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INFLUENCE OF SEEDLING AGE AND NITROGEN FERTILIZER LEVELS ON GROWTH, GRAIN YIELD, N-UPTAKE AND N-USE EFFICIENCY OF HYBRID RICE VARIETIES.

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ABSTRACT

Two field experiments were conducted at Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt, in 2008 and 2009 growing seasons. The objective of this research was aimed to find out the optimum seedling age and nitrogen levels to obtain maximum production of hybrid rice varieties under normal soil. Growth analysis, grain yield and its components, N-uptake and nitrogen use efficiency were determined. The most important obtained results could be summarized as follows:

In both seasons, SK2034H hybrid rice variety significantly exceeded SK2058H variety. and recorded the highest dry matter production, plant height, number of panicles/m^2, number of spikelets/panicle, number of filled grains (%), panicle weight, grain yield, N content, N-uptake for grains and straw and N-use efficiency (NUE).

25 day old seedlings had higher values of dry matter (DM), leaf area index (LAI), plant height, grain yield, harvest index (HI), and most of its attributes, nitrogen content, N-uptake, and use efficiency (NUE) than old seedlings 35 or 40 day old. The minimum values of these traits were obtained when plants were transplanted with 40 day old seedlings.

Increasing nitrogen fertilizer levels significantly improved growth, yield and its components. Each unit increase in N-levels led to a significant increase in all these traits. Nitrogen use efficiency (NUE) was significantly higher at lower N levels and decreased significantly with increasing N fertilizer levels. On the other hand, N-content and N-uptake for grain and straw yields significantly increased by increasing the nitrogen fertilizer level up to 220 kg N/ha.

The interaction between hybrid rice varieties and seedling age significantly affected dry matter, panicle weight, 1000-grain weight, grain yield and N-uptake for grains. A significant interaction effect between hybrid rice varieties and N fertilizer levels for dry matter, grain yield and N-uptake for grains. The interaction between seedling age and nitrogen levels significantly affect dry matter, number of spikelets/panicle and grain yield.

It could be concluded that hybrid rice varieties must be transplanted with seedling, 25 days old, fertilized at a rate of 220 kg N/ha in three equal splits to get maximum grain yield per unit area.

INTRODUCTION

Rice is an important food crop in Egypt for local consumption, as well as, the demand for increasing population. It contributes about 20% to the main cereal consumption. Grain yield of rice depends on its genetic potential, agro-climatic conditions and various cultural practices. Introducing hybrid rice is one way to improve rice grain yield by exploiting the heterosis in the F_1 hybrid. Hybrid rice varieties can out yield conventional varieties by about 15-

20% under the same input levels (Lin 1994). Gu *et al*. (1991) reported that in general hybrid rice had strong tillering ability, high harvest index, short vegetative growth period, long grain-filling period, high grain yield potential and bigger sink size, as compared to inbred rice. Also, Song *et al.* (1990) observed that greater carbohydrate translocation occurred from vegetative parts to the spikelets and larger leaf area index (LAI) during the grain-filling period. Specific characteristics of the uptake and physiology of nitrogen in hybrid rice appear to play a key role in this. Moreover, Singh (2002) and Gautam (2004) reported a significant better growth performance of rice hybrids than conventional varieties, particularly LAI, DM and grain filling. In addition, Patil *et al.* (2003), Gautam (2004) and Gorgy (2007) observed superiority of rice hybrid over inbred one in panicles number/plant, number of filled grains/panicle, panicle weight, 1000-grain weight, straw and grain yield and harvest index. Yang *et al.* (1999), Kumar *et al.* (2002) and Sing (2002) stated that rice hybrids had higher N-uptake and nitrogen use efficiencies (NUE) than those of inbred rice.

Agronomic management of hybrid rice considerably differ from the conventional varieties. So, appropriate age of seedlings is essential for obtaining uniform stand establishment. Transplanting of aged seedlings caused heavy reduction in grain yield and its components since the latter depend very much on age of seedlings used in transplanting (Mandal *et al.*, 1984). When seedlings stay longer in seed bed, primary tiller buds on the lower nodes are easily degenerated and primary tiller buds of the 4^{th} to 7^{th} nodes are held inside at the 7^{th} leaf age (Matsuo and Hoshikawa, 1993). Roy and Sattar (1992) observed more absolute tillering rate in younger seedlings and as the seedling age increased, the tillering rate decreased. They, also, stated that, within a variety, the number of total tillers decreased with older seedlings. Chandrakar and Chandravanshi (1988) reported that panicle weight was higher in 25 day old seedlings than 45 day old ones. On the other hand, Banik *et al*. (1997) found that 40- and 50-day old seedlings gave the maximum grain yield, compared with 30 day old seedlings in aberrant weather conditions.

