle weight, 1000-grain weight, grain yield and harvest index were produced when SK2047 hybrid rice did not receive any doses of potassium (K_1) treatment. The obtained results a greed with reported by Velayuthan *et al.* (1992), Ghoshi *et al.* (1995), Devasenapathy (1997), Mutanal *et al.* (1997), and Wang and Zou (1997).

The interaction was insignificant between splitting of nitrogen and times of potassium application for these traits.

Table 5: Panicle weight (g), 1000-grain weight, grain yield (t/ha) and harvest index as affected by times of both nitrogen and potassium split application during 2007 and 2008 seasons.

Characters / Treatment	Panicle weight (g)		1000-grain weight (g)		Grain yield (t/ha)		Harvest index (HI)	
	2007	2008	2007	2008	2007	2008	2007	2008
Time of N application								
N_1	3.48 c	3.43 b	25.79 b	25.40 b	10.53 c	11.29 c	0.426 c	0.447 c
N_2	4.05 a	3.94 a	26.26 a	25.86 a	11.40 a	12.10 a	0.449 a	0.472 a
N_3	3.91 b	3.79 b	26.00 b	25.58 b	10.97 b	11.67 b	0.435 b	0.457 b
F-test	**	**	**	*	**	**	**	**
Time of K application								
K_1	3.14 c	3.1 c	24.64 c	24.20 c	10.18 c	11.03 c	0.405 d	0.419 c
K_2	3.85 b	3.78 b	25.96 b	25.59 b	10.88 b	11.62 b	0.430 c	0.454 b
K_3	3.91 b	3.86 ab	26.09 b	25.70 b	11.01 b	11.82ab	0.440bc	0.464 b
K_4	3.98 b	3.88 ab	26.78 a	26.16 a	11.48 a	12.09 a	0.453ab	0.481 a
K_5	4.17 a	3.97 a	26.66 a	26.33 a	11.31 a	11.88 a	0.455 a	0.478 a
F-test	**	**	**	**	**	**	*	**
Interaction: N x K	NS	NS	NS	NS	NS	NS	NS	NS

In each column, means followed by a common letter are not significantly different at 5% level according to DMRT.

C. Chemical analysis:

C.1. Nitrogen and potassium in rice shoots (leaves + stem):

Data in Table 3 present effect of splitting of nitrogen and times of potassium application on N and K on shoot content (after week from heading) and their interaction.

Regarding, times of N application effect data showed that splitting nitrogen in three equal doses (N_2); 1/3 B + 1/3 MT + 1/3 PI gave the highest values of N and K content in SK2047 hybrid rice plant. This means that hybrids have stronger and more active root system at early and middle growth stages (Cheng *et al.*, 1989 and Gorgy, 2007). Also, Norman *et al.* (1998) reported that accumulation of N element in rice productive organs and its distribution is an important process for determination of grain yield.

Considering times of potassium application effect (Table 3). It was observed that (K_4) treatment; (50% B + 25% MT + 25% PI) and four equal (K_5) potassium splits (25% B + 25% MT + 25% PI + 25% heating) gave the highest values of both of N and K shoot contents and ranked first followed by splitting K in one dose as basal K_2) treatment while, the lowest values of N and K shoot content were produced when rice plants did not receives any potassium (K_1) treatment.

The interaction between nitrogen and potassium splitting application had significant effect on K shoot content only in 2007 season, it is worthy to mention that the highest K shoot content was obtained by the combination of three equal nitrogen splits (N_2) and (K_4) treatment; 50% B + 25% MT + 25% PI. On the other hand, the low values of K-content were produced under all nitrogen treatments when rice plants did not receive any potassium in Table (6).

It was clear that, three equal nitrogen splits (N_2) treatment had a high ability to increase photosynthetic rate, growth rate, chlorophyll content and nitrogen shoot content which delayed the early senescence of leaves during grain filling period and leading to a high current photosynthesis, which enhanced high grain yield resulted form stored assimilates pre-heading.

