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Effect of Natural Soil Conditioners and Rice Straw Residues Application on Sandy Soil Properties and Wheat Production

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THE PRESENT study was carried out through two seasons (2006 and 2007) in El-Bostan region at the west of Nile Delta, Egypt using wheat Sakha93 as the indicator crop. The soil is sandy in texture. Taflah (TF) (bentonite clays) and rice straw residues (RS) were incorporated into the surface soil layer 45 days before cultivation.

The obtained results show that incorporating TF and RS into the sandy soil improved physico-chemical properties and available nutrients of the soil besides N, P and K concentration in the plants. The mixture treatments (TF+RS) were significantly affect yield production and nutrients concentrations of wheat compared with the single treatments being higher with TF especially at higher rates (6 and 8%). The maximum effective treatment was TF_4 (8%) + RS_2 (4%), which achieved 5.70 and 2.93 ton/fed for straw and wheat grain, respectively, with insignificant differences with the treatment TF_3 (6%) + RS_2 (4%), that produced 5.63 and 2.88 ton/fed for straw and wheat grains, in sequence, which is recommended.

Keywords: Taflah, Rice straw residues, Sandy soil, Yield of wheat.

Sandy soils deserve special consideration as their physico-bio-chemical characteristics and nutritional status adversely affect-to a great extent-their irrigation practices and agricultural potentialities. It is worth mentioning that the reclamation of sandy soils in Egypt was dependent upon the annual addition of Nile suspended matter as well as organic manures. The reduction in qualities of clay and silt after the construction of the Aswan High Dam has led the research to be directed towards finding substitutes such as bentonites and composts of plant residues. Bentonites are widely spread in Egypt as natural deposits (El-Sherif *et al.*, 1982). Some Egyptian bentonite deposits such as Quasr El-Sagha (El-Fayoum) and those located adjacent to Cairo-Alexandria Desert Road were evaluated as conditioners for sandy soils. Particle side distribution, chemical and mineralogical composition, hydrophysical and chemical characteristics of these deposits revealed to their high clay content, high percentage of montmorillonites (about 60%), high surface area, high values of moisture retained at different suctions, high CEC, high content of nutrients essential for plant growth and low hydraulic conductivity. Beneficial changes were achieved in soil structural class

towards the finer ones. Consequently, properties related to soil structure, moisture retention and water movement were improved. Soil CEC was also increased. A conclusion was drawn that mixing sandy soils with local bentonites improves soil mechanical, hydrophysical and chemical properties and nutritional status of soils. Consequently, crop yield and water use efficiency were increased. Under the conditions of the experimental locations (South Tahreer and Anshas sandy soils), the highest yield was produced at the rate of 9% bentonite (Lotfy and El-Hady, 1984, El-Sherif and El-Hady, 1986 and El-Hady & El-Sherif, 1988 a & b).

Moreover, Aziz *et al.* (1998) reported that the soil conditioners were taflah [24% clay, 43% silt and 32% fine sand] farmyard manure and their mixture, incorporated into the surface soil layer (0-15 cm) of Anshas sandy soil at the rate of 5% (w/w) before cultivation of cucumber. The maximum yield of cucumber was obtained from the plots treated with mixture (Taflah and manure).

On the other hand, Himanshu Pathak *et al.* (2006) showed that burning of rice straw residues could be avoided without affecting yield of wheat crop by incorporating rice straw residues in soil with an additional dose of inorganic N or microbial inoculation. The lowest yield was recorded in the plots where rice straw residues were incorporated in soil without additional inorganic N and with manure application. All the treatments with rice straw residues incorporation had larger soil organic C despite the effect on the mineralization of soil organic matter. Gurpreet *et al.* (2007) reported that manuring and residues management increased organic carbon (OC) content of the soil, which improved aggregation status, infiltration rate and decreased the bulk density, dispersion ratio and soil strength correspondingly.

Gupta *et al.* (2007) reported that incorporation of residues increased soil Olsen inorganic and organic P; reduced P sorption and increased P release. Data show that continuous incorporation of residues substituted for 13 kg inorganic P/ha/yr and improved the yield, while Anan Polthanee *et al.* (2008) found that rice straw residues incorporated into the soil had no significant effect on grain yield when compared with the effect of burning.

The aim of the present work was to study the effect of applying taflah (bentonite clays) and rice straw residues on some soil properties and fertility status to approach a maximum yield of wheat under sandy soils conditions.

