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Influence of Mineral and Organic Fertilizers on Rice Kernel Smut Disease

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ABSTRACT

Disease resistance of rice plant is mainly genetically controlled but has a close association with the soil fertility status of the plants or pathogens; and thus, nutrient management has always been an important regulator for rice plant diseases. There is a dynamic interrelation between the soil fertility of rice plants with pathogen and abiotic environment, and hence, proper management of nutrients in cultivated rice crop can effectively reduce the severity of most diseases. Therefore, the current research is aimed to investigate the effects of mineral and organic fertizers of kernel smut incidence disease on the Giza 178 rice cultiver. Laboratory and field experiments were carried out at Rice Research & Training Center (RRTC) during 2016 and 2017 grwoing seasons. Kernel smut disease, caused by *Tilletia barclayana* was isolated and identificated in this study. Pathogenicity test was carried out on Giza 171, the most sensitive rice cultivar. While Giza 178 was used to field evaluated. Randomized complete block design (RCBD) experiment with three replicates was used. Farm yard manure (FYM), compost and different P, K and Zn combinations (total 15 treatments) with and without urea application were used. Chlorophyll content, leaf area, total protein, total carbohydrate, rice grain yield, disease assessment, plant analysis for total N, P, K and Zn were estimated. The results indicated that, the highest N% content was obtained from FYM+Zn and P+compost combination. There were significant differences between FYM, composts and mineral fertilizer application with and without urea on rice disease incidence. Also, chlorophyll content, leaf area and grain yield were significantally affected by applying mineral and organic fertilizer with and without urea application. The hulling% and milling% decreased by increasing the disease severity. The infection % of Giza 178 rice cultivar without urea application ranged from 6.5% to 10.20% in 2016 and 2017 seasons, respectively , while with application of urea increased the infection% to the range from 21.75% to 24.50% in the same seasons.

Keywords: Kernel smut incidence, rice yield, organic fertilizer, mineral fertilzer.

INTRODUCTION

Kernel smut is a fungal rice disease caused by *T. barclayana*. This disease is a serious threat affecting negatively on rice yield and grains quality. Rice yield losses caused by kernel smut range from 1% to 15% (Ladhalakshmi *et al*., 2012). Kernel smut appears as a black mass of chlamydospores that replace all or part of individual kernels near or at maturity (Alice *et al*., 2003). Usually, only a small number of kernels in each panicle are infected. Completely smutted kernels may be slightly swollen while others may break open exposing the dark spores (Mandhare *et al*., 2008). These black spores make the disease easy to recognizes. If the disease is severe, a dark cloud of spores may be observed coming from the harvesters. Rice kernel smut incidence is affected by rice cultivars (Slaton *et al*., 2007), seeding rate or their interaction. However, its has been proven that this disease is nor affected by air temperature nor by precipitation (Biswas, 2003) and Zemolin *et al*., (2009) reported the rice kernel smut (*T. barclayana*), which is considered as a secondary disease, lately has been growing in importance due to its high infestation levels and effects in rice yield.

The most important for high yielding rice production is soil fertility management which may affect the response of rice plants to diseases due to the change of microclimate under rice plant canopy (Altieri and Nicolls, 2003). The knowledge of soil fertility is a basis for setting up a high yield production system. The capacity of a resistant plant to diseases is strictly related to optimal physical, chemical and mainly biological characteristics of soils. Nitrogen management studies suggest that high preflooding applications of nitrogen increases kernel smut severity but only when environmental conditions are favourable for disease incidence (Slaton *et al*., 2004). Application of organic materials alone or in combination with inorganic fertilizer help in maintenance of soil fertility and crop productivity (Assefa, 2015). The understanding of these interactions between different sources of mineral and organic fertilizers and disease becomes the basis for design of the sustainable rice production system. Therefore, the current research aimed to investigate the effects of mineral and organic fertilzers on incidence of kernel smut in Giza 178 rice cultivar.

MATERIALS AND METHODS

Isolation, Identification and pathogen culture preparation

Isolates of rice kernel smut fungus were undertaken according to Anil and Singh (1987). The fungus was identified morphologically and microscopically, and type of germination was recoanized at Rice Plant Pathology Lab. at RRTC using the key given by Fischer and Holton (1957). The source of isolaties were isolated from different rice cultivares and governorates as Table 4.The fungus was grown on Potato dextrose agar media, then incubated at 26±2°C for 7 days. Plates were exposed to continuous fluorescent light for 48 hours to enhance sporulation. Inoculum of secondry sporidia suspension was prepared with adding 10 ml sterilized water in each dish. Mycelia mats were harvested by spatula and filtered through cheese cloth. Spore suspension was adjusted to $5x10^7$ secondary sporidia per ml.

Scanning Electron Microscopy (SEM)

The morphology of culture for *T. barclayana* was examined by SEM using Jeol Scanning (Electron Microscope model JSM- 5500lv at Electron Microscope Unit, Tanta University) to identifying the fungus.The spores pathogen were grown on potato dextrose agar for 7 days at 28°C. Preparation of specimens for SEM was carried out according to Manzali *et al*. (1993). One cm^2 was excluded for SEM. The mycelial sample region was fixed with osmium oxide and then dehydrated using a serial dilution of ethylalcohol, then finally acetone. The processed sample was then dried using a critical point drier (EMS 850) coated with gold using a sputter coater (EMS

550), then the sample was examined using a SEM (Jeol 100cx-11 ASID-4D).