Also, three or four split application of potassium (K_4 and K_5 treatments) significantly increased chlorophyll leaf contents and nitrogen and potassium shoot content which, help rice plant to translocation of carbohydrates from shoot to grains in heading stage and this leading to higher grain yield.

Table 6: Filled grains % and K-content as affected by the interaction between splitting of N and K treatments in 2007 season.

Potassium splitting treatments	Nitrogen splitting treatments					
	N_1	N_2	N_3	N_1	N_2	N_3
	Filled grains %			K-content		
K_1	85.49 d	88.39 d	87.46 d	8.79 c	9.53 c	9.52 c
K_2	91.11 c	92.69 c	91.80 c	10.53 b	11.39 b	11.86 b
K_3	91.17 c	92.95 c	92.00 c	11.00 b	13.77 a	13.63 a
K_4	92.06 b	93.90 b	92.91 b	13.48 a	14.65 a	14.30 a
K_5	93.28 a	95.97 a	94.88 a	13.53 a	14.57 a	14.15 a

In a column, means followed by a common letter are not significantly different at 5% level according to DMRT.

It could be concluded that for raising hybrid rice productivity, both nitrogen and potassium should be applied in the following formulas; 1/3 basal (B) + 1/3 at mid tillering stage (MT) + 1/3 at panicle initiation (PI) and 50% basal (B) + 25% at mid tillering stage (MT) + 25% at panicle initiation (PI) for nitrogen and potassium respectively.

REFERENCES

Balasubramanian, R. (2002). Response of hybrid rice (*Oryza sativa*) to level and time of application of nitrogen. Indian J. of Agron., 47(2): 203-206.

Black, C.A.; D.D. Evan; L.E. Ensminger; D.L. White and F.E. Clark (1965). Method of soil analysis (chemical and microbiology properties, part 2). Amer. Soc. of Agron. Inc. Publisher Madison, Wisconsin, USA.

Cheng, W. and R.Y. Cheng (1989). Effects of N rates and application dates on different rice cultivars. J. of Zhejiang Agric. Sci., 3(9): 121-128 (C.F. Computer Search).

Devasenapathy, P. (1997). Split application of potassium in rice. Madras. Agric. J., 84(5): 265-266.

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

Ebaid, R.A. and H.F. El-Mowafi (2005). Effect of split applied nitrogen on the productivity of two rice hybrids and Sakha 104 rice cultivar. J. Agric. Res. Tanta Univ., 31(4-13): 760-776.

Ebaid, R.A. and S.A. Ghanem (2001). Effect of N and K fertilizer on the productivity of Sakha 101 rice cultivar. J. Agric. Sci., Mansoura Univ., 26(4): 1833-1840.

Edwin, L.; J. Krisjnarajan and M.S. Premsekhar (2004). Irrigation and nitrogen application schedules for hybrid. ADTRH1 rice (*Oryza sativa*) in Tamil Nadu. Indian. J. of Agron. 49(1): 37-39.

Ghosh, S.K.; S. Pal and A.K. Mukhopadhyay (1995). Split application of potassium to maximize its efficiency on yield of high yielding rice. Indian. Agric., 39(4): 259-264.

Gomez, K.A. and A.A. Gomez (1984). Statistical produces for agricultural research 2nd, John Wiley and Sons, USA.

Gorgy, r.N. (2007). Effect of balanced fertilizers on productivity of hybrid and inbred rice varieties. J. Agric. Res. Kafr El-Sheikh Univ., 33(1): 101-122.

Kalita, U.; N.J. Ojha and M.C. Talukdar (1995). Effect of levels and time of potassium application on yield and yield attributes of upland rice. J. of Potassium Res., 11(2): 203-206.

Kumar, R.M.; K. Padmaja and S.V. Subbaiah (1999). Tools for plant-based nitrogen management in different rice varieties grown in South India, IRRN, 24(3): 23-24.

