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Impact of Compost Rice Straw and Rice Straw as Organic Fertilizer with Potassium Treatments on Yield and some Grain Quality of Giza 179 Rice Variety

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ABSTRACT

A field trial was performed in 2015 and 2016 rice seasons at the farm of Rice Research and Training Center, Sakha, Kafr El-Sheikh, Egypt to study the role of organic fertilizer i.e. compost rice straw 5 t ha^{-1} (CRS) and rice straw 5 t ha^{-1} (RS) plus control and potassium treatments namely 60 kg K_2O ha^{-1} applied basally before planting (K1), 30 kg K_2O ha^{-1} basally plus 2% potassium sulfate (K_2SO_4) as foliar spray at panicle initiation (K2), 2% K_2SO_4 as foliar spray at both panicle initiation (PI) and late booting (LB) periods (K3) plus control (K0) on the yield and its attributes as well as some of grain quality characters of Giza 179 rice variety. The experiment was laid out in a split-plot design with four replications. The organic fertilizer was allocated in the main plots while the sub-plots received potassium treatments. The studied characters were plant height, number of tillers, number of panicle $hill^{-1}$, panicle weight, panicle length, number of branches $panicle^{-1}$, number of filled grains $panicle^{-1}$ and number of unfilled grains $panicle^{-1}$, 1000-grain weight, grain and straw yield and some grains quality characters i.e. hulling, milling and head rice percentage as well as available and uptake of potassium . The main results revealed that application of both compost rice straw (CRS) and rice straw (RS) gave the same greatest values of all the previous characters except panicle length which gave insignificant effect. Application of potassium fertilizer at the rate of 60 kg K_2O ha^{-1} basally applied before planting (K1) or as foliar spray at the rate of 2% K_2O at both panicle initiation (PI) and late booting (LB) produced the highest values of all the studied characters. As for the interaction between organic fertilizer and potassium treatments, results clarified that the combination of 5 t CRS ha^{-1} with each of 60 kg K_2O ha^{-1} (K1) or 2% K_2O as foliar spray at both PI and LB (K3) gave the same greatest values in number of panicles $hill^{-1}$, filled grains $panicle^{-1}$ and grain yield, while panicle weight and straw yield reached to the maximum values when 5 t RS ha^{-1} was combined with K1 and K3. Hulling% reached the maximum value when treated with 5 t CRS ha^{-1} while both milling and head rice responded to 5 t RS ha^{-1}. Treatment of potassium applied as a foliar spray at both PI and LB (K3) produced the highest hulling and milling% while head rice% responded to K2 and K3. The combination of 5 t RS ha^{-1} with K1 or K3 gave the highest hulling and milling% while head rice reached the maximum value when each of CRS and RS was combined with each of K1, K2 and K3. Available K reached the maximum value at 30 days after transplanting. Availability of K was the highest under rice straw treatment followed by CRS. The uptake of K reached to the greatest value when either CRS or RS was combined with K1 treatment. It can be concluded that combination of 5 t CRS ha^{-1} with K3 (2% K_2SO_4 as a foliar spray at both PI and LB) produced the greatest grain yield and saved about 40 kg K_2O ha^{-1}. Also, the combination of either 5 t CRS or 5 t RS ha^{-1} with K3 treatment improved the grain quality under study.

INTRODUCTION

Rice is the main food crop which has an important role in agricultural development in Egypt because it is the staple food source for Egyptian people. Rice crop cultivation is nowadays highly depend on inorganic fertilizer usage, whereas availability of this fertilizer is be coming more difficult and expensive so that proper technology that reduces the use of inorganic fertilizers is required, for instance using organic fertilizers. Raw material source for organic fertilizer is highly available around the paddy fields as a rice straw. Farmers in areas of rice production usually burns rice straw after harvesting period which results in environmental problems and community health disorders because dense smokes can create respiratory diseases (Hardjowigeno, 1987). The effort to increase agricultural soil quality and crop production can be done by addition of organic fertilizers which improve soil physical, chemical and biological properties (Melati *et al.,* 2008).

Incorporation of crop residues into the soil induces some changes that improve the soil quality. Crop residues are important natural resources and upon decomposition during incorporation may lead to improvement in soil properties and enhances overall ecological balance of the crop production system besides building up of soil organic matter and soil nutrients (N, P and K) (Mandal *et al*., 2004 and Yadvinder-Singh *et al*., 2004).

Sufficient organic matter is necessary for keeping soil fertility and crop performance, although organic manures alone cannot ensure sustainable rice production.

Consequently, apply of organic and mineral sources in an integrated approach are the optimal management practices for preserving soil fertility and crop yield (Sarkar *et al*., 2016).

Potassium is an important nutrient with a vital function in regulating assimilates transportation, therefore potassium short supply could affect the rice productivity.

The removal of K from fertilizer mixtures would cause a greater risk in rice production. Intensive cropping and planting modern rice varieties for high productivity caused high depletion of K in soils, particularly in the absence of K application (Tiwari, 1985).

The indiscriminate use of K fertilizer can lower the yield and deteriorate the kernel quality. The balanced and adequate use of K fertilizers has considerable effects on quality, ripening and grain yield. Thus, the improvement in K use efficiency is necessary for increasing rice production (Arif *et al*., 2010).

Straws of cereal generally have higher K content than other straws (1.2%–1.7%). Kaur and Benipal (2006) reported that recycling straw to the field could enhance potassium soil availability to a greater extent compared to manure.

Foliar application can reduce the lag time between application and uptake by the plant, which could be important during a phase of rapid growth. The foliar K application is an economic way to terminate the K deficiency against K basal application due to its requirement in lesser amounts (Khan *et al*., 2012).

Conception of K supplying power of soil is essential for judicious recommendation of K fertilizer compromising economic return and maintaining soil K reserve. On the other hand, crop residues, particularly rice straw, accumulate about 70-80% of total absorbed K and its recycling would substantially economize mineral fertilizer and assist soil K sustainability (Saha *et al.*, 2009).

The objective of this research was to study the impact of composting rice straw and incorporated raw rice straw as organic fertilizer and K inorganic fertilizers treatments on the growth, yield and grain quality of Giza 179 rice variety as well as to utilize rice straw available in great quantities at paddy areas as nutrients and organic matter sources.