Nitrogen fertilizer is the most important agronomic factor. Nitrogen is a constitute of all protein and non-protein components in rice. Suitable doses of N promote rapid growth and increase spikelets number/panicle, and number of filled grains%. Thus, N affects all parameters contributing to grain yield. The efficient N absorption might differ due to seedling age, then, the young seedlings have ability to absorb more N than old ones. Gautam (2004) stated that increasing nitrogen fertilizer levels up to 165 or 225 kg N/ha significantly increased LAI, DM, plant height and number of tillers/plant. RRTC (2004) showed that 1000-grain weight, number of grains/panicle, Number of panicles/m^2 and grain yield were significantly increased by increasing N-levels up to 92 kg N/fad. Shivay and Singh (2003) and Gautam (2004) found that increasing nitrogen rates raised the main grain yield components of rice, i.e. panicle numbers/plant, number of grains/ panicle, panicle weight, 1000-grain weight, grain and straw yields and harvest index. Meena *et al.* (2002) and Shivay and Singh (2003) indicated that increasing nitrogen rate increased nitrogen N-uptake, while the nitrogen use efficiencies (NUE) decreased.

The main objective of this research was aimed to find out the optimum seedling age and N fertilizer levels to obtain the maximum production of hybrid rice varieties under normal soil conditions.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt, in 2008 and 2009 summer seasons to study the influence of seedling age and nitrogen fertilizer levels on growth, grain yield, N-uptake and nitrogen use efficiency (NUE) of hybrid rice varieties under normal soil. The chemical analysis and physical properties of experimental soil were presented in Table (1). The preceding winter crop was Egyptian clover in both seasons. The experiment was performed in a split split plot design, with four replications. The main plots were occupied by the two hybrid rice varieties i.e. SK2034H and SK2058H, the four seedling ages (25, 30, 35 and 40 days) were arranged in the sub plots. While, the sub-sub plot contained the four nitrogen fertilizer levels i.e.; 0, 110, 165 and 220 kg N/ha.

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

Seasons	Soil texture	Properties									
		Sandy (%)	Clay (%)	Silt (%)	O.M. (%)	pH	EC (dS/m)	Available (ppm)			
								N	P	K	Zn
2008	Clay	12.5	55.3	32.2	1.51	8.16	2.75	17	16	325	0.84
2009	Clay	13.8	56.0	30.2	1.60	7.82	2.63	19	14	332	0.90

Seedlings from the different nurseries were pulled out according to the assigned four ages and two seedlings/hill were transplanted in 20 x 20 cm spacing into 15 m^2 size. The nitrogen fertilizer in the form of urea (46.5% N) and was applied in three equal doses (1/3 basal into the dry soil before flooding, 1/3 at mid-tillering stage and 1/3 at panicle initiation). All plots were given 36 kg P_2O_5/ha during land preparation and 50 kg K_2O/ha were applied two equal doses in dry soil before flooding and before panicle initiation. Zinc sulphate (24 kg $ZnSO_4$/ha) was mixed with fine soil and broadcasted in flooded soil before transplanting and the rest of cultural practices were followed as recommended. At heading (50% heading), five hills from sub-sub plots were taken to determine the dry matter and leaf area index (LAI). At harvesting, plant height are measured from soil surface up to the top of the main panicle. Ten random hills from sub-sub plots were collected to determine the number of panicles/m^2, and ten panicles were chosen estimate the number of spikelets/panicle, % of filled grains, panicle weight and 1000-grain weight. Ten square meters of each sub-sub plot was harvested, dried and threshed to estimate the grain yield. The grain yield was adjusted to 14% moisture content and converted into ton/ha. Harvest index (HI) was estimated according to the following equation:

$$HI = \text{Economic yield (t/ha)}/\text{biological yield (t/ha)}$$

Where, economic yield is the actual grain yield and biological yield is the total yield of grain plus straw yield. Dried grain and straw from each sub-sub plot were ground and analysis. Nitrogen content was determined using Microkjeldahl method. The uptake of nitrogen (kg/ha) was calculated as the computation from the percentage of the element in the plant and total dry matter. Nitrogen use efficiency (NUE) was estimated using the following according to Mikkelsen (1987):

NUE = Grain yield in treated plots (kg/ha) – grain yield in control plots (kg/ha)/amount of N applied (kg/ha)

All the collected data were statistically analyzed with IRRISTAT program and the differences among the treatments mean were computerized by M-state using Duncan, 1955 multiple range test at 5% level and as described by Gomez and Gomez, 1984.

RESULTS AND DISCUSSION

A- Growth characters:

Means of dry matter content, LAI, number of days to heading and plant height as affected by varieties, seedling age and nitrogen fertilizer levels as well as their interactions in 2008 and 2009 seasons are presented in Table (2).

In both seasons, the results indicated that significant differences existed between the two hybrid rice varieties for dry matter content, number of days to heading and plant height. In general, SK2034H significantly surpassed SK2058H in dry matter, and plant height While, SK2058H was earlier in heading time than SK2034H by about four days in both seasons. The results showed insignificant differences existed between the two hybrid rice varieties for LAI. Such differences could be attributed to these genetic contribution. Yamauchi (1994) reported that more DM accumulation in hybrid rice was due to root activity of F_1 hybrids.