Greenhouse Experiment and Pathogenicity test

Fourty two isolates of *T. barclayana* isolated from different location and cultivars. Giza 171 rice cultivar (sensitive Egyptian cultivar for rice kernel smut disease) was used with three replication , and seeded in plastic pots 25 cm diameterX 30cm. the pots were kept in the greenhouse at 25±30^{o} C and fertilized with urea 46.5% N (5gm/plot). Plants at flowering stage were sprayed with 5x10^{7} secondary sporidia ml^{-1} of each isolate using electrical spray gun (atomizer).The inoculated plants were held in a moist chamber with at least 95% RH and 25±28^{o}C for 24 hrs and then kept in the greenhouse till maturity. Disease severity was assessed using number of infected grains and total number of grains per panicles (Slaton *et al*., 2004).

chemical analysis

Soil and organic fertilizer samples

Soil samples were collected from RRTC experimental farm, Sakha, Kafr El-Sheikh, Egypt. Soil samples were air-dried at room temperature for two weeks and then sieved by 2-mm stainless steel sieve. The pH and EC of samples were measured (using 1: 2.5 ratio with distilled water) by pH-meter and the EC meter, respectively. Particle size distribution was analyzed according to Gee and Bauder (1996). Organic matter was dtermined according to Allison (1965) while available P, K and Zn were measured using the methods of Watanabe and Olsen, (1956) and Jackson (1967), respectively. Some selected soil and organic fertilizer properties are shown in Tables 1 and 2.

Table 1. Some chemical and physical properties of soil used

Property	2016	2017	Method
EC (dS m^{-1})	2.50	3.70	EC-meter
pH (1:2.5)	7.84	7.63	pH-meter
Oranic matter (%)	1.30	1.28	Allison (1965)
Total N (mg kg^{-1})	22.4	39.2	Bremner (1965)
Available P (mg kg^{-1})	7.50	9.57	Watanabe and Olsen (1965)
Available Zn (mg kg^{-1})	2.00	2.35	Jackson (1967)
Available K (mg kg^{-1})	138.6	168.0	Jackson (1967)
Sand %	21.40	21.8	Gee and Bauder (1996)
Silt %	29.0	28.4	Gee and Bauder (1996)
Clay %	49.6	49.8	Gee and Bauder (1996)
Texture	Clayey	Clayey	

Table 2. Chemical properties of farmyard manure and compost used in the experiment

Property	Farmyard manure	Compost	Method
Total N%	1.50	0.95	Bremner (1965)
Total C%	29.5	18.0	Allison (1965)
C:N ratio	19.6	18.3	
Total P (mg kg^{-1})	0.21	0.15	Watanabe and Olsen (1965)
Total Zn (mg kg^{-1})	62.0	75.0	Jackson (1967)
Total K (mg kg^{-1})	1.50	1.10	Jackson (1967)
Oranic matter (%)	53.5	31.5	Allison (1965)

Field evaluation:

Randomized complete block design (RCBD) experiment with three replicates was adopted for each treatment on susceptible Giza 178 cv under natural infection of kernel smut incidence. Effect of different nitrogen sources and P, K and Zn as treatment are shown in Table 3.

Table 3. Treatments combination

Treatment*	
PKZn	P
FYM + PKZn	FYM + P
Compost + P K Zn	Compost + P
Zn	K
FYM + Zn	FYM + K
Compost + Zn	Compost + K
FYM	Compost
Control	

***The same treamenst were repeated with 150 kg urea application**

The plot size was 3x3 m. After preparing the soil, added the quantity of FYM (5 m^{3}/ Fadden), Compost (5 m^{3}/ Fadden), Phosphor (100 kg/ Fadden) and 1:2 quantity of potassium (100 kg/ Fadden) were added to the dry soil. Zinc (10 kg/ Fadden) were added after preparing the plots. Thirty days old seedlings were transplanted in rows with three plants /hill. The other half of Potassium was added in flowering stage. Samples of rice grains were taken at the late maturity and all yield compontes were taken recorded beginning from two weeks after fertilization.

Chlorophyll content

Total chlorophyll content of rice leaves was determined using chlorophyll meter (SPAD-502) as method of Kalboush (2007).

Plant analysis

Dry oven rice leaves samples (0.20 g) from each treatment at flowering stage were digested with 5 ml of H_2SO_4+1 ml $HClO_4$ acid 70% for 4 hrs using a hot block heater. After cooling, the digest was transferred to a 50-ml volumetric flask and then filtered. Total N content was determined by the modified micro-Kjeldahi methods as described by Bremner (1965). Phosphorus (P) was determined calorimetrically by ascorbic acid according to Olsen *et al*. (1954). Potassium (K) was determined by the flame photometer as described by Jackson (1967). Zinc (Zn) concentrations of these samples were determined according to Jackson (1967), using atomic absorption spectrophotometry model (2380).

After harvest, rice grain samples were taken from each treatment and examined at grain quality Laboratory of the RRTC to determine some grain quality characters, as percentages of hulling, milling, total proteins and total carbohydrates.

Hulling % was calculated according to Adair (1952) as follows:

$$\text{Hulling (\%)} = \frac{\text{Weight of brown rice (g)}}{\text{Weight of rough rice (g)}} \text{ X 100}$$

$$\text{Milling (\%)} = \frac{\text{Weight of milled rice (g)}}{\text{Weight of rough rice (g)}} \text{ X 100}$$

Determination of total protein

Total protein content was determined by the modified micro-kjeldahi method as described by Bremner (1965). Grain materials which were randomly collected from each plot were oven dried at 70^{o}C for 3days, then ground and samples were triplicated to indicate the levels of protein and carbohydrate. The milled grain sample (0.20g) was digested as described above. Ten Ml from digested solution were added to 10 ml NaOH 20% solution and diluted up to 100 ml by distilled water and left for 30 minutes in micro-Kjeldahi. The protein content in the grains (%) was calculated by multiplying N content of the grains (%) with the conversion factor of 6.25 as reported by Anon (1962).

