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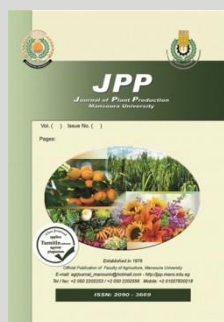
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Effect of Potassium Fertilizer on Yield, Yield Components and Grain Quality Characters Of Rice

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ABSTRACT

This study evaluated the effect of time and rate of potassium application on yield and grain quality characters of Giza179 cultivar during 2017 and 2018 seasons by using this new variety which had high yield but had high broken rice percentage, which reduced the quality characters. Three times of potassium application as basle, maximum tillering and booting stages. Apply three levels of potassium fertilizer (0, 58, 116 kg K /ha) have been applied using a split plot design. The results indicated that non-significant was among the times of potassium application on number of panicles/plant, but different graded levels of K significantly influenced the same character for Giza 179. The applying of K at maximum tillering resulted the longest panicle, the heaviest panicle, the maximum number of filled grains/panicle, the minimum sterility %, the highest grain yield (Kg/m²) and the highest harvest index % as compared to at booting stage and basle. Applying of 116 Kg/ ha of potassium showed superiority of Giza 179 for 1000- grain weight, number of filled grains/panicle, the minimum sterility %, grain yield (kg/m²) and harvest index % with insignificant differences between 58 and 116Kg K ha⁻¹ on almost characters under study. Potassium increasing significantly effect on grains quality. Applying potassium at maximum tillering stage showed superiority of Giza 179 for milling % and head rice %. Based on quadratic regression model indicating the maximum does of K varied according to the time of K applications. The highest rate observation of K with maximum tillering stage for all studied characters.

Keywords: rice, Potassium, yield, head rice% and quadratic model

INTRODUCTION

Rice (*Oryza sativa L.*) is one of the most important cereal crops, (Krishnan et al., 2011). Grains quality traits dictate market value and have a pivotal role in the adoption of new varieties (Han et al., 2004). Milling quality is the important for rice producers. The premium product is a whole, unbroken kernel of the appropriate length with a uniform white translucent color. Broken kernels result in steep price reductions. (Dunn and Stevens 2017). Rice grains quality characteristics are affected by many factors. Fertilizer is an important factor that can increase the yield and improve the quality of rice (Alam et al., 2009).

Application of inadequate fertilization to crops not only results in low crop yield but also deteriorate the soil health. Since the fertilizer is an expensive input, determination of its economical and appropriate dose to enhance crop productivity is imperative to fetch the maximum profit for the growers. (Javeed et al., 2017).

Potassium (K) is one of the three essential macro nutrients required in large amounts for plant growth. This versatility of K nutrition is well documented in enhancing yield and quality of rice (Srivastava and Singh, 2007). Potassium is required for the activity of many enzymes, including those of energy metabolism and protein synthesis (White and Karley, 2010). The application of K in soils increases the crop yields even though total K content in soil was high (Ravichandran and Sriramachandrasekharan 2011). It plays an essential part in the formation of starch and in the production and translocation of sugars, and is thus

of special value to carbohydrate-rich crops, and influences tillering or branching of plant and size and weight of grain. Potassium fertilization ensures proper root growth and uptake of other nutrients, which ultimately increase the crop growth and development (Islam et al., 2015).

Giza 179 cultivar was new cultivar in Egypt, had high yield and had high broken percentage, this problem is attributed to the disturbance in the normal functioning of the vital physiological processes like photosynthesis, translocation of carbohydrate and regular nutritional supply. (Asif et al., 2000).

The main objective is to analyze and fix up time and optimum dose of potassium application for transplanting rice on the yield and the quality of Giza 179 cultivar grains and to study the relationships between yield parameters of this cultivar and K fertilizer rates under different times of application.

MATERIALS AND METHODS

The experiments were conducted at the research farm of Rice Research and Training Center Sakha, Kafrelshirikh, Center during the two rice-growing seasons in 2017 and 2018. Twenty five days old seedlings were manually transplanted into a paddy field with a hill spacing of 20×20 cm and 2-3 seedlings per hill. The field experiment was a split plot design with three replications. Three times of application, which used in this investigation at basle, maximum tillering stage and booting stage were (25 days and 45 days respectively) after transplanting as main plots. While potassium rate applications (0, 58 and 116 kg K₂O

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/ha from potassium sulfate source) as sub-plots.. At harvest time, the following parameters were recorded, plant height (cm), number of panicles/ hill, panicle length (cm), panicle weight (g), number of filled grains/panicle, sterility %, thousand grain weight (g), grain yield (ton/ha), harvest index (%), and milling recovery were measured according to the methods of (Khush et al., 1979).

Quadratic regression is a way to model a relationship between two sets of variables. The result is a regression equation that can be used to make predictions about the data. A quadratic regression is the process of finding the equation of the parabola that best fits a set of data. We use A quadratic when making predictions for future observations of K, this relationship was established between applied K rate and yield characters of rice to estimate maximum K rate (K max) for rice by following (Gomez and Gomez, 1984):

The rice yield and yield component characters of two years average was regressed against the applied K to fit into a quadratic model

$$Y = a + bx + cx^2 \quad (1)$$

Where Y = value of character like plant height and grain yield, K = applied K (kg ha⁻¹); a, b and c are regression coefficients.

$$K \text{ max} = b/2c \quad (2)$$

Using this equation on this study to know the maximum K rate in the three application times.