Dry matter, LAI, heading date and plant height were significantly affected by the age of seedlings as shown in Table (2). Transplanting seedlings of 25 day old recorded significant increases DM, LAI and plant height while 40 day old seedlings gave the longest period to heading. Transplanting seedlings of 25 day old recorded highest number of tillers compared with other old seedlings (Song *et al*., 1990) and Gautam (2004). So, DM at 25 day old seedlings gave the highest values compared with the other treatments.

Nitrogen fertilizer levels significantly influenced the growth characters in both seasons (Table 2). Increasing N-fertilizer rates from zero up to 220 kg N/ha caused linear increases for the studied growth characters; DM, LAI and plant height. Increasing nitrogen fertilizer levels up to 220 kg N/ha significantly increased number of days to heading. Such result could be ascribed to the effect of nitrogen fertilizer in enhancing rice plant vegetative growth and hence delaying flowering. Ebaid and El-Mowafy (2005) and Ebaid and Abou-Yousef (2006) found similar results. The favourable effect of increasing N fertilizer levels on rice LAI was reported by Kreem (1993) and Gautam (2004). They found that increasing N-fertilizer rates increased LA due to increases in number of tillers and/or size of leaf per plant.

Table 2: Dry matter (g/m^2), leaf area index (LAI), heading date (days) and plant height (cm) of two hybrid rice varieties as affected by seedling ages, N fertilizer levels during 2008 and 2009 seasons.

Characters / Treatments	Dry matter		LAI		Heading date		Plant height	
	2008	2009	2008	2009	2008	2009	2008	2009
Varieties (V):								
SK2034H	1293.47 a	1414.53 a	5.03	6.17	98.02 a	99.23 a	108.08 a	109.18 a
SK2058H	1123.27 b	1233.44 b	4.91	5.87	94.43 b	93.15 b	106.00 b	106.28 b
F-test	**	**	NS	NS	**	**	**	**
Seedling ages (A):								
25 days	1359.66 a	1473.94 a	5.25 a	6.23 a	94.04 d	93.96 d	111.12 a	111.93 a
30 days	1250.47 b	1366.65 b	5.07 b	6.17 b	95.09 c	94.99 c	107.95 b	108.73 b
35 days	1139.38 c	1255.00 c	4.87 c	5.99 c	96.92 b	96.80 b	105.56 c	106.62 dc
40 days	1083.97 d	1200.38 d	4.71 d	5.64 d	98.84 a	99.01 a	103.53 d	103.63 d
F-test	**	**	**	**	**	**	**	**
N-levels (kg/ha) (N):								
0	821.97 d	856.66 d	3.02 d	3.72 d	93.73 d	93.81 d	97.17 d	96.78 d
110	1152.59 c	1293.16 c	3.56 c	4.92 c	96.21 c	96.02 c	108.37 c	109.14 c
165	1373.03 b	1517.19 b	6.39 b	7.59 b	97.03 b	96.94 b	110.43 b	111.66 b
220	1485.88 a	1628.94 a	6.93 a	7.85 a	97.92 a	98.00 a	112.19 a	113.34 a
F-test	**	**	**	**	**	**	**	**
Interactions:								
V x A	*	*	NS	NS	NS	NS	NS	NS
V x N	**	**	NS	NS	NS	NS	NS	NS
A x N	**	**	NS	NS	NS	NS	NS	NS
V x A x N	NS	NS	NS	NS	NS	NS	NS	NS

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

While, the control plots recorded the lowest values in those traits. These results could be attributed to the role of nitrogen, that applied to rice plants in increasing the efficiency of photosynthesis process and, consequently, the metabolism in plants. However, the dry matter weight, at heading showed a quadratic relationship with the final grain yield but the dry matter accumulation after heading showed a linear correlation with the grain yield (Ling *et al*., 1994). So, nitrogen absorption from 30 days before heading (DBH) to heading was more important for enlarging the grain yield sink than other stages.

B- Grain yield and its attributes:

Results presented in Table (3) clearly indicated that hybrid SK2034H produced a significantly higher number of panicles/m^2, number of spikelets/ panicle and filled grains (%) compared with SK2058H. These results were expected and could be explained on the basis that hybrids have stronger and more active root systems at early and middle growth stages, having 21-34% higher root ability at seedling stage (Cheng *et al*. 1989). Hybrid rice SK2034H confirmed its superiority in early vegetative growth resulting high dry matter and leaf area index which led to improvement a great main grain yield components namely; number of panicles, number of spikelets and filled grain (%) that finally mainly attributed to higher grain yield, as it will be observed in grain yield.