Determination of total carbohydrate

Total Carbohydrates were determined in digestion suspension by adding (5ml phenol+ 5ml H_2SO_4). The absorbance was measured at 490 nm using spectrophotometer (Milton Roy, Spectronic, 1201 Digital) according to the method described by Herbert *et al.* (1971).

Disease Assessment

Disease severity of infection was estimated with calculated 400 randomly grain during harvested yield from each plot , the grains examind and calculating the number of smut grains to musered infection severity according to the (IRRI, 2002) as following:

$$\text{Disease Severity \%} = \frac{\text{No. of infected grain/panicles}}{\text{Total no. of rice grain/ panicles}} \text{ X 100}$$

Disease infection percentage was measured with collecting hundered panicles randomly from each plot and calculated as panicles condacted one or more smut grains, measured infection percentage according to formula (Slaton *et al*., 2004) as following:

$$\text{Disease Infection \%} = \frac{\text{No. of infected panicles}}{\text{Total no. of rice panicles}} \text{ X 100}$$

Statistical analysis

Data were statistically analyzed using standard statistical analysis with MSTATC pakcage. In the table of main treatments, Ducan Multiple Range Test (Range, 1955**)** was applied to compare the significantly different averages by using critical difference values at 5% level of probability

RESULTS AND DISCUSSION

Isolation and Identification

Kernel smut disease caused by *T. barclayana* appeared at leate maturity as in (Fig. 1A and B). Our results under steriomicrosope indicated that a black mass of ooze pushes out of the hull to become visible. By the time, the teliospore masses dry down to a powder and can easily be rubbed off on fingers. The isolates were identified according to their morphological characteristics as *T. barclayana* (Bref.) Sacc. and Syd. Morphological characters of the teliotospores are light brown to black, globose or sub-globose measuring 12-35 µm in diameter with or without an appendage in (Fig. 1C). Along with these spores, sterile cells are also found in the powdery mass which are more or less globose, hyaline to yellowish tinted, 10-30 µm in diameter in (Fig.1C). Teliospore germinated producing promycelium in (Fig.1D1) which produces a large number of primary sporidia (basidiospores) in Fig (1D2&3). The promycelium is mostly simple, non-septate to 1-3 septate, 7 µm in diameter and 35-52 µm in length. The primary sporidia are long, cylindrical to filliform or needle shaped with flat base and pointed tip measuring 35-60 µm in length, 1.3-2 µm in size in Fig (1E1&2). Each haploid cell of the basidiospore in fig (1F)can produce hyphae, filiform sporidia after the mating gave the secondary sporidia in Fig (1G1), and it is the primary infective unit of such fungus. The seconddary sporidia are hyaline and curved/allantoid, 7.5-14 x 1.2-2 µm in size under electron microscope in Fig (1G2,3 and 4). Matsumoto *et al*. (1985) observed considerablle variation in teliospores of different isolates of N. horrida in California. These morphological differences and range in variation were used to compile specific criterion for the identification of this species which can be used by quarantine personnels. This fungus was previously reported to be the causal agent of rice kernel smut disease (Takahashi, 1896; Biswas *et al*., 2003).

Pathogenicity test

Fourty two kernel smut isolate which collected from different cultivars and locations were carried out using Giza 171 cv as the most susceptible one.The tested isolates varied in their virulence. Isolates number 12, 28, 29 , 11 and 14 previously isolated from diseased rice samples collected from Kafrelsheik, Dakahlia and Gharbia governorates, respectively proved to be the most aggressive isolates for Sakha 101 rice cv., Giza 178 and Giza 177. However, isolate no. 10 isolated from Kafrelsheikh governorate as was the least virulent one which gave the least disease severity among all tested isolates as indicated in Table (4). Pathogenecity tests revealed that these isolates were pathogenic to kernel rice with variable degrees (El-Kazzaz, *et al*., 2014). Sharma, *et al*. (2001) evaluated the pathogenisty test for *T. barclayana* using different forms of spores viz. primary as well as secondary sporidia by the syringe and spray methods in a field experiment. The plants were inoculated with secondary sporidia 8x10^5 sporidia/ml (10 ml/culture tube) at evening. The plants injected at late boot to early heading stage, exhibited 100% panicle infection. The highest grain infection ranged from 38.4 to 62.2% (average of 48.3%) using the syringe method and from 8.5 to 12.7% (average of 10.9%) using the spray method.

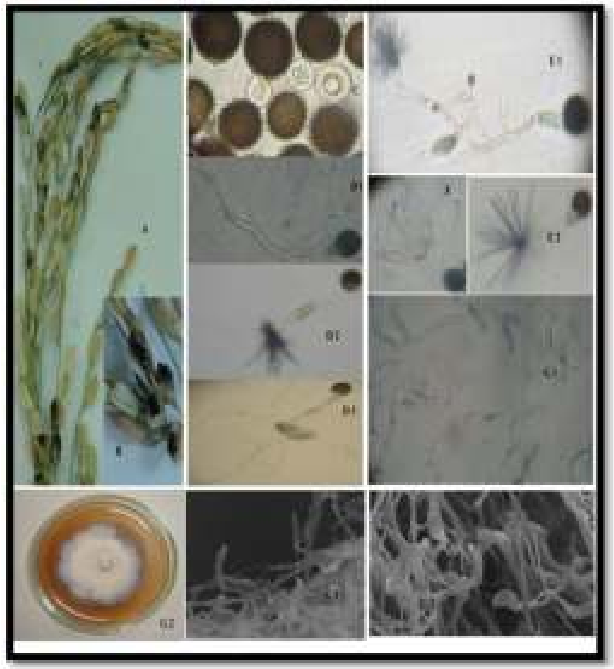

Fig. 1. Types of symptoms of rice kernel smut disease (A & B), Teliospore (C) X 100, Teliospore gramination (D 1) X 100, promycelium and different shapes of teliospore germination (D2, D3, E1&E2)X100,a large number of primary sporidia (F) X 100, seconddary sporidia (G1) X 100, seconddary sporidia in PDA (G2), seconddary sporidia and secondary mycelium (G3) X 2.000, and (G4) X 3.500 of *T. barclayana* the causal agent of rice kernel smut disease.