Coefficient of Determination (R²): indicates the proportion of the variance in the dependent variable (Y) that

is predicted or explained by regression and the predictor variable (X, also known as the independent variable).

$$R^2 = \frac{[S(y_i - y_{AVE})^2] - \{[(n - 1) / (n - p)] * [S(y_i - Y_i)^2]\}}{S(y_i - y_{AVE})^2}$$

Where: y_i= individual values for each dependent variable
 x_i= individual values for each independent variable
 y_{AVE} = average of the y values
 n = number of pairs of data
 p = number of parameters in the polynomial equation (i.e., 3 for third order, 2 for second order)

$$Y_i = \{[(2a * (Cx/Cis)^2) - b^2 + b + (4ac)] / (4a)\}$$

S = the sum of all the individual values

All data collected were subjected to analysis of variance according to (Gomez and Gomez, 1984). Treatments means were compared by Duncan's multiple range test (Duncan, 1955). All statistical analysis was performed using variance technique by means of "MSTAT" computer soft war package.

RESULTS AND DISCUSSION

I-Yield and its components:

1-Plant height:

Time of potassium applications and potassium rates and their interaction had no significantly on plant height of Giza 179 cultivar under study (Table 1). This might be due to the very negligible influence of potassium on the vegetative growth (Yajjala 2011). Potassium uptake is more or less continuous throughout the different stages of growth. Ravichandran and Sriramachandrasekharan (2011).

Table 1. Means of plant height (cm), number of panicles/plant and panicle length (cm) of Giza179 as affected by potassium times, rates applications and their interactions during 2017 and 2018 seasons.

Main effect and interaction	Plant height (cm)		No. of panicles/plant		Panicle length (cm)	
	2017	2018	2017	2018	2017	2018
Stages (S)						
Basle	99.20	101.17	15.66	13.03	21.87b	19.50b
Maximum tillering	97.43	99.28	15.33	13.38	23.47a	21.02a
Booting	97.81	100.72	15.36	13.70	22.78a	20.96a
F-test	Ns	Ns	Ns	Ns	*	**
Rates Kg/h (R)						
0	97.18	100.27	13.30b	14.12b	22.24b	19.81c
58	97.57	99.94	16.12a	14.62a	22.78a	20.33b
116	99.7	100.94	16.32a	14.67a	23.089a	20.74ab
F-test	Ns	Ns	**	**	**	**
Interaction RxS	Ns	Ns	Ns	Ns	*	*

*, ** and NS indicate P < 0.05, P < 0.01 and not significant, respectively. Means followed by a common letter are not significantly different at the 5% level by DMR test.

Potassium was adjusted to a quadratic regression model of Giza 179 with a potassium rate of (89.40, 92.39 and 84.52 kg/ha) in basle, maximum tillering and booting stages, respectively, which promoted the highest plant height (Fig. 1). This indicated that the maximum does of K varied according to the K of time of applications. The highest rate was observed by K at maximum tillering stage. Added K explained (24.53, 29.19 and 27.49 %) of the variability in plant height of Giza 179 respectively in three application times under study. But all treatments gave statistically similar plant height. The more variance that is accounted for by the regression model the closer the data points will fall to the fitted regression line.

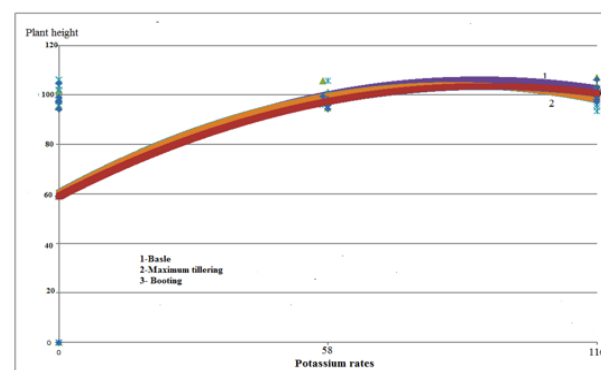


Fig.1. Quadratic model for plant height (cm) as function of K rates with three times applications

$$Y = 58.9951 + 1.03699X - 0.0058X^2 \quad R^2 = 0.2453^* \quad (\text{Basle})$$

$$Y = 58.9122 + .96085X - 0.0052X^2 \quad R^2 = 0.2919^* \quad (\text{Maximum tillering})$$

$$Y = 58.3399 + 1.0481X - .0062X^2 \quad R^2 = 0.2749^* \quad (\text{Booting stage})$$

Where y = plant height in centimeter and x = rates of potassium application (kg ha⁻¹).

2-Number of panicles/plant:

The outcomes of the study showed non-significant was among the times of potassium application on number of panicles/plant, but different graded levels of K significantly influenced number of panicles/plant (Table 1). Data indicated that among K rates, the highest number of panicle was recorded with (116 kg ha⁻¹ K₂O) followed by (58kg ha⁻¹ K₂O) though the difference was non-significant and the lowest one was recorded by control. Optimum K rate for maximum rice yield and yield components was found as 60 kg ha⁻¹ for all rice genotypes and application beyond 60 kg K ha⁻¹ had no further positive impact on various growth and yield parameters (Arif et al., 2010). While (Mahfuza et al., 2008) reported that an increased application of potassium from 0 to 66 kg ha⁻¹ increased the number of tillers m⁻¹. The interaction between two factors under study had no significant effect on number of panicles/plant

The results described by quadratic regression models (Fig.2). For potassium fertilization, the highest number of panicles was observed at the potassium rates of (87.60 at basle, 92.39 in maximum stage and 81.60 in booting stage Kg ha⁻¹). However, quadratic results indicated that the excess potassium in the fertilizer resulted in increased number of panicles. However at maximum tillering stage showed high observation of K compared as to the other two times application of potassium