Table 3: Number of panicles/m^2, number of spikelets/panicle and filled grains % of two hybrid rice varieties as affected by seedling age, N levels during 2008 and 2009 seasons

Characters / Treatments	Number of panicles/m^2		Number of spikelets/panicle		Filled grains (%)	
	2008	2009	2008	2009	2008	2009
Varieties (V):						
SK2034H	505.76 a	536.49 a	171.04 a	165.42 a	90.63 a	89.61 a
SK2058H	480.18 b	515.93 b	154.10 b	156.28 b	89.80 b	88.90 b
F-test	**	**	**	**	*	*
Seedling ages (A):						
25 days	560.24 a	593.22 a	171.74 a	169.56 a	92.10 a	91.04 a
30 days	520.86 b	556.06 b	169.46 a	167.16 a	91.47 a	90.37 a
35 days	475.33 c	511.47 c	162.49 b	160.69 b	89.66 b	88.85 b
40 days	415.45 d	443.28 d	146.59 c	145.64 c	87.64 c	86.80 c
F-test	**	**	**	**	**	**
N-levels (kg/ha) (N):						
0	301.06 d	348.66 d	137.73 d	135.76 d	88.39 c	87.33 c
110	503.73 c	537.84 c	152.34 c	150.37 c	89.81 b	88.90 b
165	567.49 b	595.75 b	170.70 b	168.78 b	91.18 a	90.17 a
220	599.60 a	621.78 a	189.52 a	188.15 a	91.48 a	90.65 a
F-test	**	**	**	**	**	**
Interactions:						
V x A	NS	NS	NS	NS	NS	NS
V x N	NS	NS	NS	NS	NS	NS
A x N	NS	NS	**	**	NS	NS
V x A x N	NS	NS	NS	NS	NS	NS

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

The effect of seedling age on number of panicles/m^2, number of spikelets/panicle and filled grains (%) was highly significant in both seasons (Table 3). Transplanting seedlings at 25 day old significantly recorded highest number of panicles/m^2, Number of spikelets/panicle and filled grains (%), followed by seedling age at 30 days. While, seedlings at 40 days gave the lowest significant value in all these traits. Roy and Sattar (1992) and Matsuo and Hoshikawa (1993) found that when seedlings are transplanted at the right time, tillering and growth proceeded normally, while, when seedlings stayed longer in seedbed, primary tiller buds of the 4th to 7th nodes were held inside at the 7th leaf age. These results agreed with those of Sing and Singh (1998) and Abou Khalifa *et al*. (2005).

Concerning the effect of N fertilizer levels on these traits, results show that nitrogen exerted significant increases in number of panicles/m^2, number of spikelets/panicle and filled grains (%) up to 220 kg/ha in both seasons. The treatment of zero nitrogen application recorded the lowest values of these yield attributes. The obtained improvement in the grain yield attribute, as a result of increasing nitrogen fertilizer, might be due to the increased accumulation of photosynthates from source to sink and during grain filling as well as delaying leaf senescence. These results are in harmony with those of Singh and Singh (1998), Shivay and Singh (2003) and Gautam (2004).

Results in Table (4) showed that highly significant differences were observed between the two tested hybrid rice varieties for some traits, except for HI. Where, SK2034H surpassed SK2058H in panicle weight and grain yield. Concerning 1000 grain weight, SK2058H grains were significantly heavier than those of SK2034H in both seasons. The trend of results was similar to those of Abou Khalifa *et al*. (2005).

Table 4: Panicle weight, 1000-grain weight, grain yield and harvest index of two hybrids rice varieties as affected by seedling ages, N fertilizer levels **and their interactions** during 2008 and 2009 seasons.

Characters / Treatments	Panicle weight (g)		1000-grain weight (g)		Grain yield (t/ha)		Harvest index (HI)	
	2008	2009	2008	2009	2008	2009	2008	2009
Varieties (V):								
SK2034H	4.47 a	4.53 a	24.32 b	23.66 b	10.98 a	11.20 a	0.449	0.450
SK2058H	4.11 b	4.18 b	25.42 a	24.68 a	10.18 b	10.34 b	0.445	0.442
F-test	**	**	**	**	**	**	NS	NS
Seedling ages (A):								
25 days	4.62 a	4.68 a	25.43 a	24.80 a	11.52 a	11.81 a	0.465 a	0.461 a
30 days	4.53 a	4.60 a	25.24 a	24.48 a	11.39 a	11.55 b	0.460 a	0.458 a
35 days	4.09 b	4.16 b	24.75 b	24.02 b	10.35 b	10.54 c	0.441 b	0.440 b
40 days	3.91 c	3.95 c	24.06 c	24.40 c	9.06 c	9.19 d	0.422 c	0.424 c
F-test	**	**	**	**	**	**	**	**
N-levels (kg/ha) (N):								
0	3.67 d	3.73 d	23.75 d	23.11 d	6.64 d	6.67 d	0.396 d	0.403 d
110	4.26 c	4.35 c	24.76 c	24.05 c	11.00 c	11.20 c	0.431 c	0.433 c
165	4.52 b	4.60 b	25.33 b	24.63 b	11.99 b	12.22 b	0.472 b	0.465 b
220	4.78 a	4.76 a	25.64 a	24.90 a	12.69 a	12.99 a	0.492 a	0.484 a
F-test	**	**	**	**	**	**	**	**
Interactions:								
V x A	**	**	*	*	**	**	NS	NS
V x N	NS	NS	NS	NS	**	**	NS	NS
A x N	NS	NS	NS	NS	**	**	NS	NS
V x A x N	NS	NS	NS	NS	NS	NS	NS	NS

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

In both seasons, SK2034H hybrid rice significantly outyielded SK2058H and their mean values were 10.98 and 10.18 t/ha, in 2008, and 11.20 and 10.34 t/ha in 2009, respectively. Such differences could be attributed to grain yield components; viz, number of panicles/m^2, Number of spikelets/panicle, filled grains (%) and panicle weight, as mentioned before.