Material and Methods

A two-year (2006 and 2007) completely randomized with three replications field experiment was carried out in the west Nile Delta at El-Bostan of Behira Governorate (30° 35' 59' N and 30° 16' 31" E). Wheat variety Sakha 93 was the indicator crop. Some chemical and physical properties and soil available nutrients are presented in Table 1.

TABLE 1. Some chemical and physical properties of El-Bostan region prior to cultivation*.

Depths cm	pH	E.C ds/m1:1	OM	$CaCO_3$	Sand	Silt	Clay	C.E.C Cmol/kg	Texture
			%						
0-30	7.51	0.57	0.52	2.51	88.71	7.24	4.05	4.27	S
30-60	7.64	0.69	0.45	2.94	87.23	8.39	4.38	4.73	S

Soluble cations and anions in soil (me/L)							
Depths	Na	K	Ca	Mg	HCO_3	CL	SO_4
0-30	1.56	0.17	1.89	2.12	0.62	1.71	3.41
30-60	1.89	0.19	2.11	2.74	0.95	2.08	3.89

Available nutrients in soil (µg/g)							
Depths	N	P	K	Fe	Mn	Zn	Cu
0-30	31	2.1	19	1.54	0.78	0.29	0.12
30-60	27	1.67	23	1.79	0.93	0.35	0.15

* determined after Page *et al.* (1982) and Klute (1986).

The experimental field design included four additions of taflah from El-Fayoum region (2, 4, 6 and 8% wt/wt of surface soil layer) and two rates of rice straw residues (2 and 4% wt/wt). The characteristics of rice straw were found to be: 40.04% organic carbon, 1.41% nitrogen, 0.2% phosphorus and 2.7% potassium, while C/N ratio was 28.3. Taflah and rice straw residues were incorporated into the surface soil layer (0-30cm) before cultivation of wheat by 45 days. Phosphorus (40 kg/fed) was added during seedbed preparation. Nitrogen (80kg/fed) and K (60kg/fed) were split into three equal doses 20, 40 and 90 days after sowing.

To follow up the improvement of soil properties, nutrient content and response of wheat plants to the applied TF and RS residues and their combinations, plant samples were collected at three growth stages, 15 days after emergence as whole plants, 30 days from sowing, and harvest time. At the end of each experiment, grain and straw yields were recorded. Plant samples were analyzed for N, P and K according to Cottenie *et al.* (1982). Obtained data were statistically analyzed (Gomez and Gomez, 1984).

Results and Discussion

Effect of Taflah and rice straw residues rates on soil fertility and soil properties

Data presented in Table 2 show that texture of studied soil was changed by incorporated Taflah rates through soil depth 0-30cm from sandy to loamy sand. Some chemical and physical properties and available nutrients were improved with increased rate of Taflah. The above results agree with those obtained by El-Hady and El-Sherif, 1988 a and b.

TABLE 2. Chemical and physical of soil properties and available nutrients in soil of El-Bostan region after applied Taflah.

Taflah %	pH	E.C ds/m1:1	OM	$CaCO_3$	Sand	Silt	Clay	C.E.C Cmol/kg	Texture
			%						
0%	7.51	0.57	0.52	2.51	88.71	7.24	4.05	4.27	S
2%	7.75	0.71	0.59	4.88	87.02	7.62	5.36	4.87	S
4%	7.87	0.84	0.63	5.13	85.33	7.99	6.67	5.59	S
6%	7.93	0.97	0.67	5.54	83.65	8.37	7.99	6.26	L. S
8%	8.05	1.09	0.71	5.86	81.96	8.74	9.30	7.02	L. S
100%	8.63	7.37	0.48	5.89	15.60	18.80	65.60	38.48	CL

Soluble cations and anions in soil (me/L)

Taflah	Na	K	Ca	Mg	HCO_3	CL	SO_4
0%	1.56	0.17	1.89	2.12	0.62	1.71	3.41
2%	2.52	0.24	2.12	2.25	0.84	2.24	4.04
4%	3.41	0.29	2.31	2.43	1.08	2.68	4.67
6%	4.12	0.37	2.56	2.65	1.44	3.14	5.12
8%	4.86	0.44	2.73	2.88	1.68	3.62	5.61
100%	51.1	2.62	10.5	9.45	12.88	27.84	32.95

Available nutrients in soil (µg/g)