MATERIALS AND METHODS

A field trial was undertaken in 2015 and 2016 seasons at the farm of Rice Research and Training Center, Sakha, Kafr El-Sheikh, Egypt to investigate the impact of three organic treatments namely control (without any organic fertilizer) (C0), 5 t compost rice straw (CRS) ha^{-1} C1 and 5 t rice straw (RS) ha^{-1} C2 with four potassium treatments i.e., control (without any potassium fertilizer) K0, 60 kg K_2O ha^{-1} applied basally before planting (K1), 30 kg K_2O ha^{-1} as a basal application plus foliar spray with 2% of potassium sulfate (K_2SO_4) at panicle initiation (PI) period (K2) and foliar spray with 2% of K_2SO_4 at both panicle initiation (PI) and late booting (LB) periods (K3) on yield and its attributes as well as some grain quality characters of Giza 179 rice variety. Experiment was laid out in a split-plot design with 4 replications. The organic fertilizer treatments were allocated in the main plots, while the sub-plots had four potassium treatments. Representative soil samples were taken from the experimental site and subjected to chemical analysis following the standard procedures described by Cottenie *et al*. (1982). The results of the soil analysis were as follow:- soil was clayey in texture with 1.56 % organic matter, pH 8.10, EC 3.20 dS m^{-1}, total N 0.052%, available P 13.00 ppm, available K 305.00 ppm, available Zn 0.72 ppm, available Fe 5.30 ppm and available Mn 2.87 ppm. Samples of rice straw and compost rice straw were randomly collected, combined and chemically analyzed as shown in Table 1.

Table 1. Chemical analysis of composted rice straw (CRS) and rice straw (RS) in 2015 and 2016 seasons

Organic fertilizer	Season	C %	N %	C:N Ratio	P %	K %	Fe (ppm)	Mn (ppm)	Zn (ppm)
Composted	2015	35.00	1.40	25.00	0.61	0.81	554.40	264.52	42.36
rice straw	2016	37.00	1.45	25.51	0.58	0.83	570.65	280.40	47.17
Rice straw	2015	46.00	0.53	86.79	0.26	1.37	335.00	350.00	38.45
	2016	47.00	0.56	83.93	0.24	1.32	329.00	323.00	33.34

Rice straw was chopped well for enhancing its decomposition. All amounts of composted rice straw (CRS) and rice straw (RS) were applied as basal applications and incorporated well into the dry soil during land preparation. Potassium fertilizer treatments in the form of potassium sulfate (50% K_2O) were applied according to the treatments under study either as soil application before planting or as foliar spray at the rate of 2% of potassium sulfate. Seeds at the rate of 96 kg ha^{-1} were soaked in water for 24hr, after that incubated for 48hr to hasten germination. Pre-germinated seeds were broadcasted in the well prepared nursery on 9^{th} and 7^{th} of May in the two seasons, respectively. The permanent field was properly prepared, *i.e.* plowed twice and well dry leveled. Nitrogen fertilizer was applied at the rate of 165 kg N ha^{-1} as urea (46.5% N) in two splits (two third of the dose basal before transplanting and the rest at 30 days after transplanting). All plots received phosphorus at the rate of 36 kg P_2O_5 ha^{-1} as basal dose as single super phosphate (15% P_2O_5) and immediately irrigated and slight leveling were done. Seedlings were transported to the plots 30 days after sowing, and manually transplanted at the space of 20x20 cm between rows and hills, with 3 seedlings $hill^{-1}$.

The subplot area was 12 m^2 (3x4m). All other agronomic practices were done as the recommendation of Rice Research and Training Center (RRTC, 2012). Five hills were randomly identified from each plot four days before harvest to estimate the plant height (cm), number of tillers $hill^{-1}$ and number of panicles $hill^{-1}$. Ten panicles were randomly collected to estimate the panicle weight (g), panicle length (cm), number of branches $panicle^{-1}$, number of both filled and unfilled grains per panicle, and 1000-grain weight. Grain and straw yield were estimated by identifying central 5 m^2 of each plot, harvested at full maturity, dried and threshed, then the grain and straw yields were recorded. Grain yield was adjusted to 14% moisture content and converted into t ha^{-1}. The straw yield resulting from 5 m^2 was weighed and transferred to t ha^{-1}. Hulling, milling output and head rice percentages of grains were estimated according to the method described by Khan and Wikramanayake (1971). Soil samples were taken at 30, 60 and 90 days after transplanting (DAT) to determine the available soil K (ppm). Samples of both grain and straw were taken at harvest to estimate K uptake according to the procedures described by (Yoshida *et al*., 1972 and Page *et al*., 1982). Data were statistically analyzed according to Gomez and Gomez (1984). The differences among treatments were compared using Duncan's Multiple Range Test (DMRT, 1955).

RESULTS AND DISCUSSION

Plant height, number of tillers $hill^{-1}$ and number of panicles $hill^{-1}$ as influenced by organic fertilizer application, potassium fertilizer treatments and their interaction are presented in Table 2. Organic fertilizer caused a significant increase in plant height as compared with control. Application of 5 t CRS ha^{-1} produced the tallest plants followed by 5 t RS ha^{-1} treatment without significant differences in both seasons. While, control (without organic fertilizer) produced the shortest plants. These results are in the trend of data findings of Metwally (2015). Also, potassium treatments caused a significant increase in plant height as compared with control (Table 2). Basal application of 60 kg K_2O ha^{-1} (K1) produced the tallest plants and was statistically at par with foliar spray with 2% of K_2SO_4 at both panicle initiation (PI) and late booting (LB) (K3), while the control treatment produced the shortest plants. Also, data in Table 2 revealed that organic fertilizer caused a significant increase in number of tillers $hill^{-1}$ as compared with control.

The greatest number of tillers were found when either CRS or RS was applied without any significant difference between them. In addition, the application of K either basally or as a foliar spray increased number of tillers compared to control. In both seasons, basal application of 60 kg K_2O ha^{-1} (K1) produced the highest number of tillers and it was statistically the same of K2 and K3 treatments, while the control treatment produced the lowest number of tillers. Interaction between organic fertilizer and K treatments did not show any significant variation in respect of plant height and number of tillers $hill^{-1}$ in both seasons (Table 2). Yang *et al*. (2005) reported that rice roots greatly modify potassium mobility in the rice rhizosphere which ultimately enhances K uptake and activate the nods to emerge more tillers. These results are in agreement with those of Gorgy *et al*. (2009). Data in Table 2 indicated that organic fertilizer significantly increased number of panicles $hill^{-1}$ compared with control. Application of either 5 t CRS or 5 t RS ha^{-1} produced the same highest value of number of panicles $hill^{-1}$ without significant differences. The control (without organic fertilizer) produced the lowest value of number of panicles $hill^{-1}$. Data also showed that in both seasons, potassium treatments caused a significant increase in the number of panicles $hill^{-1}$ as compared with control (Table 2). It can be easily observed that all the K treatment under study produced nearly the same number of panicles without any significant differences, while control treatment produced the lowest value of number of panicles $hill^{-1}$. The increase in number of panicles $hill^{-1}$ with the application of K basally or foliar spray at both PI and at LB might be due to the increase in number of tillers when K application was basally applied before planting. Also, spraying K at PI caused an increase in number of panicles premordia initiation, beside the increase in length and number of spikelets per panicle. Results agree with those obtained by Ramos *et al*. (1999) who found that soil application with potassium or 1% K sprayed twice at the end of tillering stage and panicles initiation stage resulted in the highest number of panicle per unit area.