Regarding the effect of seedling ages, results in Table (4) showed that highly significant differences were observed among different seedling age in panicle weight, 1000-grain weight, grain yield and harvest index in both seasons. Where, seedlings at 25 day old gave the highest values of these traits followed by seedling age at 30 days. However, the differences were not significant between the two ages for panicle weight, 1000-grain weight and HI, in both seasons and grain yield at 2008. While, old seedlings (35 and 40 days) gave the lowest significant values of those traits. The obtained data are in conformity with those decided by Islam and Ahmed (1981) who reported that seedlings 30 day old gave higher grain yield than 20 or 40 day old seedlings. Also, Singh and Singh (1998) and Abou Khalifa *et al*. (2005) found that transplanting seedlings at 25 day old gave the highest grain yield. These results mean that seedlings 25 day old were the optimum age to transplanting hybrid rice varieties to get the maximum grain yield, under study.

Concerning N levels effect, results in Table (4) indicated that increasing levels of nitrogen up to 220 kg/ha highly significantly increased panicle weight, 1000-grain weight, grain yield and harvest index. The obtained data are in agreement with those reported by RRTC (2004). This might be due to increased accumulation of photosynthates from source of sink with increased levels of nitrogen fertilizer. These results agreed with those of Behra (1998), Singh and Singh (1998) and Kumura (1995) who concluded that the grain yield of new cultivars was more dependent on the translocation of carbohydrates stored before heading. However, the dry matter weight at heading showed a quadratic relationship with the final grain yield and the DM accumulation after heading showed a linear correlation with the grain yield (Ling *et al*., 1994).

C- Nitrogen content (%), N-uptake (kg/ha) and nitrogen use efficiency (NUE)

Nitrogen content (%), N-uptake by grains and straw and NUE as affected by hybrid rice varieties, seedling age, N fertilizer levels as well as their interactions in both seasons are presented in Table (5).

Results indicated that highly significant differences were observed between the two varieties for N-content (%), N-uptake for grains and straw and NUE (Table 5). In general, SK2034H hybrid significantly surpassed SK2058H in all these traits. These results might be attributed to the fact that, SK2034H had active root system and a high root absorbing area, compared with SK2058H.

The effect of seedling age on N-content, and uptake and NUE was almost highly significant in both seasons (Table 5). Where, young seedlings gave the highest values of these traits. It may be due to higher root absorption of nitrogen for young seedlings. So, young seedlings grew vigorously (Chandrakar and Chandravanshi, 1988). Also, Prasad *et al*. (1992) and Singh and Singh (1998) mentioned that nitrogeN-uptake was reduced with an increase in age of seedlings and was the highest with the use of young seedlings for transplanting.

Furthermore, nitrogen levels had almost a highly significant effect on N-content, and uptake and NUE (Table 5). Data indicated that N content and uptake in rice grains and straw significantly increased with the application of nitrogen and reached its maximum values with the highest rates of nitrogen (220 kg N/ha) in both seasons. Similar data had been emphasized by Hari *et al*. (1998). Increasing N content could be attributed to the role of N metabolism in rice plant (Meena *et al*. 2002). Shivay and Singh (2003) reported similar results and mentioned that increasing N fertilizer rates increased N content and total nitrogeN-uptake in rice plants. Moreover, nitrogen fertilizer levels had significant effect on NUE. Application of 110 kg N/ha recorded NUE of 39.60 and 41.15 during 2008 and 2009, respectively. While application of 220 kg N/ha showed lesser NUE of 27.46 and 28.73 during 2008 and 2009, respectively (Table 5). Similar findings were reported by Singh *et al*. (2004) and Gorgy (2010).

D- Interaction effect:

The interaction was significant between hybrid rice varieties and seedling ages for DM accumulation in both seasons (Tables 2 and 6). The combination of SK2034H hybrid rice variety and 25 day old seedlings gave the maximum value of DM accumulation. While, the lowest value of DM was obtained when SK20-58H was transplanted with 40 day old seedlings. The interaction between the two hybrid rice varieties and N-levels had a significant markedly effect on DM in both seasons (Tables 2 and 7). Data showed that the highest value of DM was produced by SK2034H when it was fertilized with 220 kg N/ha. Besides a significant effect due to the interaction between seedling ages and N levels, was detective on dry matter. Result in Tables (2 and 8), showed that the best combination between seedling age and N levels for DM was transplanting 25 day old seedlings under 220 kg N/ha. In contrast, the lowest DM was obtained when 40 day old seedlings were transplanted and no N-fertilizer was added. That was true in the two seasons. The other interactions were not significant (Table 2)

The interaction between seedling ages and nitrogen levels had a highly significant effect on number of spikelets/panicle in both seasons (Tables 3 and 8). The combination of seedlings 25 day old and highest N fertilizer level (220 kg/ha) gave the maximum number of spikelets/panicle. While, the lowest values were obtained when seedlings transplanting at 40 day old was grown without nitrogen application.