Taflah	N	P	K	Fe	Mn	Zn	Cu
0%	31	2.10	19	1.54	0.78	0.29	0.12
2%	35	2.84	32	3.35	1.62	0.72	0.31
4%	39	3.18	39	4.16	2.15	0.98	0.45
6%	45	3.52	47	4.85	2.83	1.26	0.63
8%	47	3.85	59	5.67	3.31	1.58	0.79
100%	83	10.0	245	85	39.00	16.5	7.6

Effect of Taflah and rice straw residues on yield of wheat

Data in Table 3 and Fig. 1 also show that the TF and RS in combination significantly increased straw and grain of wheat compared with the single treatment. The TF_4+RS_2 treatment achieved highest increase yield and yield parameters of wheat. The above results agree with those obtained by Himanshu Pathak *et al.* (2006), Gupta *et al.* (2007) and Anan Polthanee *et al.* (2008). Concerning the effect of addition of TF and RS on the yield parameters of wheat, the TF showed higher increase in yield of wheat than that of RS.

Moreover, the yield parameters of wheat were increased with increased rates of applied TF and RS. The maximum yield was recorded using the treatment of 8% TF and 4% RS, while the cconomic treatment was 6% TF and 4% RS. The results obtained assure that sandy soil was higher deficiency of nutrients than loamy sand soil. This reflects the importance the role of TF and RS for improving soil properties and soil fertility. All TF and RS highly improve soil properties and highly increase wheat production compared with the control treatment.

TABLE 3. Effect of TF and RS and their combinations on yield and yield components of wheat.

Treatments	Application rates %		Yield (ton/fed)		Weight	Spikes/m²	
	TF	RS	Straw	Grain	1000 (g)	W.Kg	No.
Control	0	0	2.22	0.93	29.6	0.31	213
TF_1	2	0	3.80	1.88	41.9	0.42	278
TF_2	4	0	3.85	1.97	45.5	0.46	305
TF_3	6	0	3.94	2.1	48.6	0.49	318
TF_4	8	0	4.00	2.15	49.4	0.51	322
RS_1	0	2	3.86	1.95	43.3	0.44	291
RS_2	0	4	3.92	2.03	47.1	0.47	309
TF_1+RS_1	2	2	4.27	2.19	52.8	0.54	337
TF_2+RS_1	4	2	4.43	2.32	54.4	0.56	351
TF_3+RS_1	6	2	4.54	2.41	56.7	0.58	365
TF_4+RS_1	8	2	4.65	2.49	57.8	0.59	373
TF_1+RS_2	2	4	5.39	2.65	58.7	0.64	391
TF_2+RS_2	4	4	5.58	2.81	61.3	0.73	407
TF_3+RS_2	6	4	5.63	2.88	64.6	0.78	423
TF_4+RS_2	8	4	5.70	2.93	65.6	0.79	432
$LSD_{0.05}$	-	-	0.04	0.03	0.3	0.01	4

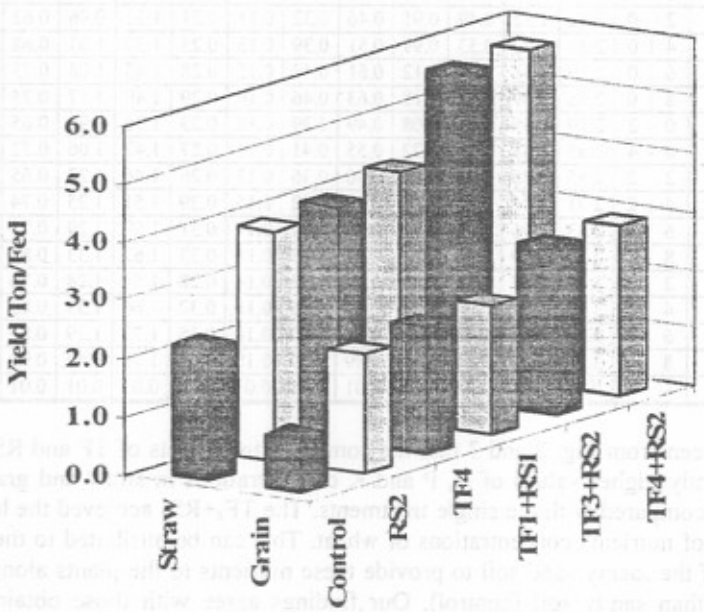

Fig.1. Effect of Taflah and rice straw residues on yield of wheat.

Effect of Taflah and rice straw residues on NPK content of wheat

Data from Table 4 revealed that the increase of nutrients concentrations at different stages of wheat growth with the increase in rates of TF and RS applied to sandy soil. The maximum treatment was TF_4+RS_2 treatment, which achieved higher N, P and K concentrations at different stages of wheat growth than other treatments, while the economic treatment was TF_3+RS_2 treatment.