Table 2. Plant height, number of tillers $hill^{-1}$ and number of panicles $hill^{-1}$ of Giza 179 rice variety as affected by organic fertilizer application, potassium treatments and their interaction in 2015 and 2016 seasons

Character	Plant height (cm)		No. of tillers $hill^{-1}$		No. of panicles $hill^{-1}$	
Treatment	2015	2016	2015	2016	2015	2016
A-Org. fertilizer						
Control	77.50b	76.86b	20.82b	20.47b	18.38b	18.76b
5 t CRS ha^{-1}	79.81a	79.17a	21.86a	21.36a	20.46a	20.67a
5 t RS ha^{-1}	78.83a	78.58a	21.81a	21.32a	20.23a	20.55a
B- K treatment						
K0	78.22c	76.86c	19.46b	18.89b	17.53b	17.95c
K1	79.17a	79.02a	22.31a	21.85a	20.53a	20.80a
K2	78.53b	78.25b	22.06a	21.64a	20.28a	20.55b
K3	78.95ab	78.73ab	22.17a	21.82a	20.41a	20.66ab
AxB	NS	NS	NS	NS	*	*

K0 = control, K1= basal of 60 kg K_2O ha^{-1}, K2 = basal of 30 kg K_2O ha^{-1} plus 2% K_2SO_4 foliar at PI and K3 = 2% K_2SO_4 foliar at both PI and LB.

Data indicated that number of panicles $hill^{-1}$ reached maximum value when 5 t CRS ha^{-1} was combined with each of K1, K2 and K3 (Table 4). The combination of 5 t RS ha^{-1} with only K1 produced nearly the same greatest number of panicles as the previous combination (5 t CRS ha^{-1}) with all the K treatments except control (K0).

Means of panicle weight, panicle length and number of branches $panicle^{-1}$ of Giza 179 variety as affected by organic fertilizer, K treatments applications and their interaction are presented in Table 3. Data indicated that application of any of organic fertilizer significantly increased panicle weight as compared with control and gave nearly the same value in both seasons. Significant variation in panicle weight was observed due to K treatments application in the both seasons (Table 3).

Application of any of K treatment caused a significant increase in panicle weight as compared with control. Spraying the tested variety with 2% K_2SO_4 at both PI and LB recorded the heaviest panicles followed by basal application (K1), while K2 gave the least. Interaction between organic fertilizer and K fertilizer treatments in panicle weight is presented in Table 4. Combination of either K1 or K3 with each of 5 t CRS ha^{-1} and 5 t RS ha^{-1} produced the greatest weight of panicle followed by K2 when combined with the same organic fertilizer treatments, while the lowest panicle weight was obtained when K0 was combined with the organic fertilizer treatments. This could be attributed to the increase in the growth of plant canopy, as K applied basally which caused an increase in the photosynthesis and its assimilates that are trarnslocated to the panicles and fill most of the spikelets completely resulting in an increase in the panicle weight.

Also, K as co-activator in the enzymes, causes a fast translocation of the metabolites form source to sink of plant that increases the filling of spikelets consequently increases the weight of panicles (Fischer and Hsiao, 1968).

Organic fertilizer did not show any significant variation in respect of panicle length in both seasons (Table 3). Data revealed that potassium fertilizer treatments caused a significant increase in panicle length as compared with control. Basal application K1 or foliar spray with 2% of K_2SO_4 at both PI and LB periods (K3) produced the tallest panicles without any significant difference between them in the two studied seasons. While control treatment (K0) gave the lowest value. Results are in agreement with Khan *et al*. (2012), who reported no significant differences among the K treatment applied basally and foliar spray treatments on panicle length

Organic fertilizer had no significant effect on number of branches $panicle^{-1}$ in both seasons (Table 3). Number of branches $panicle^{-1}$ significantly varied due to the treatments of potassium application in both seasons. Application of 60 kg K_2O ha^{-1} as basal before planting or foliar spray with 2% K_2SO_4 at both PI and LB produced the greatest number of branches $panicle^{-1}$, in both seasons. While the plants grown without K fertilizer (control) had the lowest number of branches $panicle^{-1}$. Interaction between organic fertilizer and K treatments had no significant effect on panicle length and number of branches $panicle^{-1}$ (Table 3).

Table 3. Panicle weight, panicle length, number of panicles hill^{-1} and number of branches panicle^{-1} of Giza 179 rice variety as affected by organic fertilizer application, potassium treatments and their interaction in 2015 and 2016 seasons

Character	Panicle weight (g)		Panicle length (cm)		NO. of branches panicle^{-1}	
Treatment	2015	2016	2015	2016	2015	2016
A-Org. fertilizer						
Control	3.00b	3.15b	20.38a	21.08a	8.90a	9.10a
5 t CRS ha^{-1}	3.16a	3.40a	20.63a	20.88a	9.61a	9.69a
5 t RS ha^{-1}	3.11a	3.32a	20.63a	20.93a	9.50a	9.48a
B-K treatment						
K0	2.85d	3.07c	19.31c	19.67c	8.62c	8.66c
K1	3.19b	3.37a	21.08a	21.61a	9.67a	9.77a
K2	3.02c	3.28ab	20.71b	21.20b	9.37b	9.50b
K3	3.31a	3.44a	21.08a	21.37ab	9.68a	9.73a
AxB	*	*	NS	NS	NS	NS

K0 = control, K1= basal of 60 kg K_2O ha^{-1}, K2 = basal of 30 kg K_2O ha^{-1} plus 2% K_2SO_4 foliar at PI and K3 = 2% K_2SO_4 foliar at both PI and LB.