Table 4. Pathogenicity test of isolates of *T. barclayana* isolated from rice cultivars grown at different governortes during 2016 growing season using Giza 171 cultivar under greenhouse condition

No.	Location	Source of isolate	Disease severity(%)	Disease incidence(%)
1	Kafrelsheikh	Giza178	1.50 m-q	9.34 n-r
2		Giza178	2.00 i-n	15.00 i-l
3		Giza178	3.50 de	18.34 g-j
4		Giza178	1.26 n-s	11.00 l-p
5		Sakha 104	2.43 g-l	24.00 ef
6		Sakha 104	1.86 j-o	25.00 ef
7		Hybrid 1	0.037 u	8.00 pqr
8		Hybrid 1	0.45 stu	14.67 j-m
9		Sakha101	0.43 stu	16.34 ijk
10		Sakha101	0.013 u	6.34 r
11		Sakha101	4.50 bc	38.34 b
12		Sakha101	6.70 a	43.34 a
13	Gharbia	Giza177	3.03 e-h	26.34 de
14		Giza177	3.26 d-g	33.00c
15		Giza177	1.90 j-o	17.00 h-k
16		Hybrid 1	2.63 f-k	24.4 ef
17		Hybrid 1	1.53 m-g	15.34 ijk
18		Giza 178	2.30 h-m	25.00 ef
19		Giza 178	1.53 m-q	21.67 fg
20	Dakahlia	Giza 178	0.31 k-u	12.67 k-o
21		Giza 178	1.53 m-q	19.00 g-j
22		Giza 178	1.06 o-t	18.00 g-j
23		Giza 178	1.53 m-q	13.34 k-n
24		Giza 178	0.02 u	9.34 n-r
25		Giza 178	0.05 u	6.67 qr
26		Giza 178	1.80 k-p	15.00 i-l
27		Giza 178	0.76 q-u	17.00 h-k
28		Giza 178	6.30 a	32.34 c
29		Giza 178	4.97 b	40.34 ab
30		Giza 178	2.86 e-i	24.67 ef
31		Giza 177	4.86 b	24.34 ef
32		Giza 177	3.43 def	26.67 de
33		Sakha 102	2.43 g-l	19.34 ghi
34		Sakha 102	2.67 e-k	14.67 j-n
35		Hybrid 2	0.97 p-t	10.67 m-q
36		Hybrid 2	0.6 r-u	9.00 o-r
37	Damietta	Giza 178	3.90 cd	294 cd
38		Giza 178	1.47 m-r	15.67 ijk
39		Hybrid 2	2.50 g-l	24.00 kf
40		Hybrid 2	2.70 e-j	19.34 ghi
41		Giza 177	1.70 l-p	15.00 i-l
42		Giza 177	1.46 m-r	21.00 fgh

Means followed by a common letter in a column are not significantly different at 5% level by DMRT.

Effect of mineral and organic fertilizer on rice kernel smut disease severity and infection

Infection and severity of Giza 178 cv. as affected by application of chemical and organic fertilizers and their combinations are presented in (Tables 5 and 6). The results show that the mean infection and severity of rice cultivar without urea application ranged from 6.5 to 10.20% and from 0.05 to 0.20% in 2016 and 2017 growing seasons, respectively. Application of urea increased the rang from 21.75 to 24.50% and from 1.20 to 0.96%, in 2016 and 2017 growing seasons, respectiveily. Balanced soil fertility leads to a healthy rice plant, which reduces the disease susceptibility and infection. Thus, it is important to provide a balanced nutrition at the time when the nutrient can be most effectively used for disease control. Not only fertilization can affect the disease development but also any management practice that affects the soil environment such as pH modification through liming or gypsum application, tillage, seedbed firmness, site of nursery, moisture control through irrigation (Ebid *et al*., 2007) and organic fertilizers (Al Harbi *et al*., 2013). Soils with high organic matter and active soil biological activity generally exhibit good soil fertility as well as complex food webs and beneficial organisms that minimize infection (Ramesh *et al*,. 2005). Organic amendments encompass a wide range of products, from crop residues and wastes and animal manures to solid wastes and various rural/urban composts. Till date, most of the research has often concluded that addition of organic amendments to fields has a beneficial effect on the disease suppression (Khan *et al*., 2016; Ghoneim *et al*., 2016).