The mixture treatments between TF and RS gave significantly higher levels of nutrients in plant tissues at different stages of wheat growth than the single treatments. This result was due to the important role of incorporation of TF and RS with sandy soil on enhancing the fertility status of soil and the positive nutrients content of wheat. This reveals the greater ability of TF and RS to provide the plants with these nutrients along their lifetime. Analogous results were obtained by Davis *et al.* (2002) Sun Kegang (2004) and Singh *et al.* (2007).

TABLE 4. Effect of Taklah and rice straw residues applied with NPK fertilizer on nutrients contents of wheat during two seasons.

Fertilizer Treatments	Applied %		N%				P%				K%			
	TF	RS	$Stage_1$	$Stage_2$	Straw	Grain	$Stage_1$	$Stage_2$	Straw	Grain	$Stage_1$	$Stage_2$	Straw	Grain
Control	0	0	1.83	0.98	0.46	0.72	0.38	0.25	0.08	0.17	1.08	0.61	0.48	0.29
TF_1	2	0	2.12	1.32	0.49	0.91	0.46	0.32	0.11	0.21	1.31	0.96	0.62	0.37
TF_2	4	0	2.21	1.42	0.53	0.99	0.51	0.39	0.13	0.25	1.39	1.01	0.68	0.41
TF_3	6	0	2.39	1.51	0.57	1.12	0.61	0.44	0.15	0.28	1.45	1.08	0.73	0.44
TF_4	8	0	2.56	1.69	0.58	1.18	0.63	0.46	0.16	0.29	1.49	1.17	0.75	0.46
RS_1	0	2	2.19	1.39	0.52	1.08	0.49	0.39	0.12	0.23	1.35	0.99	0.65	0.39
RS_2	0	4	2.35	1.48	0.55	1.22	0.55	0.41	0.14	0.27	1.42	1.06	0.72	0.43
TF_1+RS_1	2	2	2.55	1.75	0.61	1.35	0.56	0.36	0.13	0.26	1.46	1.23	0.65	0.45
TF_2+RS_1	4	2	2.71	1.86	0.64	1.42	0.62	0.42	0.15	0.29	1.51	1.25	0.74	0.49
TF_3+RS_1	6	2	2.83	1.96	0.68	1.51	0.72	0.44	0.17	0.31	1.59	1.29	0.79	0.52
TF_4+RS_1	8	2	2.89	2.09	0.69	1.57	0.73	0.45	0.18	0.33	1.62	1.33	0.82	0.55
TF_1+RS_2	2	4	3.07	2.27	0.73	1.49	0.68	0.43	0.14	0.28	1.54	1.28	0.76	0.47
TF_2+RS_2	4	4	3.16	2.39	0.76	1.56	0.82	0.46	0.16	0.32	1.66	1.33	0.83	0.53
TF_3+RS_2	6	4	3.32	2.52	0.79	1.68	0.87	0.47	0.18	0.35	1.73	1.39	0.89	0.58
TF_4+RS_2	8	4	3.39	2.61	0.81	1.71	0.89	0.49	0.19	0.36	1.79	1.42	0.93	0.59
$LSD_{0.05}$	-	-	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

It is seen from Fig. 2 and 3 that the combined treatments of TF and RS gave significantly higher values of N, P and K concentrations in straw and grains of wheat if compared with the single treatments. The TF_4+RS_2 achieved the highest increase of nutrients concentrations of wheat. This can be attributed to the great ability of the loamy sand soil to provide these nutrients to the plants along their lifetime than sandy soil (control). Our findings agree with those obtained by Abdel Magid Elmobarak *et al.* (2004) and Sun Kegang(2005). In the same respect, Buchholz and Brown (1999) reported that P and K removal by wheat in sandy soils was less than that in loamy sand ones.