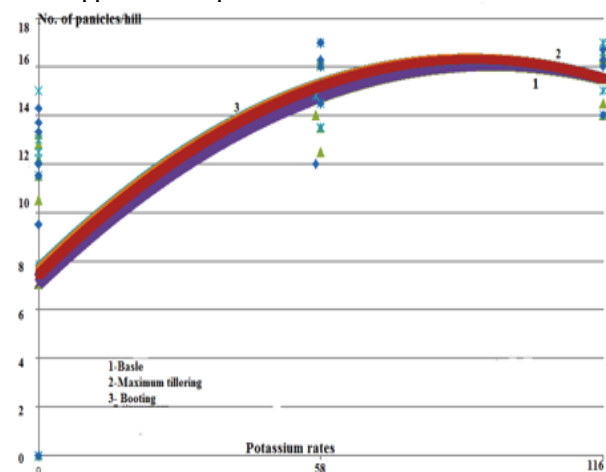


Fig. 2. Quadratic model for number of panicle/ plant as function of K rates with three time applications

Added K explained (49.85, 27.29 and 44.15) % of the variability in number of panicles/plant of Giza 179, respectively in three application times under study.

$$Y = 7.0694 + .19272X - .0011X^2 \quad R^2 = 0.4985^{**} \quad (\text{Basle})$$

$$Y = 58.9122 + .96085X - .0052X^2 \quad R^2 = 0.2729^* \quad (\text{Maximum tillering})$$

$$Y = 7.6696 + .19585X - .0012X^2 \quad R^2 = 0.4415^{**} \quad (\text{Booting stage})$$

Where y = number of panicle /hill and x = rates of potassium application (kg ha⁻¹).

3-Panicle length (cm):

Different K application times and K levels had significantly effect on the panicle length in both seasons (Table I). Apply K at maximum tillering gave the longest panicle. Potassium uptake is more or less continuous throughout the different stages of growth. Ravichandran and Sriramachrasekharan (2011). Crop fertilized with 116 kg K ha⁻¹ produced the longest panicle which was attributed to

sustained supply of k during the entire growth period of the crop by resulting in panicle length, An increase in these growth parameters with the increasing K fertilizer application has been reported by (Bahmaniar and Ranjbar, 2007). While, the lowest value was recorded for (0 kg K ha⁻¹). No significant difference between K rates 58 and 116 K₂O Kg ha⁻¹. May be due to benefit of proper K nutrition includes vigorous vegetative growth (Gebreslassie 2016). The interaction between times and rates of Potassium applications had a significant effect on panicle length

A quadratic behavior showed that with the addition of K rates in the soil (Figure 3). According to the regression model, the maximum values of panicle length would be achieved with (80.68, 90.13 and 80.44 kg/ha) found at basle, maximum tillering and booting stages respectively.

Added K explained (30.5, 29.7 and 31.38) % of the variability in panicle length of Giza 179 in three application times under study, respectively.

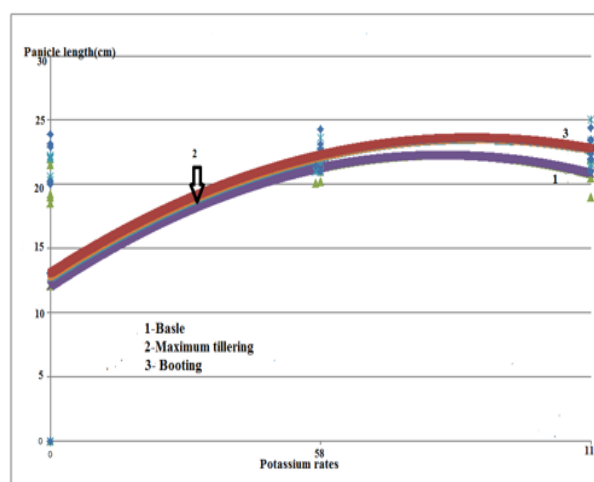


Fig. 3. Quadratic model for panicle length as function of K rates with three time applications

$$Y = 12.069 + .24203X - .0015X^2 \quad R^2 = 0.305^* \quad (\text{Basle})$$

$$Y = 13.0293 + .23435X - .0013X^2 \quad R^2 = 0.297^* \quad (\text{Maximum tillering})$$

$$Y = 12.7491 + .2253X - .0014X^2 \quad R^2 = 0.3138^* \quad (\text{Booting stage})$$

Where y = panicle length and x = rates of potassium application (kg /ha).

4-Panicle weight (g):

Applying of K at maximum tillering stage resulted the heaviest panicle compared to at booting stage and basle Table (2). Applying of 116 Kg K/ ha of potassium showed superiority in case of Giza 179 followed by 58Kg/ ha then control with insignificant difference between 58 and 116Kg/ha in 2017 season. An increase in yield and yield attributes with the increasing application of K fertilizer has been reported by many others (Awan et al., 2007). The interaction between times and rates of Potassium applications had a significant effect on panicle weight.

Panicle weigh showed a quadratic response with K rates at the three times of applications under study (Fig 4). The heaviest panicle was observed by the application of (77.68, 94.13 and 73.38) of K with basle and maximum tillering and booting stages, respectively. Adding K explained (40.19, 42.17 and 30.48) % of the variability in panicle weight of Giza 179 in three applications time under study, respectively.