The interaction between hybrid rice varieties and seedling ages had either significant or highly significant effects on panicle weight, 1000-grain weight and grain yield (Tables 4 and 6). The combination of SK2034H and seedlings at 25 day old gave the maximum values of panicle weight without no significant differences with 30 day old seedlings. The lowest values of panicle weight was obtained when SK2058H was transplanted with 40 day old seedlings. The interaction between hybrid rice varieties and seedling age had a significant effect on 1000-grain weight in both seasons. The heaviest 1000-grain weight was produced by SK2058H when transplanted with young seedlings (25 and/or 30 days). The lowest value of 1000-grain weight was obtained by the combination of SK2034H and 40 day old seedlings. The interaction between hybrid rice varieties and seedling age had significant effects on grain yield in both seasons. The highest grain yield (11.86 and 12.19 t/ha) in 2008 and 2009 seasons, respectively was obtained by SK2034H hybrid variety when transplanted with 25 day old seedlings. While, the lowest grain yield was obtained when SK2058H was transplanting with old seedlings (40 day). The interaction between hybrid rice varieties and N levels had significant effects on grain yield in both seasons (Tables 4 and 7). The highest grain yield (13.33 and 13.66 t/ha) in 2008 and 2009, respectively, was obtained by SK2034H hybrid when fertilized with the highest N level (220 kg /ha).

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The interaction between seedling ages and N fertilizer levels had a significant effect on grain yield in both seasons (Tables 4 and 8). The highest grain yield was obtained by transplanting seedlings at 25 day old and fertilized with 220 kg N/ha with insignificant differences with seedlings at 30 day old. The minimum values of grain yield were registered under 40 day old seedlings and zero N-fertilizer.

The interaction between hybrid rice varieties and seedling ages had highly significant effects on N-uptake for rice grains (Tables 5 and 6). The combination of SK2034H and seedlings at 25 day old gave the maximum values of N-uptake without no significant differences with 30 day old seedlings. These results are in harmony with Singh and Singh (1998). The interaction between hybrid rice varieties and N-fertilizer levels had a highly significant effect on N-uptake for rice grains in both seasons (Tables 5 and 7).

Table 7: Means of dry matter (g/m^2), grain yield (t/ha) and N-uptake of grains (kg/ha) as influenced by the interaction between hybrid rice varieties and seedling ages during 2008 and 2009 seasons.

Varieties	N-levels (kg/ha)	Dry matter (g/m^2)		Grain yield (t/ha)		N-uptake (kg/ha)	
		2008	2009	2008	2009	2008	2009
SK2034H	0	871.1 f	910.9 f	6.74 f	6.80 f	55.80 g	54.37 f
	110	1229.1 d	1376.1 d	11.26 d	11.50 d	140.54 e	136.80 d
	165	1477.4 b	1626.9 b	12.60 b	12.85 b	168.62 b	163.91 b
	220	1596.1 a	1744.0 a	13.33 a	13.66 a	186.6 a	179.86 a
SK2058H	0	772.8 g	802.3 g	6.53 f	6.54 f	54.67 g	51.80 f
	110	1076.0 e	1210.1 e	10.75 e	10.90 e	130.91 f	128.76 e
	165	1268.6 d	1407.4 d	11.38 d	11.60 d	150.40 d	146.64 c
	220	1375.5 c	1513.8 c	12.05 c	12.33 c	163.23 c	162.07 b

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

Table 8: Means of dry matter (g/m^2), Number of spikelets/panicle and grain yield (t/ha) as influenced by the interaction between seedling age and N levels during 2008 and 2009 seasons.