Table 5. Effect of FYM, compost, P, K and Zn without urea application on kernel smut disease incidence in Giza 178 rice cultivar during 2016 and 2017 seasons

	Treatment	Infection (%)		Mean	Severity (%)		Mean
		2016	2017		2016	2017	
Without Urea	PKZn	7.500	5.500	6.500	0.075	0.023	0.050
	FYM + PKZn	15.00	13.50	14.25	0.625	0.410	0.520
	Compost+ P K Zn	27.50	15.83	21.67	0.842	0.433	0.640
	Zn	15.00	13.45	14.23	0.500	0.233	0.370
	FYM + Zn	17.50	11.00	14.25	0.250	0.300	0.270
	Compost + Zn	17.50	15.83	16.67	0.750	0.317	0.530
	P	10.00	11.00	10.50	0.400	0.350	0.370
	FYM + P	27.50	21.00	24.50	0.900	0.950	0.930
	Compost + P	20.00	29.17	24.58	1.000	1.167	1.080
	K	5.500	5.300	5.400	0.120	0.100	0.110
	FYM + K	12.50	12.83	12.67	0.200	0.283	0.240
	Compost + K	1.830	1.000	1.420	0.150	0.100	0.130
	FYM	18.00	9.330	13.67	0.433	0.210	0.320
	Compost	22.33	19.67	20.83	0.750	0.550	0.650
	Control	12.00	8.330	10.20	0.250	0.153	0.200
LSD, 5%		2.720	2.120	-	0.320	0.300	-

Table 6. Effect of FYM, Compost, P, K and Zn with urea application on kernel smut disease incidence of Giza 178 rice cultivar during 2016 and 2017 seasons

	Treatments	Infection (%)		Mean	Severity (%)		Mean
		2016	2017		2016	2017	
With urea	PKZn	24.17	19.33	21.75	1.500	0.883	1.200
	FYM + PKZn	25.50	21.67	23.58	1.250	0.933	1.100
	Compost+ PKZn	30.50	24.17	27.33	2.500	0.967	1.730
	Zn	37.50	25.83	31.66	2.650	1.750	2.200
	FYM + Zn	27.58	25.83	26.70	2.750	2.667	2.700
	Compost + Zn	35.00	36.67	35.83	2.500	2.967	2.740
	P	35.00	48.33	41.66	2.500	2.917	2.710
	FYM + P	45.00	52.50	48.75	3.250	3.167	3.210
	Compost + P	27.50	25.83	26.67	3.000	2.750	2.870
	K	22.50	25.00	28.75	0.400	0.500	0.450
	FYM + K	25.00	21.00	23.00	0.500	0.250	0.360
	Compost + K	28.00	25.00	26.50	0.570	0.550	0.560
	FYM	32.67	30.00	31.34	1.267	1.770	1.520
	Compost	25.33	24.17	24.70	1.533	1.000	1.270
	Control	25.80	23.20	24.50	0.983	0.953	0.960
LSD, 5%		4.87	3.82	-	1.96	1.637	-

Plant contents of N, P, K and Zn

The effects of mineral and organic fertilizer with and without urea application on concentration of N, P, K, Zn and disease serverity of Giza 178 rice cultivar at flowering stage are resented in (Tables 7 and 8). The results show that the highest N% content was obtained from FYM + Zn and P + compost. Nitrogen content in rice plants due to the different application of organic fertilizer was higher than those fertilized without any of the used elements except Zn in 2016 season proved increasing of N content. Generally, N% was lower in 2017 season than in 2016 season. These results indicate that FYM+Zn and

P+compost are responsible for the increased kernel smut disease severity (Tables 7 and 8). The increased N contents of rice plant tissues predisposed rice plants to infection with kernel smut disease. In concern to P, K and Zn contents in rice plant tissue, results indicated that there were variation in P, K and Zn contents of Giza 178 fertilized by recommended rates of P, K and Zn. Nitrogen content of rice plant increased in response to increasing other elements. Generally, all element contents in the tested rice plant were lower in 2016 season than in 2017 season. Data indicated that there were significant differences among sources of organic N fertilizers and application without urea of P, K and Zn as reflected on rice disease incidence%. The lowest kernel smut incidence % were recorded in plots received K, K + FYM and K + compost in both 2016 and 2017 growing seasons. Also, it was noticed that addition of FYM and compost to the soil increased the kernel smut incidence %. The obtained results are in agreement with Atia (2004) they concluded that excessive nitrogen levels are rarely a problem of disease in organic production. On the other hand, P + FYM and P + compost induced the highest disease incidence in 2016 and 2017 grwing seasons. Macronutrients (N, P and K) are equally important as with micronutrients such (Zn) in controlling the plant diseases. Micronutrients play a role in reducing the severity of different diseases due to the involvement in physiology and biochemistry of the plant because many of the important micronutrients are involved in many processes in plants which affects the response of plants to pathogens (Ghoneim *et al*. 2004). Micronutrients inhibit the pathogen from penetrating by affecting the cell wall rigidity and also the physical integrity of the membrane structure (Huber *et al*., 2012). The sources of organic matter for incorporation into the soil are becoming scarce. The FYM is the source of primary, secondary and micro nutrients for plant and is a constant source of energy for hetrotrophic micro organisms, which helps in increasing the availability of nutrients, quality and quantity of the crop produce (El-Refaee *et al*., 2014). In addition, micronutrients can also affect disease resistance indirectly, as nutrient-deficient plants not only exhibit an impaired defense mechanism but may also become more suitable for feeding as many metabolites such as sugars and amino acids leak out from cell (Huber *et al*. 2012). However, micronutrients are also known to reduce the severity by inducing the resistance within the plant that is called a systemic acquired resistance (Dordas, 2008).