Mutanal, S.M.; P. Kumar; V.R. Joshi and N.S.Y. Honnan (1997). Effect of split application of potassium on grain yield of paddy in transplanted condition. Karanataka J. of Agric. Sci., 10(2): 248-301.

Norman, R.J.; P.K. Bolltch; C.E. Wilson and N.A. Staton (1998). Influence of nitrogen rate, application timing and tillage on grain yields of water seeded rice. Research series Arkansas. Agricultural. Experiment Station, 460, 299-302.

Peng, S.; F.V. Garcia; R.C. Laza; A.L. Sanico; R.M. Visperas and K.G. Cassman (1996). Increased N-use efficiency using chlorophyll meter on high yielding irrigated rice. Field Crop Res., 47: 243-251.

Peng, S.; R.C. Laza; A.L.Sanico; R.M. Visperas and T.T. Son (2003). Physiological bases of heterosis and crop management strategies for hybrid rice in the tropics. Hybrid rice for food security, poverty alleviation and environment protection. Proceedings of the 4th International Symposium on hybrid rice. Hanoi, Vietnam, 14-17 May 2002. Loss Banos. Philippines IRRI.

Roy, R.N. (1981). Fertilizers and plant nutrition in rice In. Com. Rice Newsletter, 30(1): 1 and 8.
Siddiq, E.A. (1993). Rice production strategy for the 21st century. Oryza 30: 186-196.
Surekha, K.; M. Narayana Redy and R.T.M. Kumar (1999). Yield attributes and yield of rice (*Oryza sativa*) hybrids as influenced by nitrogen sources and its splits application. Indian J. of Agron., 44(1): 88-90.
Velayuthan, A.; K. Velayudham and R. Balasubramanian (1992). Effect of split application of potassium to lowland rice on NPK uptake and yield. Orissa J. of Agric. Res., 5(3): 162-165.
Venkitaswamy, R.; C.S. Sridharan; R. Madhiyazhagan and N.K. Prabhakaran (1997). Split application of nitrogen and potassium to MGR hybrid rice. Madras Agric. J., 84(1): 43-44.
Wang Yang Rui and J.X. Zou Die (1997). Effect of N and K supply at the initial stage of panicle emergence on physiological traits in the flag leaf of hybrid rice Shan Xou 63. Chinese J. of Rice Sci., 11(3): 165-169.
Yang, X.E. and X. Sun (1991). The physiological effect of nitrate or ammonium top dressing on hybrid and conventional rice cultivars at the late growth stage. Acta Agronomic Sinica 17(14): 283-291.
Yoshida, S.; D.A. Forno; J.H. Cock and K.A. Gomez (1972). Laboratory manual for physiological studies of rice. IRRI, Philippines.
Zayed, B.A. (2002). Performance of some rice cultivars as affected by irrigation and potassium fertilizer treatments under saline soil conditions. Ph.D. Thesis, Agronomy Dept. Faculty of Agric., Mansoura University.

تأثير اضافة كل من النتروجين والبوتاسيوم علـــى دفعــات علـــى الارز الهجـــين SK2047

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أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بسخا ضمن برنامج الارز وذلك لايجاد افــضل مواعيد اضافة لكل من النتروجين والبوتاسيوم على النمو ومحصول الارز الهجين للصنف SK2047 وذلك خلال موسمى الزراعة ٢٠٠٧ ، ٢٠٠٨ وكان التصميم المستخدم هو القطع المنشقة مرة واحدة حيث احتوت القطع الرئيسية على ثلاث مواعيد اضافة للتسميد الازوتى (١٦٥ كجم/هكتار) وهـــى: ٣/٢ الكميــة علـــى الشراقى + ٣/١ عند مرحلة تكوين النورة (N_1) ، ٣/١ الكمية على الشراقى + ٣/١ عند مرحلــة التفريــغ المتوسط + ٣/١ عند مرحلة تكوين النورة (N_2) ، ٢/١ الكمية على الشراقى + ٤/١ عند مرحلــة التفريــع المتوسط + ٤/١ عند مرحلة تكوين النورة (N_3) ــ أما مواعيد اضافة البوتاسيوم (٦٠ كجم/هكتــار) فهـــى: بدون اضافة K_1 ، دفعه واحدة ارضى (١٠٠% على الشراقى K_2) ، اضافة على دفعتين متساويتين (٥٠% ارض على الشراقى + ٥٠% عند التفريع المتوسط K_3) ، ثلاث دفعــات (٥٠% ارض علـــى الـــشراقى + ٢٥% عند التفريع المتوسط + ٢٥% عند مرحلة بداية تكوين النورة K_4) ، اربعة دفعات متــساوية (٢٥% ارض على الشراقى + ٢٥% عند التفريع المتوسط + ٢٥% عند تكوين النورة + ٢٥% عند الطــرد K_5) وقد وزعت معاملات التسميد البوتاسى فى القطع المنشقة عشوائيا وتتلخص اهم النتائج فيما يلى:

- بالنسبة لمواعيد اضافة النتروجين: وجد ان الاضافة على ثلاث دفعات متساوية (٣/١ على الــشراقى + ٣/١ عند التفريع المتوسط + ٣/١ عند مرحلة تكوين النورة (N_2) هى الافضل حيث تفوقت معنويا عن

باقى المعاملات وأعطت أعلى القيم لكل من المادة الجافة ومعدل المساحة الورقية وعـدد السنابل/ م٢ والنسبة المئوية للحبوب الممتلئة للنورة. ووزن النورة — ووزن الالف حبه ومحصول الحبوب ومعامل الحصاد ومحتوى النتروجين والبوتاسيوم فى الاشطاء عند مرحلة الطرد. وكانت اقل القيم فـى اغلـب الصفات السابقة عند اضافة التسميد الازوتى على دفعتين (N_1).

- بالنسبة لتأثير اضافة البوتاسيوم على دفعات: فقد وجد تـأثيرا معنويا لاضـافته للصنف الهجين SK2047 بالمقارنـة بعدم الاضـافة (الكنترول K_1) لجميع الصفات التـى تم دراستها بمـا فيها محصول الحبوب. قد سجلت المعاملة (K_4): ٥٠% ارضى على الشراقى + ٢٥% عند التفريـع المتوسط + ٢٥% عند تكوين النـورة. اعلـى القيم فـى اغلب الصفات محل الدراسـة وكذلك محصول الحبـوب للهكتـار تليها اضافة البوتاسيوم على اربع دفعات متساوية (K_5): ٢٥% ارض على الشراقى + ٢٥% عند التفريـع المتوسط + ٢٥% عند تكوين النورة + ٢٥% عند الطـرد بينمـا سـجلت المعاملـة (K_1) بدون اضـافة اقل القيم لجميـع الصفات محل الدراسة بما فيها محصول الحبوب.
- أظهرت النتائج ان هناك تأثيرا معنويا نتيجه تفاعل اضافة كل من النتروجين والبوتاسيوم علـى دفعات علـى صـفتى النسبة المئويـة للحبوب الممتلئـة ومحتوى البوتاسيوم فـى الاشطاء فـى مرحلة الطـرد وذلك لموسم ٢٠٠٧.
- توصـى الدراسـة بانـه للحصـول علـى اعلـى انتاجيـة من صـنف الارز الهجين SK2047H يجب اضـافة النتروجين علـى ثـلاث دفعـات متساوية وهـى ثلـث الكميـة الموصـى بهـا علـى الشراقى قبل الشتل والثلث الثانى عند التفريغ المتوسط والثلث الاخير عند بداية تكوين النوره بالاضـافة الى التسميد البوتاسـى وتجزئتـه ايضا علـى ثـلاث دفعـات وهـى: ٥٠% من الكميـة الموصـى بهـا علـى الشراقى وقبل الشتل + ٢٥% من الكمية عند مرحلة التفريغ المتوسط + ٢٥% الاخيره عند بداية مرحلة تكوين النورة.

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