Table 4. Number of panicles hill^{-1} and panicle weight of Giza 179 rice variety as affected by interaction between organic fertilizer and potassium treatments application in 2015 and 2016 seasons

	Number of panicles hill^{-1}							
	2015				2016			
K treatment Org. fert.	K0	K1	K2	K3	K0	K1	K2	K3
Control	16.13e	19.24c	19.00c	19.13c	16.93e	19.43c	19.27c	19.39c
5 t CRS ha^{-1}	18.15d	21.37a	21.04ab	21.26ab	18.52d	21.51a	21.27a	21.38a
5 t RS ha^{-1}	18.30d	20.97ab	20.79b	20.85b	18.41d	21.45a	21.10b	21.22b
	Panicle weight							
Control	2.79c	3.09b	2.92c	3.19b	2.94d	3.22c	3.16c	3.27b
5 t CRS ha^{-1}	2.90c	3.24a	3.09b	3.42a	3.19c	3.45a	3.38b	3.56a
5 t RS ha^{-1}	2.86c	3.24a	3.03b	3.31a	3.07d	3.44a	3.29b	3.47a

K0 = control, K1= basal of 60 kg K_2O ha^{-1}, K2 = basal of 30 kg K_2O ha^{-1} plus 2% K_2SO_4 foliar at PI and K3 = 2% K_2SO_4 foliar at both PI and LB.

Data showed that number of filled grains panicle^{-1} increased when either CRS or RS were applied as compared with control in both seasons (Table 5). Application of 5 t CRS ha^{-1} recorded the highest number of filled grains panicle^{-1} in the first season, while in the second season, 5 t RS ha^{-1} treatment gave the same highest number of filled grains panicle^{-1} as 5 t CRS ha^{-1} treatment with no significance. The improvement of number of filled grains by organic fertilizer may be due to high availability of some nutrients such N, P and K in the soil resulting in greater growth subsequently yield components involving filling percentage. These results are in agreement with Satyanarayana *et al*. (2002) and Metwally (2015) who reported that application of rice straw compost gave the highest values of filled grain percentages.

As for potassium fertilizer treatments, data revealed that application of any of K treatments caused an increase in number of filled grains as compared with control. The highest number of filled grains was observed when the plants were sprayed with 2% K_2SO_4 at both PI and LB (K3) without any significant difference with basal application of 60 kg K_2O ha^{-1} (K1). A similar trend was found by Ranamukhaarachchi and Ratnayake (2006) who indicated that plots receiving K near to grain filling period had a higher number of filled grains when compared to corresponding treatments which received no K.

Significant variation in number of filled grains panicles^{-1} of the tested rice variety was observed due to the interaction between organic fertilizer treatments and K fertilizer application (Table 6). The combination of either K1 or K3 with each of CRS or RS produced the maximum values of number of filled grains panicles^{-1} which was statistically at par with the combination of K2 with CRS alone. The minimum number of filled grains panicle^{-1} was recorded when neither organic fertilizer nor K fertilizer was added.

Number of unfilled grains panicle^{-1} of Giza 179 rice variety, as influenced by organic fertilizer under study, is presented in Table 5. Data revealed that application of 5 t CRS ha^{-1} produced the lowest number of unfilled grains panicle^{-1} in both seasons. Plots with no organic fertilizer gave the highest number of unfilled grains panicle^{-1}. Also, data Table 5 showed that significant differences were obtained among K fertilizer treatments with regards to number of unfilled grains panicle^{-1}. Potassium application (K) either basally or as foliar spray resulted in a decrease in number of unfilled grains panicle^{-1} compared to control. Foliar spray with 2% K_2SO_4 at both PI and LB stages in K3 treatment gave the lowest value of number of unfilled grains panicle^{-1} in both seasons.

Organic fertilizer or K fertilizer caused an increase in 1000-grain weight as compared with control treatment (Table 5). The highest 1000-grain weight was observed with application of 5 t CRS ha^{-1} followed by 5 t RS ha^{-1} with no significant differences. Among K fertilizer treatments, 60 kg K_2O ha^{-1} gave the heaviest 1000-grain weight followed by spraying with 2% K_2SO_4 at both PI and LB periods treatment without any significant difference between them in the two seasons under study. Interaction between organic fertilizer and K applied as basal or foliar spray did not show any significant variation in respect of number of unfilled grains panicle^{-1} and weight of 1000-grain in both seasons (Table 5).

Grain and straw yield:

Data in Table 5 indicated that organic fertilizer treatments or K fertilizer application caused significant increase in grain yield as compared with control treatment in both seasons. The highest grain yield was produced when Giza 179 rice variety was fertilized with 5 t CRS ha^{-1}

followed by 5 t RS ha^{-1} treatment without any significant differences. These findings are in line with those of Saha *et al*. (2009) and Sarkar *et al*. (2017) who stated that apply of rice straw in paddy soil improves organic C, N, and availability of P, K, and Si and results in producing more than one ton per hectar yield advantage. Also, a marked superiority was recorded in all potassium treatments against the control in respect of grain yield. Application of 60 kg K_2O ha^{-1} produced the greatest value of grain yield followed by 2% K_2SO_4 applied as foliar spray at both PI and LB periods without any significant difference between them in the two seasons under study. Potassium serves a vital role in photosynthesis by direct increase in rice canopy which improves CO_2 assimilation and increases the translocation of more ATP essential for vigorous growth. Many researchers have stated the affirmative response of K_2SO_4 as foliar application to rice crop (Hussain and Jilani, 1991 and Ramos *et al.* 1999). A similar trend was found by Ali *et al*. (2007) who reported that foliar application of 6.0 % K_2SO_4 at 30 and 45 DAT was a safe and reasonable amount of K fertilizer and can produce yield of rice equal to the yield obtained with basal application of K_2O at the rate of 50 kg ha^{-1}. The interaction between organic fertilizer and K fertilizer treatments in grain yield is presented in Table (6). Data demonstrated that combination of 5 t CRS ha^{-1} with each of K1, K2 and K3 produced the greatest grain yield and came in the first rank followed by the combination of 5 t RS ha^{-1} of each of the same K treatment came in the second rank. While the combination of control treatment which did not receive any of organic fertilizer with the same previous K treatments came in the third rank. The lowest value of grain yield, however, was found when neither organic fertilizer nor K fertilizer was applied. The increases in grain yield when 5 t CRS ha^{-1} combined with either K applied as basal or spray at both PI and LB could be attributed to the gradually decomposition of organic fertilizer under study which release some macro and micro nutrient elements that make continuous supply to the plant by these nutrients through the different stages of plant, at the same time application of K basally with the released nutrients from CRS cause a significant increase in number of tillers and leaves (plant canopy). Moreover, these nutrients lead to an increase in photosynthesis and its products (assimilates) beside the role of K as co-factor for plenty of transferring enzymes. These enzymes improve the rate and percentage of filling, consequently increase number of filled grains, panicle weight and 1000-grain weight resulting in an increase in grain yield (Fischer and Hsiao, 1968). The increase in grain yield also due to the application of K as foliar spray at both PI and LB under CRS treatment might be due to the increase in number of panicles at panicle initiation premordia as well as the increase in the viability of flag leaf plus the second and third leaves which increase photosynthesis and its assimilates resulting in an increase in grain yield as a result to increase in number of panicles, panicle weight, number of filled grain and 1000-grain weight. These results are in harmony with those obtained by Saha *et al.* (2009).