Table 7. Effect of mineral and organic fertilizer on kernel smut disease using Giza 178 at flowering stage during 2016 and 2017 seasons

Treatment	N content(%)		P Content(%)		K Content(%)		Zn Content(ppm)	
(without Urea)	2016	2017	2016	2017	2016	2017	2016	2017
PKZn	0.700	0.756	0.080	0.015	1.407	1.085	20.33	16.95
FYM + PKZn	1.120	0.867	0.092	0.028	1.513	1.245	28.10	23.68
Compost+ P K Zn	0.980	0.588	0.086	0.054	1.193	1.340	25.97	24.53
Zn	1.260	0.672	0.091	0.029	1.341	1.283	25.67	23.53
FYM + Zn	1.800	0.700	0.118	0.036	1.532	1.183	30.02	23.20
Compost + Zn	1.120	0.812	0.099	0.040	1.438	1.198	23.94	21.87
P	0.980	0.743	0.079	0.048	1.404	1.210	16.68	17.18
FYM + P	1.330	0.812	0.100	0.067	1.550	1.167	16.70	17.16
Compost + P	2.107	1.560	0.118	0.060	1.406	1.140	17.23	23.93
K	0.980	0.588	0.055	0.034	1.266	1.1270	17.20	15.33
FYM + K	1.260	0.728	0.064	0.030	1.681	1.435	17.78	18.55
Compost + K	0.770	0.746	0. 090	0.024	1.740	1.667	18.25	21.33
FYM	1.610	0.976	0.131	0.028	1.513	1.225	21.05	17.00
Compost	0.980	0.812	0.382	0.030	1.373	1.140	17.12	19.15
Control	0.640	0.539	0.85	0.025	1.770	1.003	15.00	15.36
LSD, 5%	0.189	0.039	0.0524	0.022	0.0350	0.508	1.818	1.320

Table 8. Effect of mineral and organic fertilizer with applied on kernel smut disease using Giza 178 at flowering stage during 2016 and 2017 seasons

Treatment	N content(%)		P Content(%)		K Content(%)		Zn Content(ppm)	
with Urea	2016	2017	2016	2017	2016	2017	2016	2017
PKZn	1.240	0.925	0.100	0.051	1.853	1.560	17.80	24.10
FYM + PKZn	1.680	1.00	0.120	0.022	1.856	1.530	28.45	28.98
Compost+ P K Zn	1.680	0.975	0.108	0.038	1.796	1.557	18.25	26.70
Zn	1.540	0.920	0.079	0.028	1.720	1.215	23.65	27.90
FYM + Zn	1.440	1.260	0.120	0.013	1.866	1.182	26.60	26.58
Compost + Zn	1.400	0.812	0.100	0.016	1.870	1.188	25.52	25.60
P	1.690	1.925	0.380	0.059	1.870	1.192	19.40	20.70
FYM + P	1.940	1.900	0.126	0.037	1.890	1.170	21.4	18.67
Compost + P	2.090	2.585	0.124	0.032	1.846	1.187	20.33	18.48
K	1.610	0.925	0.094	0.029	1.803	1.470	16.51	21.50
FYM + K	0.925	0.812	0.054	0.020	1.833	1.760	17.30	17.72
Compost + K	0.917	0.812	0.098	0.023	1.811	1.795	16.3	21.50
FYM	1.277	1.120	0.132	0.028	1.956	1.497	15.70	22.95
Compost	1.357	1.075	0.108	0.030	1.855	1.240	17.97	21.33
Control	2.107	0.925	0. 080	0.25	1.770	1.195	16.62	17.80
LSD, 5%	0.86	0.71	0.213	0.220	0.171	0.246	5.393	7.45

Growth parameters, rice yield and grain quality

Growth parameters including chlorophyll content (SPAD values), leaf area, plant height and grain yield are presnetd in tables 9 and 10. Chlorophyll content, leaf area, plant height and grain yield were significantally affected by applying mineral and organic fertilizer with and without urea application in both growing seasons. However, the urea applications increased chlorophyll content, leaf area, plant height and grain yield. Without urea application, the grain yield ranged from 2.65 to 3.24 t/feddan. All mineral and organic fertilizer increased the grain yield compared to the control treatment. However, with urea application, the grain yield increased significantally and the grain yield varied from 3.25 to 3.68 t/feddan. Organic fertilizer had significant influences on chlorophyll content, leaf area, plant height and grain yield. Micronutrient tissue concentration were not significantly correlated to panicle blast severities except for Zn. The low panicle blast severities of improved cultivar Guarani were associated with high K and Zn and low N, P, and Mg tissue concentrations (Persson *et al*., 2003). Adequate nitrogen fertilization is a prerequisite to produce high rice yield and improve the grain quality, while P plays a key role in the energy related activities and development of the root system (Huber *et al*., 2012).

Table 9. Effect of FYM, compost, P, K and Zn without N application on rice yield and some related characteristics during 2016 and 2017 seasons

	Treatments	Chlorophyll content (SPAD)		Leaf Area (cm^2)		Plant height (cm)		Grain yield (t/ Feddan)	
		2016	2017	2016	2017	2016	2017	2016	2017
Without Urea	PKZn	33.0	34.7	15.0	16.5	76.4	81.7	2.66	2.65
	FYM + PKZn	33.0	34.7	15.3	16.9	76.0	82.3	3.74	3.33
	Compost + PK Zn	31.3	32.6	16.7	18.2	76.0	81.8	2.93	2.89
	Zn	30.3	31.9	15.0	16.5	74.3	76.5	2.80	2.77
	FYM + Zn	31.3	32.9	14.0	15.4	71.6	80.5	2.98	2.95
	Compost + Zn	31.3	32.7	15.3	17.1	73.6	79.1	2.99	2.83
	P	32.3	33.7	15.0	16.6	73.7	76.0	2.93	2.89
	FYM + P	33.0	34.5	14.3	15.7	75.7	77.9	3.08	3.03
	Compost + P	30.0	31.4	14.0	15.3	73.7	76.1	2.98	2.95
	K	33.0	34.5	12.3	13.8	72.3	74.5	2.94	2.92
	FYM + K	33.0	34.5	16.6	17.9	80.3	85.5	3.56	3.42
	Compost + K	32.0	33.7	10.7	12.1	71.6	74.0	3.28	3.24
	FYM	34.0	35.5	15.7	17.3	82.3	84.6	3.02	3.04
	Compost	32.3	33.5	16.7	18.4	79.0	81.2	3.04	3.08
	Control	32.0	33.5	13.7	15.3	76.7	78.9	2.59	2.64
	LSD, 5%	0.72	0.70	1.51	1.55	1.66	1.20	0.17	0.09

Table 10. Effect of FYM, Compost, P, K and Zn witht N application on rice yield and some related characteristics during 2016 and 2017 seasons..