Table 2. Means of Panicle weight (g), 1000- grain weight (g) and No. of filled grains of Giza179 as affected by potassium times, rates applications and their interactions during 2017and 2018 seasons.

Main effect and interaction	Panicle weight (g)		1000- grain weight (g)		No. of filled grains	
	2017	2018	2017	2018	2017	2018
Stages (S)						
Basle	3.96c	3.27c	24.40b	24.22b	157.68c	109.04c
Maximum tillering	5.05a	3.93a	26.23a	26.11a	180.69a	133.43a
Booting	4.76b	3.46b	26.95a	26.00a	164.57b	118.33b
F-test	**	**	*	**	**	**
Rates Kg/h (R)						
0	4.32b	3.04c	24.00b	22.88b	142.80b	109.94b
58	4.73a	3.70b	26.22a	26.44a	176.64a	122.35a
116	4.77a	3.92a	26.37a	27.00a	183.51a	128.51a
F-test	**	**	*	**	**	**
Interaction RxS	*	*	Ns	Ns	Ns	Ns

*, ** and NS indicate P < 0.05, P < 0.01 and not significant, respectively. Means followed by a common letter are not significantly different at the 5% level by DMR test.

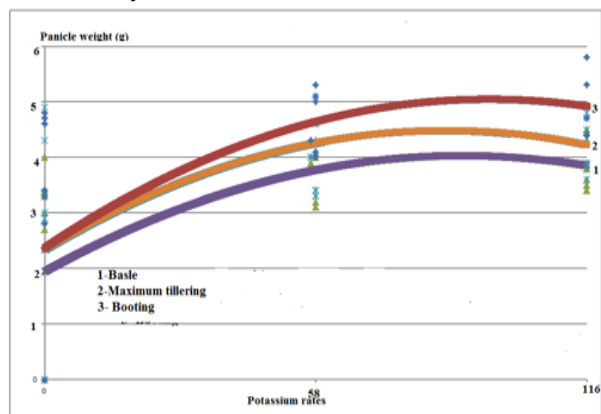


Fig.4. Quadratic model for panicle weight as function of K rates with three time applications

$$Y = 1.9401 + .04661X - .0003X^2 \quad R^2 = 0.4019^{**} \quad (\text{Basle})$$

$$Y = 2.3597 + .05648X - .0003X^2 \quad R^2 = 0.4217^{**} \quad (\text{Maximum tillering})$$

$$Y = 2.3298 + .05003X - .0003X^2 \quad R^2 = 0.3048^{**} \quad (\text{Booting stage})$$

Where y = panicle weight and x = rates of potassium application (kg ha-1).

5-1000- grain weight (g):

The application techniques and potassium rates significantly affected on 1000- grain weight (Table 2). Data indicated that application at booting stage produced the heaviest 1000-grain weight than the other two applications of times under study.

Data revealed that 116 g K/ha superior in 1000 grain-weight as compare with the other two rates under study, No significant difference were detected was between 58 and 116Kg/ha. Potassium is required for activation of starch synthase, which might have played a vital role in starch conservation, thus might have resulted in heavier grains as stated by (Yajjala 2011). Regarding to the number of leaves /seedling as affected by the interaction between some rice cultivars and planting date.

The interaction between two factors under study had no significant effect on 1000- grain weigh.

An increasing in 1000- grain weight as a function of K rates was adjusted to quadratic model for all the time of applications (Fig 5). However, it was observed that apply at maximum tillering had achieved the major increments, nearing a linear response. In fact, it was possible estimated the heaviest panicle, due to the rates of 86.98, 83.38 and 80.78, kg K ha-1. Added K explained (38.3,36.93 and 30.48) % of the variability in 1000-grain weight of Giza 179 in three application times under study, respectively.

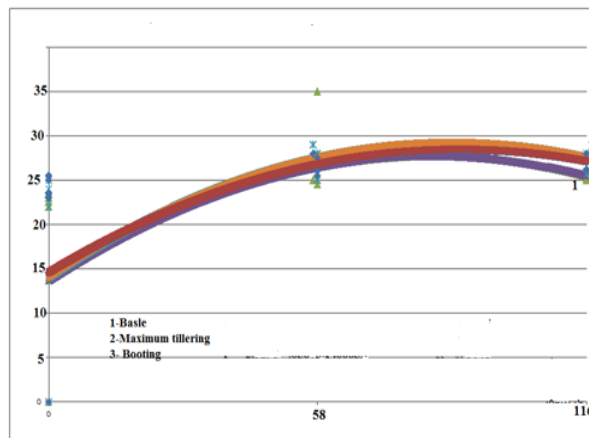


Fig. 5. Quadratic model for 1000- grain weight as function of K rates with three application times

$$Y = 13.6488 + .33926X - .0021X^2 \quad R^2 = 0.382^* \quad (\text{Basle})$$

$$Y = 2.3597 + .05648X - .0003X^2 \quad R^2 = 0.3693^* \quad (\text{Maximum tillering})$$

$$Y = 2.3298 + .05003X - .0003X^2 \quad R^2 = 0.3048^* \quad (\text{Booting stage})$$

Where y = 1000-weight and x = rates of potassium application (kg ha-1).

6- No. of filled grains/panicle

Applying K at maximum tillering recorded the highest value in number of filled grains than other two application times under study (Table 2).The maximum number of filled grains per panicle was recorded with the application of 116 kg K₂O ha-1, while the lowest number was with the control. The increase in number of filled grains due to application of potassium might be due to prolongation of physiologically active period of flag leaf during the later stage of grain filling (Yajjala, 2011). No remarkable response of rice genotypes beyond 60 kg K ha⁻¹ might be due to a disturbance in the balanced proportions of nutrients as well as the potential nutrients. (Muthukumararaja et al., 2009) revealed that rate 50 kg K₂O ha-1 recorded the highest LAI, chlorophyll content, and grains. More favorable panicle size and increase in fertile grains per panicle with higher potash level (Yajjala, 2011). The interaction between two factors under study had no significant effect on number of filled grain.