Straw yield was significantly affected due to the application of both organic fertilizer treatments and K fertilizer and their interaction in both seasons (Table 5).

Table 5. Number of filled grain panicle^{-1}, number of unfilled grain panicle^{-1}, 1000-grain weight, grain yield and straw yield of Giza 179 rice variety as affected by organic fertilizer application and potassium treatments and their interaction in 2015 and 2016 seasons

Character Treatment	No. of filled grain panicle^{-1}		No. of unfilled grain panicle^{-1}		1000-grain weight (g)		Grain yield t ha^{-1}		Straw yield t ha^{-1}	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
A-Org. fert.										
Control	119.22c	123.47b	8.24a	7.62a	25.20c	25.73c	9.75c	10.10b	11.60b	12.03b
5 t CRS ha^{-1}	124.30a	130.03a	6.72c	7.05c	25.64a	26.83a	10.65a	10.78a	12.53a	12.69a
5 t RS ha^{-1}	120.95b	128.27a	7.97b	7.33b	25.52a	26.78a	10.38ab	10.53a	12.50a	12.60a
B-K treat.										
K0	113.18c	121.18c	8.11a	8.01a	24.73c	25.65b	9.83c	9.89c	11.77c	11.92c
K1	125.07a	129.89a	7.87b	7.39b	25.79a	27.00a	10.60a	10.71a	12.59a	12.94a
K2	121.40b	127.83b	7.41c	7.15b	25.60b	26.36b	10.30b	10.47b	12.12b	12.24b
K3	126.31a	130.13a	7.17d	6.78d	25.68ab	26.79a	10.47ab	10.63ab	12.35ab	12.64ab
AxB	*	*	NS	NS	NS	NS	*	*	*	*

K0 = control, K1= basal of 60 kg K_2O ha^{-1}, K2 = basal of 30 kg K_2O ha^{-1} plus 2% K_2SO_4 foliar at PI and K3 = 2% K_2SO_4 foliar at both PI and LB.

Application of both CRS and RS gave the greatest straw yield without any significant difference between them as compared with control. Concerning to K treatments, K1 and K3 produced the highest straw yield followed by K2, while the treatment which did not receive any K fertilizer (control) gave the least in the two studied seasons. Interaction of organic fertilizer treatments and K fertilizer application significantly affected the straw yield in both seasons (Table 6). Application of 5 t CRS ha^{-1} or 5 t RS ha^{-1} combined with K1 produced the maximum values of straw yield without any significant differences. The minimum values of straw yield, however, were obtained when neither organic fertilizer nor K fertilizer was added.

These results are in agreement with those obtained by Ranamukhaarachchi and Ratnayake (2006) who reported that straw yield was significantly lower in treatments that had a limited supply of K, as well as organic matter.

Grain quality characteristics:

Organic fertilizer treatments and K fertilizer application caused a significant increase in the percentage of grain quality under study as compared with control treatment in both seasons (Table 7). Application of 5 t RS ha^{-1} or 5 t CRS ha^{-1} produced the highest percentage of hulling while, milling and head rice of grains reached to the maximum value when the tested variety fertilized with 5 t RS ha^{-1} followed by 5 t CRS ha^{-1} in both seasons.

Table 6. Number of filled grain panicles^{-1}, grain yield t ha^{-1} and straw yield t ha^{-1} of Giza 179 rice variety as affected by interaction between organic fertilizer and potassium treatments application in 2015 and 2016 seasons

	Number of filled grain panicles^{-1}							
	2015				2016			
K treatment Org. fert.	**K0**	**K1**	**K2**	**K3**	**K0**	**K1**	**K2**	**K3**
Control	109.00e	124.47b	119.13c	124.27b	118.00d	126.13b	123.63c	126.13b
5 t CRS ha^{-1}	118.67c	126.20a	123.67b	128.67a	123.33c	132.73a	131.07a	133.00a
5 t RS ha^{-1}	111.87d	124.53ab	121.40c	126.00a	122.20c	130.53a	128.80b	131.53a
	Grain yield t ha^{-1}							
Control	9.34d	10.06c	9.67cd	9.91c	9.53e	10.39cb	10.19c	10.30c
5 t CRS ha^{-1}	10.25c	10.93a	10.63b	10.78a	10.31c	11.00a	10.85a	10.96a
5 t RS ha^{-1}	9.85cd	10.75a	10.39b	10.54ab	9.90d	10.80a	10.60b	10.82a
	Straw yield t ha^{-1}							
Control	11.50c	11.66c	11.74bc	11.51c	11.73c	12.23bc	11.97bc	12.18bc
5 t CRS ha^{-1}	11.87bc	13.04a	12.34b	12.86a	11.97bc	13.39a	12.43b	12.69b
5 t RS ha^{-1}	11.95bc	13.08a	12.29b	12.68ab	12.06bc	13.20ab	12.33b	12.60b

K0 = control, K1= basal of 60 kg K_2O ha^{-1}, K2 = basal of 30 kg K_2O ha^{-1} plus 2% K_2SO_4 foliar at PI and K3 = 2% K_2SO_4 foliar at both PI and LB.

Table 7. Percentage of hulling, milling and head rice in grains of Giza 179 rice variety as affected by organic fertilizer application and potassium treatments and their interaction in 2015 and 2016 seasons

Character Treatment	Hulling %		Milling %		Head rice %	
	2015	2016	2015	2016	2015	2016
A-Org. fertilizer						
Control	77.22b	78.17b	65.33c	65.34c	81.91c	83.74c
5 t CRS ha^{-1}	78.00a	78.83a	65.51b	66.26b	85.69b	86.63b
5 t RS ha^{-1}	78.31a	78.94a	66.11a	66.67a	86.88a	87.11a
B-K treatment						
K0	76.70d	77.22d	64.77c	64.56c	78.58b	81.05c
K1	77.74c	78.11c	65.66b	66.23b	85.97a	86.83b
K2	78.13bc	79.08b	66.00a	66.51b	86.65a	87.54a
K3	78.80a	80.07a	66.17a	67.06a	86.76a	87.88a
AxB	*	*	*	*	*	**

K0 = control, K1= basal of 60 kg K_2O ha^{-1},
K2 = basal of 30 kg K_2O ha^{-1} plus 2% K_2SO_4 foliar at PI and
K3 = 2% K_2SO_4 foliar at both PI and LB.