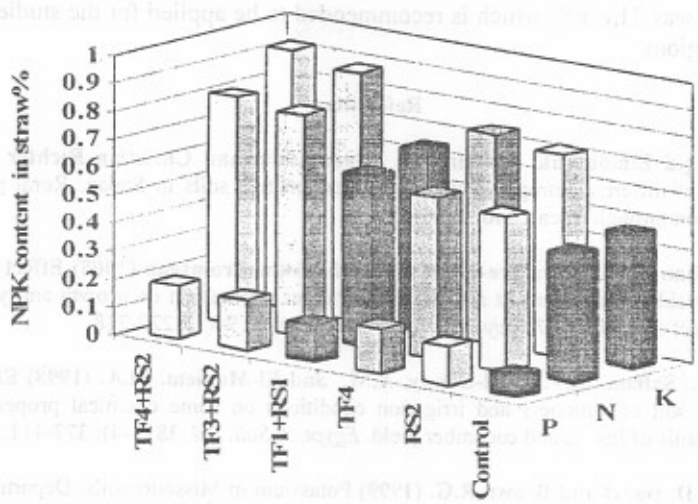

Fig.2. Effect of Taflah and rice straw residues on NPK content of wheat straw.

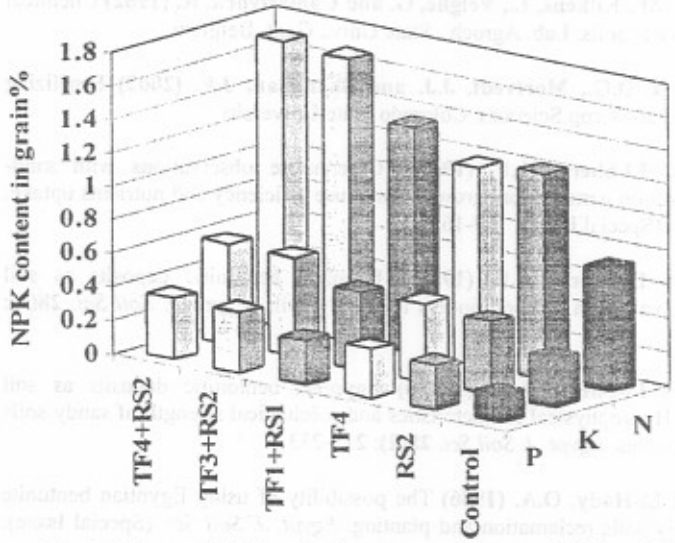

Fig. 3. Effect of Taflah and rice straw residues on NPK content of wheat grain.

On conclusion, the addition of TF and RS to sandy soil improved chemical and physical soil properties and soil available nutrient. Taflah gave significantly higher increase than RS especially with higher rates of TF (6 and 8%). The combined treatments of TF and RS gave highly significant increase yield and nutrients content of wheat compared the single treatments. The most effective treatment was TF_4+RS_2 treatment, which achieved the highest yield parameters and N, P and K content at different stages of wheat growth. The economic

treatment was TF_3+RS_2 which is recommended to be applied for the studied area similar regions.

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تاثير اضافة محسنات التربة الطبيعية و مخلفات قش الارز على خواص التربة الرملية وانتاجية القمح

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اقيمت هذه الدراسة خلال موسمين فى عام ٢٠٠٦ و٢٠٠٧م فى منطقة البستان بغرب الدلتا محافظة البحيرة بمصر وهى ذات قوام رملى مستخدماً صنف القمح سخا ٩٣ والهدف من الدراسة هو معرفة تأثير إضافة الطفلة ومخلفات قش الأرز على خواص التربة وخصوبتها للوصول لأعلى محصول من القمح تحت ظروف الأراضى الرملية بالمنطقة. خلطت الطفلة ومخلفات قش الأرز مع الطبقة السطحية قبل كل موسم زراعة للقمح وتم تحضينها حوالى (٤٥ يوم).

وقد أظهرت النتائج أن إدماج الطفلة ومخلفات قش الأرز الى التربة الرملية أدى إلى تحسين فى الخواص الطبيعية والكميائية للتربة و زاد من تيسرالمغذيات منها. المعاملات المخلوطة من الطفلة ومخلفات قش الأرز أعطت تأثيراً إيجابياً معنوياً على إنتاجية المحصول وتركيز المغذيات للقمح إذا ما قورنت بالمعاملات الفردية، وكانت الطفلة هى الأعلى من مخلفات قش الأرز خاصةً عند المعدلات الأعلى (٦٪ و ٨٪). وكانت المعاملة الأكبر تأثيراً هى TF_4 (8%) + RS_2 (4%) والتى حققت ٥,٧ و ٢,٩٣ طن /فدان للقش والحبوب من القمح ، بينما المعاملة الاقتصادية هى TF_3 (6%) + RS_2 (4%) والتى حققت ٥,٦٣ و ٢,٨٨ طن /فدان للقش والحبوب من القمح والتى نوصى باستخدامها فى منطقة الدراسة والمناطق الأخرى المماثلة.