Evaluating the rate effects (Fig 6), could verify the changes in number of filled grain have allowed to be adjusted to quadratic models, with maximum points estimated for the rates of (99.64, 51.51 and 51.58 %) kg K ha-1, respectively, at basle, maximum tillering and booting stages.

Adding K explained (41.13, 38.55 and 40.58) % of the variability in number of filled grains/ panicle of Giza 179 in the three application times under study, respectively.

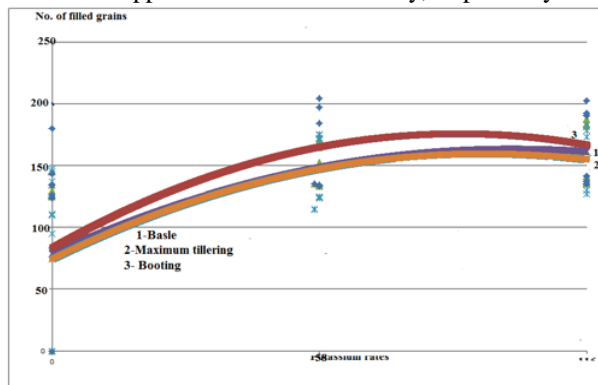


Fig. 6. Quadratic model for no. of filled grains as function of K rates with three time applications

$$Y = 78.4788 + 1.69392X - .0085X^2 \quad R^2 = 0.4113^{**} \quad (\text{Basle})$$

$$Y = 83.0744 + 2.09593X - .0119X^2 \quad R^2 = 0.3855^{**} \quad (\text{Maximum tillering})$$

$$Y = 74.3919 + 1.80965X - .0097X^2 \quad R^2 = 0.4058^{**} \quad (\text{Booting stage})$$

Where y = number of filled grains/panicle and x = rates of potassium application (kg ha⁻¹).

Table 3. Means of sterility%, grain yield (kg/m²) and harvest index % (HI) of Giza179 as affected by potassium times, rates applications and their interactions during 2017 and 2018 seasons.

Main effect and interaction	Sterility%		Grain yield (Kg/m ²)		Harvest index % (HI)	
	2017	2018	2017	2018	2017	2018
Stages (S)						
Basle	2.62 a	9.09 a	1.46 b	1.72 b	40.78b	40.35 c
Maximum tillering	2.40 b	7.67 b	2.86 a	2.10 a	45.82a	47.18a
Booting	2.67 c	8.41 c	1.81 a	2.10 a	45.64a	44.62 b
F-test	*	*	**	**	**	**
Rates Kg/h (R)						
0	2.64 a	10.22 a	1.57 b	1.76 b	39.26b	38.53c
58	2.51 ab	7.58 b	1.75 a	2.07 a	46.17a	46.0b
116	2.43 b	7.09 b	1.80 a	2.09 a	46.90a	47.62a
F-test	*	**	**	**	**	**
Interaction RxS	*	**	Ns	**	*	**

*, ** and NS indicate P < 0.05, P < 0.01 and not significant, respectively. Means followed by a common letter are not significantly different at the 5% level by DMR test.

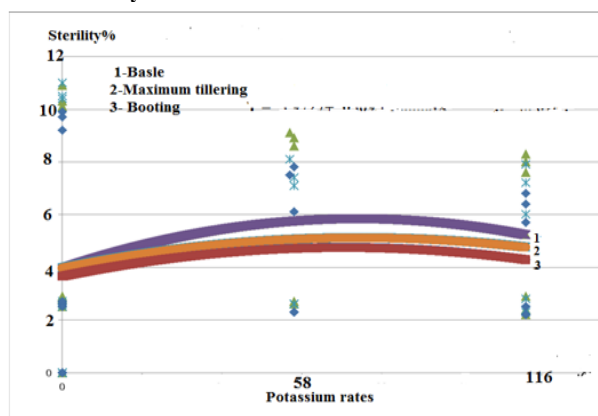


Fig.7. Quadratic model for sterility % as function of K rates with three time application

In addition, sterility was reduced as a function of K rates, being adjusted to a quadratic model with minimum point estimated as 63.78, 51.51 and 51.58 K ha⁻¹ (Fig 6), in three times of application, respectively.

Added K explained (1.9, 1.8 and 1.8) % of the variability in sterility of Giza 179 respectively, in three

7 -Sterility%:

Data in (Table 3) revealed that application of K at basle gave the highest percentage of sterility while the lowest one was found in application at booting. Application of 116 kg K₂O ha⁻¹ produced the highest percentage of sterility. No significant difference were between 58 and 116 kg K₂O ha⁻¹. The spikelet sterility as expected was also the minimum with higher potassium level (Yajjala 2011). Yuan and Huang (1995) reported that potassium application markedly reduced the number of unfilled spikelets due to its promoting effects on cytokinin synthesis, which resulted in less zygote regeneration. While high rate of potassium helped to produce large amounts of starch due to K-mediated carbohydrate metabolism. Also, it helps in efficient translocation of photo-assimilates to the developing sinks/spikelets and ultimately reduced the percentage of sterility grain (Islam and Muttaleb,2016).

application times under study. Because this was not significant under this study.

$$Y = 3.6624 + .03091X - .0003X^2 \quad R^2 = 0.0192 \quad (\text{Basle})$$

$$Y = 3.9727 + .03095X - .0003X^2 \quad R^2 = 0.0184 \quad (\text{Maximum tillering})$$

$$Y = 3.9727 + .03095X - .0003X^2 \quad R^2 = 0.0184 \quad (\text{Booting stage})$$

Where y = sterility % and x = rates of potassium application (kg ha⁻¹).