The lowest percentage in the grain quality was observed under control treatment in the two studied seasons. These results are in agreement with Metwally (2015) who reported that application of different organic materials significantly increased percentage of hulling, milling and head rice in grains of Giza 179 rice variety.

The highest values were recorded when rice plants were fertilized with compost rice straw. This could be attributed to the adequate amount of nutrients (N,P and K) released from the decomposed of the organic fertilizer under study that cause an increase the filling process resulting in accumulation of desirable amounts of starch in the indosperm consequently decrease the thickness and weight of hull and bran of grains. Data also showed that significant differences were obtained among K fertilizer treatments regards to percentage of hulling, milling and head rice of grains, where applying K either basal or foliar spray resulted in increase of percentage of hulling, milling and head rice of grains compared to control. Potassium fertilizer treatment, applied as foliar spray with 2% K_2SO_4 at both PI and LB periods, produced the greatest percentage of hulling, milling and head rice of grains.

While the lowest percentage of hulling, milling and head rice of grains were obtained with control treatment. The increases in hulling, milling and head percentage due to application of K as foliar spray at both PI and LB might be attributed to the role of K for translocation the photosynthetic products (assimilates) from flag leaf and other green leaves to the panicles that cause complete accumulation of the starch in grains, consequently increase the weight of starchy indosperm and reduce the thickness and weight of the hull of grains.

Interaction between organic fertilizer and K treatments applications significantly affected the percentage of hulling, milling and head rice of grains in both seasons (Table 8).

Table 8. Percentage of hulling, milling and head rice of Giza 179 rice variety as affected by interaction between organic fertilizer and potassium treatments application in 2015 and 2016 seasons

	Hulling (%)							
K treatment Org. fert.	2015				2016			
	K0	**K1**	**K2**	**K3**	**K0**	**K1**	**K2**	**K3**
Control	76.22d	77.00c	77.27c	78.39b	77.00c	77.34c	78.33b	78.83b
5 t CRS ha^{-1}	76.88c	78.00b	78.22b	78.89a	77.17c	78.50b	79.25b	80.00a
5 t RS ha^{-1}	77.00c	78.22b	78.89a	79.11a	77.50c	78.50b	79.67a	80.39a
	Milling (%)							
Control	64.33c	65.32c	65.67b	66.00b	64.00d	65.69c	65.84b	65.84b
5 t CRS ha^{-1}	64.44c	65.77b	65.89b	65.94b	64.67cd	66.70b	66.34b	67.50a
5 t RS ha^{-1}	65.55bc	65.89b	66.44a	66.56a	65.00c	66.83b	67.34a	67.84a
	Head rice (%)							
Control	75.55d	83.14b	84.42b	84.51b	78.48f	84.40d	85.82c	86.26c
5 t CRS ha^{-1}	80.01c	87.07a	87.79a	87.89a	82.20e	87.55ab	88.22a	88.54a
5 t RS ha^{-1}	80.18c	87.69a	87.75a	87.89a	82.48e	88.50a	88.57a	88.84a

K0 = control, K1= basal of 60 kg K_2O ha^{-1}, K2 = basal of 30 kg K_2O ha^{-1} plus 2% K_2SO_4 foliar at PI and K3 = 2% K_2SO_4 foliar at both PI and LB.

The combination of either 5 t CRS ha^{-1} or 5 t RS ha^{-1} treatments with any of potassium fertilizer treatments cased an increase in percentage of hulling, milling and head rice of grains as compared with control (neither organic fertilizer nor K fertilizer was added). The combination of 5 t RS ha^{-1} with 2% K_2SO_4 at both PI and LB (K3) treatments as foliar spray produced the maximum values of hulling% which was statistically at par with combination of 5 t RS ha^{-1} with K2 and combination of 5 t CRS ha^{-1} with K3 in the two studied seasons. The same trend was observed with milling character in second season, while in the first season, 5 t RS ha^{-1} gave the highest milling % when combined with both K2 and K3 treatments. Concerning to the head rice, data in Table 8 revealed that combination of either 5 t CRS ha^{-1} or 5 t RS ha^{-1} with each of K1, K2 and K3 produced the highest percentages of head rice without any significant difference among them in both seasons. The lowest percentage of hulling, milling and head rice were found when neither organic fertilizer nor K fertilizer was added.

Available soil-K (ppm):

Available soil-K (ppm) at different days from transplanting (30, 60 and 90) as affected by application of organic fertilizers and K treatments is presented in Figures 1 and 2. The highest increment of available soil-K were recorded at 30 DAT, and decreased afterwards to the minimum at 90 DAT. The highest values of K availability were obtained with using 5 tons rice straw ha^{-1} followed by using 5 tons compost rice straw ha^{-1} (Fig. 1).

This may be due to that soil solution K is higher in the straw treatments. The other reason could be to higher increase in the soil solution Fe_2^+ and Mn_2^+, caused by rice straw, which release K from exchange complexes. These results are in harmony with those obtained by Kaur and Benipal (2006) who reported that recycling rice straw to the field could improve soil available potassium to a significant extent more than manure. Liao *et al.* (2013) indicated that straw management could increase exchangeable K by 26.4% and nonexchangeable K by 1.8% in comparison to a control treatment. Among K fertilizer treatments, in both seasons a little influence of the K fertilization on the soil available K was observed. A slightly higher amount of available K was observed in those plots, where 60 kg K_2O ha^{-1} was added (fig. 2).

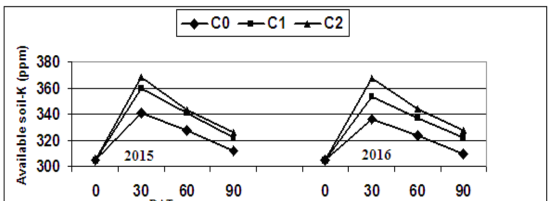

Fig. 1: Available soil-K (ppm) in the soil at 30, 60 and 90 days after transplanting (DAT) as affected by organic fertilizer treatments in 2015 and 2016 seasons

C0 = control, C2 = 5 t CRS ha^{-1} and C2 = 5 t CRS ha^{-1}

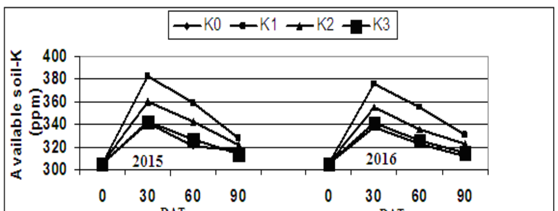

Fig. 2: Available soil-K (ppm) in the soil at 30, 60 and 90 days after transplanting (DAT) as affected by K fertilizer treatments in 2015 and 2016 seasons

K0 = control, K1= basal of 60 kg K_2O ha^{-1},
K2 = basal of 30 kg K_2O ha^{-1} plus 2% K_2SO_4 foliar at PI and
K3 = 2% K_2SO_4 foliar at both PI and LB.