	Treatments	Chlorophyll content (SPAD)		Leaf Area (cm^2)		Plant height (cm)		Grain yield (t/ Feddan)	
		2016	2017	2016	2017	2016	2017	2016	2017
With Urea	PKZn	40.6	42.3	35.0	37.9	93.0	95.5	3.53	3.56
	FYM + PKZn	42.0	43.5	39.3	42.4	87.3	89.5	3.47	3.28
	Compost+PK Zn	39.7	41.2	34.0	37.1	96.3	98.5	3.27	3.61
	Zn	38.0	39.5	35.7	38.1	91.6	94.0	3.28	3.54
	FYM + Zn	41.7	43.6	32.7	34.7	91.6	93.8	3.44	3.52
	Compost + Zn	39.0	40.2	39.7	41.9	94.7	96.7	3.17	3.39
	P	39.0	40.6	35.3	36.7	93.3	95.6	3.05	3.43
	FYM + P	41.3	42.2	32.3	33.7	85.7	87.8	3.16	3.61
	Compost + P	39.0	40.5	35.0	39.8	97.3	99.3	3.24	3.48
	K	40.3	42.0	42.7	45.0	92.0	94.2	3.93	3.68
	FYM + K	42.3	43.9	31.0	33.4	83.7	85.7	3.87	3.28
	Compost + K	38.0	39.3	37.0	38.5	93.7	95.7	3.52	3.57
	FYM	42.0	43.3	39.0	41.4	91.3	93.5	3.81	3.33
	Compost	42.3	43.4	33.3	34.8	94.7	96.8	3.81	3.69
	Control	41.3	42.8	34.6	35.9	88.0	90.2	3.35	3.25
	LSD, 5%	3.20	3.13	8.22	8.53	4.46	4.68	0.705	0.815

Table 11. Effect of mineral and different sources of organic fertilizer without N application on some grain quality of Giza 178 rice cultivar during 2016 and 2017 seasons

	Treatment	Hulling(%)		Milling(%)	
		2016	2017	2016	2017
Without Urea	PKZn	78.47	81.90	66.00	70.47
	FYM + PKZn	76.67	80.20	66.00	69.20
	Compost+ P K Zn	79.33	82.73	65.33	69.60
	Zn	79.00	82.10	65.33	68.77
	FYM + Zn	77.00	80.50	65.67	69.20
	Compost + Zn	76.67	80.50	65.67	68.80
	P	78.00	81.27	66.67	70.37
	FYM + P	75.67	79.40	63.67	67.17
	Compost + P	79.00	82.47	66.67	70.09
	K	79.67	83.27	68.67	71.77
	FYM + K	80.00	83.80	65.33	68.63
	Compost + K	77.67	80.58	66.00	69.30
	FYM	76.67	79.80	66.33	69.50
	Compost	78.67	82.03	67.33	70.67
	Control	77.67	80.89	65.00	68.37
	LSD, 5%	1.946	1.917	1.750	1.970

Table. 12. Effect of mineral and different sources of organic fertilizer with N application on some grain quality of Giza rice cultivar during 2016 and 2017 seasons

	Treatment	Hulling(%)		Milling(%)	
		2016	2017	2016	2017
With Urea	PKZn	79.00	82.50	66.33	69.70
	FYM + PKZn	78.00	81.03	63.00	66.43
	Compost+ P K Zn	78.33	82.03	63.00	66.63
	Zn	79.00	82.07	66.67	69.90
	FYM + Zn	78.33	81.77	64.67	67.90
	Compost + Zn	75.6 7	79.07	62.00	65.40
	P	79.00	82.17	65.00	68.27
	FYM + P	79.33	82.63	66.67	70.20
	Compost + P	79.67	83.00	64.67	68.30
	K	84.33	87.47	70.67	73.93
	FYM + K	81.00	84.13	67.67	70.90
	Compost + K	78.67	81.90	65.33	68.93
	FYM	80.33	83.60	65.67	68.90
	Compost	84.00	87.53	65.67	69.10
	Control	77.33	80.67	64.67	68.00
	LSD, 5%	1.994	1.951	4.044	4.080

The rice grain quality i.e. hulling and milling% as affected by different rates of mineral and organic fertilzers are presented in Tables (11 and 12). In gernral, the results indicated that hulling and milling% decreased by increasing the disease severity. On the other hand, total protein and total carbohydrate increased with the application of organic N fertilizers compared to control (Tables 13 and 14). Mineral nutrition has an important role in this system, and its management can affect not only the yield but also plant health and the environment (Katan, 2009). Total protein and total carbohydrate decreased by increasing the kernel smut disease severity in some cultivars and lines comparded with control because this disease replace the content of carbohydrate in rice grains with the fungus mass of teliospores (El-Kazzaz, *et al*., 2014).