8-Grain yield (Kg/m²):

The results revealed that grain yield of Giza 179 cultivar significantly affected by time applications and different rates of K fertilizers in both seasons (Table3). It was observed that application of K at maximum tillering resulted in maximum grain yield. The increase in grain yield may be due to increase K uptake and utilization by crop resulting in enhanced growth and yield attributes which may be due to increase photosynthetic efficiency of crop leading to greater dry matter production and translocation to sink. Positive correlation was reported among yield and potassium levels (Uddin et al., 2013).

Potassium applied in basal application might have fixed in the soil and that was not available to the crop. (Mengel and Kirkby1982).

An increasing of K rates allowed a quadratic model for times of application (Fig 8). It was observed that the

highest grain yield was obtained with the application of potassium at the estimated rate of 95.15 kg K ha⁻¹. At maximum tillering stage (55.63). (55.15) and 54.63. Added K explained (37.55, 34.48 and 38.17) % of the variability in grain yield of Giza 179 in the three application times under study respectively.

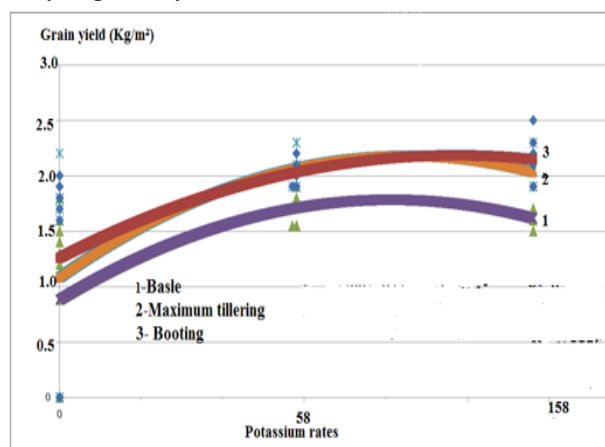


Fig.8. Quadratic model for grain yield (Kg/m²) as function of K rates with three time application

$Y = .8799 + .02225X - .0002X^2$ $R^2 = 0.3755^*$ (Basle)
 $Y = 1.2599 + .01903X - .0001X^2$ $R^2 = 0.3448^*$ (Maximum tillering)
 $Y = 1.0798 + .02185X - .0002X^2$ $R^2 = 0.3817^*$ (Booting stage)

Where y = grain yield Kg/m² and x = rates of potassium application (kg ha⁻¹).

The uptake of K essentially occurs during the vegetative stage in general (Rameshkumar et al., 2003). The pattern of K⁺ uptake in rice follows most closely that of vegetative growth. Seventy five per cent of the total K uptake even before booting stage and most of the remaining K⁺ even

before grain formation begins. The potassium content is highest (about 70-75%) in leaves and culms, with relatively little K accumulated in the milled grain. Unlike N and P, there is little K translocation among plant parts (De Datta, 1981).

9- Harvest index %:

The data obtained in (Table 3) indicated that there were significant differences among the studied of application times and potassium rates for harvest index (HI). Applying at maximum tillering and rate 116 Kg K/ha gave the highest harvest index (HI). The interaction between two factors under study had a significant effect on harvest index

An increasing in harvest index as a function of k rates was adjusted to quadratic model for all the K application times (Fig 9). However, it was observed that applying k at maximum tillering had achieved the major increments.

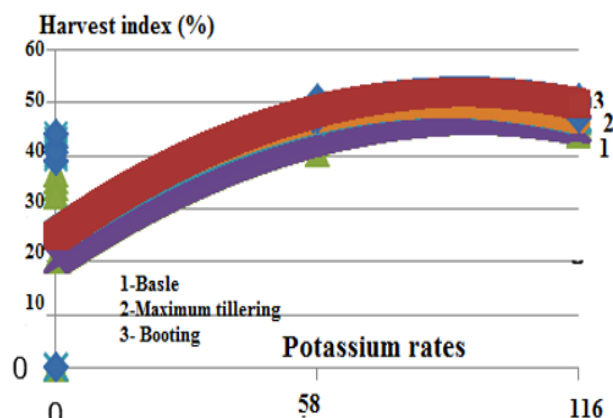


Fig. 9. Quadratic model for harvest index (%) as function of K rates with three time application

$Y = 20.391 + .56751X - .0031X^2$ $R^2 = 0.0052^{**}$ (Basle)
 $Y = 24.7999 + .60035X - .0034X^2$ $R^2 = 0.4370^{**}$ (Maximum tillering)
 $Y = 24.829 + .57847X - .0034X^2$ $R^2 = 0.3142^{**}$ (Booting stage)

II- Grains quality characters:

1- Hulling %:

No significant differences were obtained in times of application Table (4). Potassium rate at 116 showed superiority in hulling %. There was no significant difference between rates at 116kg / h and 58 kg /ha.

Table 4. Means of hulling%, milling % and head rice % of Giza179 as affected by potassium times, rates applications and their interactions during 2017 and 2018 seasons.