Potassium uptake kg ha^{-1}

Potassium uptake by grain and straw yield significantly differed among organic fertilizer application, K treatments and their interaction in 2015 and 2016 seasons (Table 9).

Table 9. Potassium uptake kg ha^{-1} of Giza 179 rice variety as affected by organic fertilizer application and potassium treatments and their interaction in 2015 and 2016 seasons

Character	K uptake by grain		K uptake by straw	
Treatment	2015	2016	2015	2016
A-Org. fertilizer				
Control	24.55c	25.74b	132.10c	132.56c
5 t CRS ha^{-1}	27.68b	27.18a	143.31b	141.80b
5 t RS ha^{-1}	28.86a	27.76a	148.03a	145.83a
B-K treatment				
K0	23.91d	24.19d	114.07c	113.97c
K1	28.92a	28.33a	152.21a	152.40a
K2	27.30c	27.40bc	150.27ab	147.56ab
K3	27.98b	27.65b	148.04b	146.32b
AxB	*	**	**	**

K0 = control, K1= basal of 60 kg K_2O ha^{-1},
K2 = basal of 30 kg K_2O ha^{-1} plus 2% K_2SO_4 foliar at PI and
K3 = 2% K_2SO_4 foliar at both PI and LB.

Data indicated that application of organic fertilizer caused a significant increase in K uptake by grain and straw yield compared with control in both seasons. The greatest values of K uptake by grains and straw yield were found with application of 5 t RS ha^{-1} followed by application of 5 t CRS ha^{-1}. These findings are in close agreement with Ponnamperuma, (1984) and Sarkar *et al.* (2017) who reported that potassium in rice straw is water soluble and is readily available to rice. Incorporating rice straw cause an increases in the available K (ppm) in the soil which reflect an increase in K uptake by rice. Data in table 9 also showed significant differences obtained among K fertilizer treatments regards to K uptake by grain and straw yield, where applying K either basal or foliar spray resulted in an increase in K uptake compared to control. Among K fertilizer treatments, in both seasons application of 60 kg K_2O ha^{-1} gave the greatest value of K uptake by grain and straw yield, followed by application of K3 in grains and by K2 treatment in straw. On contrast, the lowest K uptake by grain and straw yield was obtained with control (K0). These findings are in line with those obtained by Ali *et al.* (2007) who reported that maximum K uptake by paddy was recorded with application of K_2O at the rate of 50 kg ha^{-1}, which was statistically equal to 6.0 % K_2SO_4 foliar application. The K uptake by straw was also significantly affected with K_2SO_4 foliar spray and soil application. However, uptake pattern was not similar as noticed in K uptake by paddy.

Interaction between organic fertilizer and K treatments applications significantly affected the potassium uptake by grain and straw yield in both seasons (Table 10). The application of either 5 t CRS ha^{-1} or 5 t RS ha^{-1} treatments with any of potassium treatment caused an increase in K uptake compared with control. Application of 5 t CRS ha^{-1} or 5 t RS ha^{-1} combined with K1 produced the maximum values of K uptake by grain and straw yield without any significant difference between them in both seasons. The minimum values of K uptake by grain and straw yield, however, were obtained by the control treatment (neither organic fertilizer nor K fertilizer was added). These results are in agreement with those obtained by Saha, *et al*. (2009) who found that application of K fertilizer either as chemical K or rice straw and their combination of both increased the K uptake by rice plant

Table 10. Potassium uptake kg ha^{-1} of Giza 179 rice variety as affected by interaction between organic fertilizer and potassium treatments application in 2015 and 2016 seasons

K treatment / Org. fert.	K uptake kg ha^{-1} by grain yield							
	2015				2016			
	K0	K1	K2	K3	K0	K1	K2	K3
Control	21.31f	26.37c	24.55	25.98c	22.48f	27.30c	26.44c	26.73c
5 t CRS ha^{-1}	24.15e	29.83a	28.28b	28.46b	24.16e	28.74a	27.71b	28.11b
5 t RS ha^{-1}	26.28c	30.59a	29.06b	29.52b	25.94d	28.95a	28.04b	28.11b
	K uptake kg ha^{-1} by straw yield							
Control	99.83f	145.85c	142.85c	139.87c	101.38g	147.13c	141.34d	140.40d
5 t CRS ha^{-1}	117.34e	153.84a	152.12b	149.95bc	115.44f	153.27ab	150.19b	148.31c
5 t RS ha^{-1}	125.03d	156.95a	155.84a	154.31a	125.09e	156.80a	151.16b	150.26b

K0 = control, K1= basal of 60 kg K_2O ha^{-1}, K2 = basal of 30 kg K_2O ha^{-1} plus 2% K_2SO_4 foliar at PI and K3 = 2% K_2SO_4 foliar at both PI and LB.

CONCLUSION

According to the previous results, the combination of the application of 5 t compost rice straw ha^{-1} (5 t CRS ha^{-1}) with 2% K_2SO_4 as foliar spray at both panicle initiation (PI) and late booting (LB) gave the same greatest grain yield as the application of combination between 5 t CRS ha^{-1} with 60 kg K_2O ha^{-1}. So, from economical point of view spraying Giza 179 rice variety by 2% K_2SO_4 at both PI and LB and combined with 5 t CRS ha^{-1} was the best treatment because it may saved about 40 kg K_2O ha^{-1}.

The combination between either CRS or RS with K3 (2% K_2SO_4 at both PI and LB) improved each of hulling, milling and head rice percentage in grains of Giza 179 rice variety.

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تأثير إضافة كمبوست قش الأرز و قش الأرز كسماد عضوى و معاملات السماد البوتاسى على محصول وبعض صفات جودة الحبوب لصنف الأرز جيزة ١٧٩

السيد السيد جويلى
مركز البحوث والتدريب فى الأرز – معهد بحوث المحاصيل الحقلية مركز البحوث الزراعية – سخا – كفر الشيخ – مصر .