Table 13. Total protein and total carbohydrate in rice plants as affected by mineral and organic fertilizer without applied urea during 2016 and 2017 seasons

	Treatment	Total protein (%)		Total carbohydrate (mg/g)	
		2016	2017	2016	2017
Without Urea	PKZn	5.80	6.00	133.70	139.7
	FYM + PKZn	7.46	7.66	120.00	126.0
	Compost+ P K Zn	6.80	6.90	102.00	108.0
	Zn	6.97	6.17	116.50	122.8
	FYM + Zn	7.46	7.66	117.25	113.3
	Compost + Zn	6.75	6.95	120.00	136.0
	P	6.93	6.13	121.20	127.2
	FYM + P	6.12	6.35	139.75	135.8
	Compost + P	5.70	5.90	135.25	131.3
	K	6.88	7.08	137.00	136.0
	FYM + K	7.60	7.83	139.17	135.2
	Compost + K	7.33	7.53	140.00	136.0
	FYM	7.33	7.53	131.75	137.8
	Compost	6.99	6.89	130.00	136.0
	Control	7.50	7.70	138.50	136.5
LSD, 5%		1.42	1.40	11.57	6.21

Table 14. Total protein and total carbohydrate in rice plants as affected by mineral and organic fertilizer with applied urea during 2016 and 2017 seasons

	Treatment	Total protein (%)		Total carbohydrate (mg/g)	
		2016	2017	2016	2017
With Urea	PKZn	7.12	7.75	126.50	132.5
	FYM + PKZn	6.80	7.00	133.33	139.3
	Compost+ P K Zn	7.46	7.66	133.50	136.2
	Zn	7.29	7.50	113.50	119.5
	FYM + Zn	7.40	7.93	114.75	120.8
	Compost + Zn	7.05	7.45	113.00	119.0
	P	7.16	7.56	115.50	114.7
	FYM + P	7.40	7.61	125.50	131.3
	Compost + P	6.33	6.53	134.00	130.0
	K	7.55	7.75	138.67	136.4
	FYM + K	7.28	7.58	139.25	135.0
	Compost + K	7.12	7.22	126.42	132.0
	FYM	7.33	7.53	131.00	137.0
	Compost	7.33	7.53	135.00	134.3
	Control	7.33	7.53	131.75	137.0
LSD, 5%		0.67	0.85	5.200	4.880

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تأثير الاسمدة المعدنية والعضوية علي مرض التفحم الحبي في الأرز

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[١]قسم بحوث الأرز - معهد بحوث أمراض النبات - مركز البحوث الزراعية - الجيزة - مصر
[٢]مركز البحوث والتدريب في الارز - معهد بحوث المحاصيل الحقلية - مركز البحوث الزراعية - الجيزة - مصر

مقاومة الأمراض لنبات الأرز هي أساسها التحكم الوراثي ، ولكن لديها ارتباط وثيق مع حالة خصوبة التربة للنباتات أو مسببات الأمراض، وبالتالي، إدارة المواد الغذائية كانت دائما منظم هام لأمراض نبات الأرز. هناك ترابط الحيوي بين خصوبة التربة للنباتات الأرز مع المرض والبيئة غير الحية، وبالتالي، الإدارة السليمة من المواد الغذائية في محصول الأرز المزروعة يمكن أن تقلل بشكل فعال من شدة معظم الأمراض. ولذلك، يهدف البحث الحالي إلى دراسة تأثيرالتسميد المعدني والعضوية علي الصنف جيزة ١٧٨ ونسبة حدوث مرض التفحم الحبي. تم عمل تجارب المعمل والحقل في مركز بحوث التدريب علي الأرز (RRTC) خلال مواسم الزراعة ٢٠١٦ و ٢٠١٧ .تم عزل وتعريف المسبب المرضي *T. barclayana* ، والمسبب لمرض التفحم الحبي في الارز في هذه الدراسة. اختبار القدرة المرضية على صنف الأرز جيزة ١٧١ ، والأكثر حساسية لهذا المرض. كان تصميم التجربة كامل العشوائية (RCBD) مع ثلاثة مكررات. تم استخدام السماد العضوي (FYM)، والسماد المصنع طبيعيا والفوسفور ، البوتاسيوم ، والزنك مفردا او مجتمعة (المجموع ١٥ ومعاملة) مع وبدون إضافة اليوريا تم تطبيقها. المحتوى الكلوروفيل، مساحة الورقة، البروتين الكلي، والكربوهيدرات الكلية، المحصول الأرز التقدير المرضي، تحليل النبات لنيتروجين ، الفوسفور ، البوتاسيوم الكلي وإجمالي الزنك. وأشارت النتائج أن تم الحصول على أعلى محتوى نسبة نيتروجين من FYM + الزنك والفوسفور + مزيج السماد. كانت هناك فروق معنوية بين FYM، السمادالمصنع طبيعيا و المعدني استخدام الأسمدة مع وبدون إضافة اليوريا على حدوث المرض. وأشارت النتائج أن محتوى الكلوروفيل،مساحة الورقة ومحصول الحبوب تأثرت ايجابيا من خلال الإضافات المعدنية و العضوية مع وبدون اليوريا.وكانت نسبة التقشير والتبيض تقل بزيادة نسبة المرض. وتراوحت نسبة الاصابة علي الصنف جيزة ١٧٨ دون إضافة اليوريا من ٦,٥٪ إلى ١٠,٢٠٪ في موسمين ٢٠١٦ و٢٠١٧، في حين مع تطبيق اليوريا زيادة نسبة الاصابة لمجموعة من ٢١,٧٥٪ إلى ٢٤,٥٠٪ في نفس الموسمين.