Main effect and interaction	Hulling%		Milling %		Head Rice %	
	2017	2018	2017	2018	2017	2018
Stage (S)						
Basle	79.36	79.77	66.98c	67.33c	60.49 b	57.15c
Maximum tillering	79.76	79.73	68.62a	69.22a	62.49a	60.92a
Booting	78.96	79.65	67.59b	68.24b	60.90b	58.96
F-test	Ns	Ns	**	**	**	*
Rate Kg/h (R)						
0	77.91b	78.92b	66.36b	66.57 b	58.06b	55.63c
58	79.92a	79.94a	67.911a	68.34a	62.77a	60.08b
116	80.26a	80.30a	68.92a	68.89a	62.81a	61.32a
F-test	**	**	**	**	**	**
Interaction RxS	Ns	Ns	*	*	*	*

*,** and NS indicate P < 0.05, P < 0.01 and not significant, respectively. Means followed by a common letter are not significantly different at the 5% level by DMR test.

According adjusted to quadratic models, indicating the applied K at different times was not sufficient to reach the significant (Fig 10).

The coefficients of determination (gives you the percentage variation in hulling % explained by k rates) for quadratic equations were 28.41 % at basle, while 28.74% for Maximum tillering, in the case of Booting stage 29.46 % gives you the percentage variation in hulling % explained by k rates

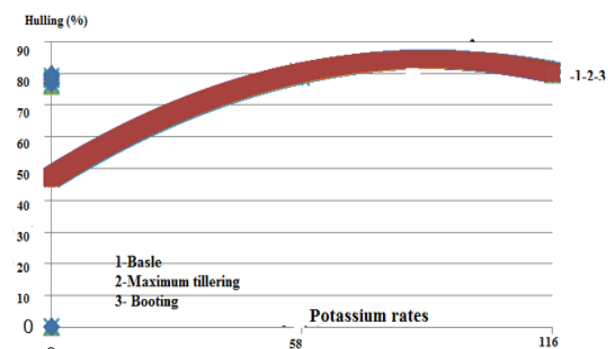


Fig. 10. Quadratic model for hulling (%) as function of K rates with three time application

$$\begin{aligned}
 Y &= 47.2602 + .85044X - .005X^2 & R^2 &= 0.2841^* & (\text{Basle}) \\
 Y &= 47.1704 + .85727X - .005X^2 & R^2 &= 0.2874^* & (\text{Maximum tillering}) \\
 Y &= 46.7015 + .84821X - .0049X^2 & R^2 &= 0.2946^* & (\text{Booting stage})
 \end{aligned}$$

2-Milling %:

The affect by time of application and potassium rates are shown in (Table 4). Applying at maximum tillering surpassed significantly the other two times of application in milling percentage followed by booting stage then basle. Rate of potassium at 116 kg/ha gave the highest hulling percentage without significant difference between applying 58 and 116 kg/ha, while control recorded the lowest one. Potassium fertility has a positive effect on rice milling quality Dunn And Stevens (2017). Among the times of K application, each at maximum tillering and booting stages recorded the highest K uptake in grain. Sivagnanam and Arivazhagan (2009).

The interaction between two factors under study had significant effect on milling %

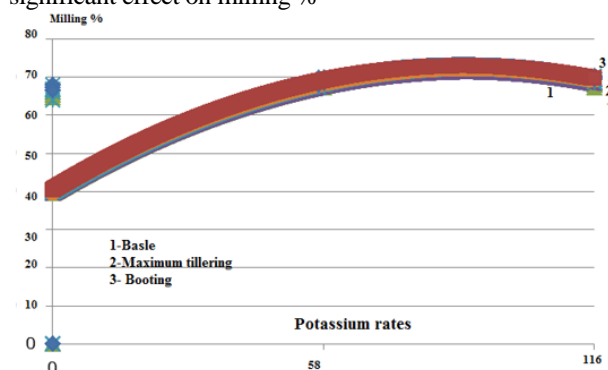


Fig. 11. Quadratic model for milling % as function of K rates with three time applications

R², indicates that 29.97, 29.57 and 30.17 % in basle, maximum tillering and booting stages respectively of the variation in milling % has been explained by the k rates. In general, the higher the R-squared, the better the model fits data.

$$\begin{aligned}
 Y &= 39.4002 + .72201X - .0041X^2 & R^2 &= 0.2997^* & (\text{Basle}) \\
 Y &= 40.4495 + .74102X - .0043X^2 & R^2 &= 0.2957^* & (\text{Maximum tillering}) \\
 Y &= 39.8097 + .73058X - .0042X^2 & R^2 &= 0.3017^* & (\text{Booting stage})
 \end{aligned}$$

3-Head rice %:

Results in (Table 4) showed that there were significant differences in head rice % among the three times of application. Applying K for rice plants at maximum tillering gave the maximum value, whereas rate at 116 Kg/ ha recorded the maximum value, while no significant between rates 116 and 58 kg K/ha in the first season . Potassium fertilization is frequently associated with improved crop

quality may be due to Potassium (K) plays significant roles in the physiological processes of protein formation, transportation of water, nutrients and carbohydrates, photosynthesis and N fertilization (Gebreslassie, 2016).