Seedling age (day)	N-levels (kg/ha)	Dry matter (g/m^2)		Number of spikelets/ panicle		Grain yield (ton/ha)	
		2008	2009	2008	2009	2008	2009
25	0	919.13 i	959.5 i	140.4 g	138.0 i	7.03 j	7.19 j
	110	1252.25 de	1384.0 e	160.3 de	157.6 fg	12.05 ef	12.31 ef
	165	1577.3 b	1721.5 b	183.0 bc	179.5 bc	13.16 bc	13.43 bc
	220	1689.8 a	1830.7 a	204.0 a	202.9 a	13.84 a	14.32 a
30	0	867.8 i	901.8 i	142.6 g	139.9 i	7.20 j	7.06 jk
	110	1173.1 fg	1316.5 fg	154.1 de	151.7 g	11.84 f	12.11 f
	165	1420.5 c	1564.8 c	178.6 c	175.9 cd	12.86 cd	13.09 cd
	220	1540.3 b	1683.2 b	202.5 a	200.9 a	13.66 ab	13.92 ab
35	0	771.0 j	803.6 j	139.8 g	137.6 i	6.44 k	6.55 k
	110	1115.0 gh	1259.0 gh	151.5 ef	149.9 gh	10.65 gh	10.81 gh
	165	1270.1 de	1414.2 de	169.7 de	168.0 de	11.82 f	12.05 f
	220	1401.3 c	1543.1 c	188.8 b	187.1 b	12.48 de	12.73 de
40	0	729.8 j	761.63 j	128.0 h	127.3 j	5.87 L	5.88 L
	110	1070.0 h	1213.1 h	143.3 fg	142.1 hi	9.46 i	9.56 i
	165	1224.1 ef	1368.1 ef	152.3 e	151.5 g	10.14 h	10.32 h
	220	1311.8 d	1458.6 d	162.6 d	161.5 ef	10.77 g	11.00 g

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

SK2034H hybrid gave the highest values of N-uptake when it received the highest N-fertilizer level (220 kg/ha). On the other hand, SK2058H recorded the minimum value of N-uptake when it received zero nitrogen application. These results agree with those of Shivay and Singh (2003).

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تأثير عمر الشتلة ومستويات التسميد النيتروجينى على النمو ومحصول الحبوب وامتصاص النيتروجين وكفاءة استخدام النيتروجين لأصناف الأرز الهجين رفعت

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أقيمت تجربتان حقليتان بالمزرعة البحثية لمركز البحوث والتدريب فى الأرز بسخا كفرالشيخ فى موسمى صيف ٢٠٠٨ و٢٠٠٩م بهدف إيجاد أمثل عمر للشتلة ومستوى التسميد النيتروجينى للحصول على أعلى إنتاجية من أصناف الأرز الهجين. واستخدم فى الدراسة الصنفان الهجينان " SK2058H, SK2034H" وأربعة أعمار لشتلات الأرز وهى: ٢٥ و ٣٠ و ٣٥ و ٤٠ يوماً. وأربعة مستويات من التسميد النيتروجينى: صفر و ١١٠ و ١٦٥ و ٢٢٠ كيلو جرام نيتروجين للهكتار.

ويمكن تلخيص أهم النتائج فيما يلى:

أوضحت النتائج أنه توجد فروق معنوية بين صنفى الأرز الهجين المختبرة فى معظم صفات النمو ومحصول الحبوب ومكوناته والقياسات الأخرى حيث تفوق الهجين "SK2034H" معنويا فى صفات المادة الجافة وارتفاع النبات وكذلك عدد الداليات للمتر المربع وعدد السنيبلات فى الدالية والنسبة المئوية للحبوب الممتلئة ووزن الدالية ومحصول الحبوب وأيضا النسبة المئوية للنيتروجين فى الحبوب والقش وكذلك امتصاص النيتروجين فى الحبوب والقش وكذلك تفوق فى كفاءة استخدام النيتروجين. بينما سجل الصنف الهجين "SK2058H" أقل عدد من الأيام من الزراعة حتى الطرد وكذلك أعلى قيمة لوزن الألف حبة.

أشارت النتائج إلى تفوق عمر الشتلة الصغيرة (٢٥ يوماً) معنويا على الأعمار الأكبر أعطت أعلى القيم للمادة الجافة ودليل مساحة الورقة واتفاع النبات وأيضا محصول الحبوب وأغلب مكوناته والنسبة المئوية لمحتوى النيتروجين وامتصاص النيتروجين فى الحبوب. ولم تظهر فروق معنوية بين عمرى الشتلات الصغيرة (٢٥ و٣٠ يوماً) فى بعض مكونات محصول الحبوب وامتصاص النيتروجين فى القش وكفاءة استخدام النيتروجين.

أظهرت النتائج زيادة معنوية فى صفات النمو (المادة الجافة ـ دليل مساحة الورقة ـ ارتفاع النبات و تأخر الطرد) وكذلك فى محصول الحبوب ومكوناته وذلك بزيادة إضافة النيتروجين من صفر حتى ٢٢٠ كيلو جراماً/هكتار. تلاحظ أنه بزيادة معدلات التسميد النيتروجينى تزداد النسبة المئوية للنيتروجين فى الحبوب والقش وكذلك امتصاص النيتروجين بينما حدث العكس فقلت كفاءة استخدام النيتروجين بزيادة إضافة معدلات التسميد النيتروجينى وذلك فى كلا الموسمين.