أجريت هذه الدراسة فى موسمى زراعه الأرز٢٠١٥ و ٢٠١٦بالمزرعه البحثية لمركز البحوث و التدريب في الأرز- سخا – كفر الشيخ – مصر وذلك لدراسة تأثير إضافة كل من كمبوست قش الأرز و قش الأرز كسماد عضوى وكانت المعاملات هي بدون إضافة, إضافة كمبوست قش الأرز بمعدل ٥ طن للهكتار و إضافة قش الأرز بمعدل ٥ طن للهكتار وكذلك تأثير إضافة السماد البوتاسى و كانت المعاملات هي بدون إضافة (كنترول), إضافة ٦٠ كجم K_2O للهكتار, و إضافة٣٠ كجم K_2O للهكتار و الرش بسماد سلفات البوتاسيوم بتركيز ٢% عند بدء تكوين السنبلة و الرش بسماد سلفات البوتاسيوم بتركيز ٢% عند كل من بدء تكوين السنبلة و قبيل طرد السنابل. كان تصميم التجربة هو القطع المنشقة مرة واحدة وذلك في أربع مكررات حيث وضعت معاملات المادة العضوية بالقطع الرئيسية ووضعت معاملات السماد البوتاسي بالقطع الشقية. وتمت دراسة الصفات الآتية: طول النبات - عدد الفروع للجورة – وزن السنبلة – طول السنبلة -عدد السنابل لكل جوره –عدد الفروع للسنبلة- عدد الحبوب الممتلئة وعدد الحبوب الفارغة لكل سنبلة, وزن ١٠٠٠– حبه, محصول الحبوب و القش,صفات جودة الحبوب (نسبة كل من التقشير, التبييض و الحبوب السليمة), كمية البوتاسيوم المتاح بالتربة بعد ٣٠,٦٠ و ٩٠ يوم من الشتل وكمية البوتاسيوم الممتص. وقد أوضحت النتائج الاتى:- أن كل الصفات المدروسة قد أعطت أعلى القيم ماعدا طول السنبلة وذلك بتطبيق إضافة أي من كمبوست قش الأرز أو قش الأرز بمعدل ٥ طن للهكتار وذلك مقارنه بالكنترول (بدون إضافة). و كذلك أوضحت النتائج أن إضافة البوتاسيوم بمعدل٦٠ كجم K_2O للهكتار ا و الرش بسماد سلفات البوتاسيوم بتركيز ٢% عند كل من بدء تكوين السنبلة و قبيل طرد السنابل قد أعطى أعلى القيم للصفات المدروسة بدون فروق معنوية بينهما وذلك مقارنة بالكنترول (بدون معاملة). و قد أوضحت نتائج التفاعل بين السماد العضوي ومعاملات السماد البوتاسى أن إضافة كمبوست قش الأرز بمعدل ٥ طن للهكتار مع إضافة سماد البوتاسيوم بمعدل٦٠ كجم K_2O للهكتار أو الرش بسماد سلفات البوتاسيوم بتركيز ٢% عند كل من بدء تكوين السنبلة و قبيل طرد السنابل قد أعطي أعلى القيم لكل من عدد السنابل لكل جورة, عدد الحبوب الممتلئة لكل سنبلة و محصول الحبوب بينما وجد إن وزن السنبلة و محصول القش قد أعطت اعلي القيم عند إضافة قش الأرز بمعدل ٥ طن للهكتار مع كل من إضافة البوتاسيوم بمعدل٦٠ كجم K_2O للهكتار أو الرش بسماد سلفات البوتاسيوم بتركيز ٢% عند كلا من بدء تكوين السنبلة و قبيل طرد السنابل. و لم يكن هناك تأثيرا معنويا للتفاعل بين السماد العضوي مع السماد البوتاسي على باقى الصفات المدروسة. وقد أوضحت النتائج أيضا أن أعلى القيم في نسبة التقشير قد نتجت بإضافة كمبوست قش الأرز بمعدل ٥ طن للهكتار بينما أعلى القيم لكل من نسبة التبييض و نسبة الحبوب السليمة قد تحققت عند إضافة قش الأرز بمعدل ٥ طن للهكتار.كما بينت النتائج أيضا أن إضافة السماد البوتاسي من خلال الرش بسماد سلفات البوتاسيوم بتركيز ٢% عند كل من بدء تكوين السنبلة و قبيل طرد السنابل قد أعطى أعلى القيم لكل من نسبة التقشير و نسبة التبييض بينما أعلى القيم لنسبة الحبوب السليمة قد نتجت عند إضافة السماد البوتاسى من خلال كل من إضافة٣٠ كجم K_2O للهكتار و الرش بسماد سلفات البوتاسيوم بتركيز ٢% عند بدء تكوين السنبلة أو الرش بسماد سلفات البوتاسيوم بتركيز ٢% عند كل من بدء تكوين السنبلة و قبيل طرد السنابل. كما أظهرت نتائج التفاعل بين السماد العضوي ومعاملات السماد البوتاسى أن إضافة قش الأرز بمعدل ٥ طن للهكتار مع إضافة البوتاسيوم بمعدل٦٠ كجم K_2O للهكتار أو الرش بسماد سلفات البوتاسيوم بتركيز ٢% عند كل من بدء تكوين السنبلة و قبيل طرد السنابل قد أعطي أعلى القيم لكل من نسبة التقشير و نسبة التبييض بينما أعلى القيم لنسبة الحبوب السليمة نتجت عند إضافة كل من كمبوست قش الأرز أو قش الأرز بمعدل ٥ طن للهكتار مع تطبيق إضافة السماد البوتاسى بأي معاملة. و قد بينت النتائج أيضا أن أعلي القيم لكمية البوتاسيوم المتاح بالتربة قد سجلت عند ٣٠ يوما من الشتل, و ذلك بإضافة قش الأرز . وكانت أعلى القيم لكمية البوتاسيوم الممتص قد نتجت بإضافة كل من كمبوست قش الأرز أو قش الأرز مع إضافة ٦٠كجم K_2O للهكتار. و قد أظهرت النتائج أن إضافة كمبوست قش الأرز بمعدل ٥ طن للهكتار مع الرش بسماد سلفات البوتاسيوم بتركيز ٢% عند كل من بدء تكوين السنبلة و قبيل طرد السنابل قد أعطي أعلى محصول مما قد يوفر ما يقرب من ٤٠ كجم K_2O للهكتار. و أن إضافة أي من كمبوست قش الأرز أو قش الأرز بمعدل ٥ طن للهكتار مع الرش بسماد سلفات البوتاسيوم بتركيز ٢% عند كل من بدء تكوين السنبلة و قبيل طرد السنابل قد أدى إلي تحسين جودة الحبوب لصنف جيزة ١٧٩.