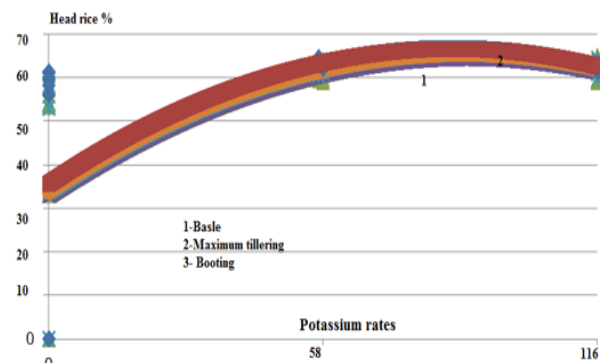


Fig. 12. Quadratic model for head rice % as function of K rates with three time applications

Effects of added K on head rice % can be best described by this 3 equations that explained 37.14% in basle and 32.69 at maximum tillering and 35.99 at booting stage of the variability

$$\begin{aligned}
 Y &= 32.9288 + .7146X - .0041X^2 & R^2 &= 0.3714^* & (\text{Basle}) \\
 Y &= 35.5609 + .72746X - .0043X^2 & R^2 &= 0.3269^* & (\text{Maximum tillering}) \\
 Y &= 33.8285 + .72135X - .0042X^2 & R^2 &= 0.3599^* & (\text{Booting stage})
 \end{aligned}$$

CONCLUSION

Potassium application at maximum tillering is recommended in this study because, supply is necessary in heading stage when the reproduction stage is complete. Potassium is particularly effective in the improvement of grain number and grain weight. The highest paddy yield of rice was recorded in treatment receiving K at 116 kg K₂O/ha and no significant between rates 58 and 116 kg / ha in almost characters.

Perusal of data presented in all Figs, indicated quadratic relationships between yield characters of rice and K levels. The current recommended dose of potassium to Giza 179 rice cultivar i.e. 58 kg K₂O ha⁻¹ may not be sufficient and the yield potential of rice cultivar can be realized by adding of more potassium even beyond 58 kg K₂O ha⁻¹. Hence finding of potassium optimum dose within the levels of potassium tried in this experiment was not possible since the linear response was obtained.

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تأثير التسميد بالبوتاسيوم علي محصول الأرز ومكوناته وصفات جوده الحبوب

نسرين نظمي بسويني

قسم بحوث الأرز سخا- كفر الشيخ-معهد المحاصيل الحقلية-مركز البحوث الزراعية

أقيمت تجربتان حقليتان بمزرعة مركز البحوث والتدريب في الأرز بسخا كفر الشيخ خلال موسمي ٢٠١٧ و ٢٠١٨ بهدف دراسة تأثير معدلات ووقت إضافة البوتاسيوم على صفات المحصول ومكوناته وجودة الحبوب من صنف أرز جيزة ١٧٩ و أجريت هذه الدراسة باستخدام هذا الصنف الجديد ذو المحصول العالي ولكن الحبوب بها نسبة عالية من الكسر مما قلل من جودة حبوب هذا الصنف وقد اشتملت التجربة علي ٩ معاملات عبارة عن التواليف بين اضافته ثلاثة مستويات من سماد البوتاسيوم (٠ ، ٥٨ ، ١١٦ كجم البوتاسيوم) و ٣ مواعيد الإضافة البوتاسيوم (في مرحلة الشراقي ، مرحلة أعلى تقريع (٢٥ يوماً بعد الزراعة) ومرحلة الحمل بعد ٤٥ يوماً من الزراعة) ونفذت التجارب في تصميم القطع المنشقة في ثلاثة مكررات. ثلاث مواعيد اضافته مرحلة اعداد الأرض ، ومرحلة النمو الخضري والتقريع (٢٥ يوماً من الشتل) ومرحلة تكوين السنبال بعد ٤٥ يوماً من الشتل) في القطع الأساسية. ومعدل الإضافة (0 ، ٥8 و ١١٦ كجم / K2O هكتار) وذلك باستخدام كبريتات البوتاسيوم كمصدر للبوتاسيوم في القطع المنشقة. اشارت النتائج الي ما يلي: كان تأثير وقت اضافته البوتاسيوم ومعدلاته غير معنوي علي طول نبات اصف الجيزة ١٧٩. كان وقت اضافته البوتاسيوم معنوي لكل الصفات المدروسة. حيث ازدادت قيم متوسطات معظم الصفات عند اضافته البوتاسيوم في مرحل أعلى تقريع مقارنة بمرحلة الشراقي والحمل. بينما أنتج الإضافة في مرحلة الحمل أثقل وزن ١.١٠٠. واكدت النتائج علي وجود استجابة مختلفة لمعدلات اضافته البوتاسيوم لكل الصفات المدروسة، حيث ازدادت قيم متوسطات معظم الصفات لزيادة معدلات اضافته البوتاسيوم، وسجلت اعلي القيم عند اضافته ١١٦ كجم / هكتاروا لا يوجد فرق معنوي في معظم الصفات بين معدل البوتاسيوم ٥٨ و ١١٦ كجم / هكتار. وبينما اثرت زيادة معدل البوتاسيوم بشكل كبير علي جودة الحبوب. الإضافة في مرحلة أعلى تقريع و أظهر تفوق صنف الجيزة ١٧٩ لصفه التبييض/ ونسبه الأرز السليم/ بناءً على نموذج الانحدار التربيعي للجيزة ١٧٩ ، والذي يشير إلى أن الحد الأقصى يتنوع وفقاً للوقت اضافته البوتاسيوم. وكان أعلى معدل للبوتاسيوم مع مرحلة أعلى تقريع لجميع الصفات تحت الدراسة. توصي هذه الدراسة بإضافة البوتاسيوم في مرحلة أعلى تقريع بمعدل ٥٨ كجم / هكتار للحصول علي محصول عالي وتقليل نسبة الكسر تحت ظروف التجربة.