أوضحت النتائج أن هناك تأثيرا معنويا نتيجة للتفاعل بين صنفى الأرز الهجين وعمر الشتلة فى تكوين المادة الجافة ووزن الدالية ووزن الألف حبة ومحصول الحبوب وامتصاص النيتروجين فى الحبوب. أيضا بين صنفى الارز الهجينين ومستوى النيتروجين فى تكوين المادة الجافة ومحصول الحبوب وامتصاص النيتروجين فى الحبوب فى كلا الموسمين. كذلك وجد تفاعل معنوى بين أعمار الشتلات فى الأرز ومستوى النيتروجين فى تكوين المادة الجافة وعدد السنيبلات للدالية ومحصول الحبوب.

من النتائج السابقة وتحت ظروف التجربة يمكن التوصية بأنه للحصول على أعلى انتاجية من صنفى الارز الهجينين "SK2034H" و "SK2058H" فإنه يجب الشتل بشتلات صغيره العمر (٢٥ يوماً) والتسميد بمعدل ٢٢٠ كجم نتروجين للهكتار موزعة على ثلاث دفعات متساوية.

قام بتحكيم البحث

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Table 5: Nitrogen content (%), N-uptake (kg/ha) and nitrogen use efficiency (NUE) of two hybrids rice varieties as affected by seedling age N fertilizer levels and their interactions during 2008 and 2009 seasons

Characters / Treatments	N content (%)				N-uptake (kg/ha)				NUE	
	2008		2009		2008		2009		2008	2009
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw		
Varieties (V):										
SK2034H	1.195 a	0.300 a	1.144 a	0.267 a	137.89 a	39.79 a	133.73 a	36.46 a	35.51 a	36.83 a
SK2058H	1.170 b	0.270 b	1.137 b	0.260 b	124.80 b	34.41 b	122.32 b	34.00 b	30.80 b	32.18 b
F-test	**	**	**	**	**	**	**	**	**	**
Seedling ages (A):										
25 days	1.230 a	0.300 a	1.151 a	0.271 a	147.16 a	39.98 a	141.60 a	37.69 a	37.64 a	38.91 a
30 days	1.195 b	0.285 b	1.147 b	0.267 ab	142.62 b	38.91 a	137.89 b	36.73 a	35.25 ab	37.87 a
35 days	1.165 c	0.275 b	1.138 b	0.260 bc	126.45 c	36.78 b	124.86 c	34.52 b	32.79 b	33.38 b
40 days	1.160 d	0.264 c	1.127 c	0.256 c	109.15 d	32.73 c	107.74 d	31.98 c	26.94 c	27.86 c
F-test	**	**	**	*	**	**	**	**	**	*
N-levels (kg/ha) (N):										
0	0.830 d	0.210 d	0.795 d	0.183 d	55.23 d	21.35 c	45.76 d	18.18 d	-	-
110	1.225 c	0.240 c	1.184 c	0.215 c	135.73 c	35.41 b	111.84 c	31.38 c	39.60 a	41.15 a
165	1.330 b	0.340 b	1.269 b	0.317 b	159.51 b	44.83 a	130.04 b	44.58 b	32.40 b	33.63 b
220	1.380 a	0.360 a	1.315 a	0.338 a	174.91 a	46.82 a	143.33 a	46.78 a	27.46 c	28.73 c
F-test	**	**	**	*	**	**	**	**	**	*
Interactions:										
V x A	NS	NS	NS	NS	**	NS	**	NS	NS	NS
V x N	NS	NS	NS	NS	**	NS	**	NS	NS	NS
A x N	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
V x A x N	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

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

Table 6: Means of dry matter (g/m^2), panicle weight, 1000-grain weight and N-uptake of grains as influenced by the interaction between hybrid rice varieties and seedling age during 2008 and 2009 seasons.

Varieties	Seedling age	Dry matter (g/m^2)		Panicle weight (g)		1000-grain weight		Grain yield (t/ha)		N-uptake (kg/ha)	
		2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
SK2034H	25	1391.5 a	1514.8 a	4.70 a	4.77 a	24.84 c	24.23 b	11.86 a	12.19 a	152.39 a	146.80 a
	30	1357.6 a	1478.7 ab	4.61 ab	4.71 a	24.51 d	23.79 bc	11.76 a	11.94 b	149.76 a	143.10 a
	35	1240.1 b	1359.4 c	4.39 c	4.46 b	24.20 d	23.52 c	11.08 b	11.33 cd	137.61 c	135.38 b
	40	1184.5 bc	1305.1 cd	4.16 d	4.19 c	23.73 e	23.12 d	9.22 d	9.357 f	111.79 e	109.65 d
SK2058H	25	1327.8 a	1433.0 b	4.53 bc	4.60 ab	26.02 a	25.37 a	11.18 b	11.440 c	141.93 b	136.41 b
	30	1143.3 c	1254.5 d	4.45 c	4.52 b	25.97 a	25.16 a	11.02 b	11.164 d	135.48 c	132.68 b
	35	1038.5 d	1150.5 e	3.80 e	3.88 d	25.30 b	24.52 b	9.61 c	9.743 e	115.29 d	114.34 c
	40	983.3 d	1095.6 f	3.66 e	3.74 d	24.39 d	23.68 bc	8.90 e	9.034 g	106.50 f	105.84 e

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