EFFECT OF FARM YARD MANURE AND SELENIUM ON WHEAT YIELD AND GRAIN QUALITY UNDER RAINFED CONDITIONS.

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ABSTRACT

Two field experiments were carried out on a private farm at Sidi Barrani, Marsa Matrouh Governorate during two successive seasons of (2011/2012 and 2012/2013) to study the integrated effect of organic manure (farm yard manure, FYM) as an organic soil amendment and selenium on wheat yield (variety Giza 168) and grain quality. Farm yard manure (FYM) was applied at three rates of 0, 2 and 4 ton fed^{-1}, while selenium was added at the rates of 0, 5,15 and 25 g fed^{-1}. The main plots were occupied with the applied FYM rates, mean while the added selenium rates were arranged among the sub-plots, and then each treatment was replicated three times. The plot area was 18 m^2 (3 × 6 m).

The obtained results showed that the applied different FYM and selenium rates exhibited a significantly ameliorated for each of the studied wheat plant parameters (*i.e.,* plant height, No and length of spike, kernels number and weight) and harvest stages (*i.e.,* biological yield of grain plus straw yields and their contents of N, P, K, Fe, Mn, Zn and Se) as well as grain quality (*i.e.,* 1000 grain weight, grain contents of protein, carbohydrates and sugar fractions).

From the economical point of view, the results of this study showed that the integrated effect of the combined treatment of (4 ton FYM/fed+15g selenium/fed) was recorded best values for all the aforementioned plant parameters, taking into consideration the possible adverse fears of human health through environmental risks as a result of the excessive use of nitrogenous fertilizers and selenium.
Keywords: Farmyard manure, selenium, wheat productivity, wheat grain quality.

INTRODUCTION

One of the factors directing crop production in terms of quality and quantity is well-balanced by plant nutrition and therefore suitable fertilization. Nitrogen fertilizers are one of the most used fertilizers in Egypt and the world, and its application increases day by day. Particularly since hybrid varieties were densely used in agriculture system of Egypt, which showed that the use of N fertilizer has increased greatly with effective irrigation. On the other hand, it is one of the elements that carry potential risk to environmental pollution of soil and water sources (Marilla *et al*., 2004, Gallardo *et al*., 2005).

Human health and environmental quality will be settled under danger because of the polluted soil and water resources with residual effect of nitrogenous fertilizers (Halvarson *et al.,* 2005). Part of the nitrogen fertilizer which could be absorbed by plants enters into a cycle in which chemical and biological processes occur. This cycle shows great variety depending on the soil, climate and land usage. Depending firstly on water parameters and soil texture, accumulation of nitrogen in the soil, its leaching and deformation determine the amount of fertilizer to be used (Hofman and Cleemput, 2004).

Selenium can be present in foods as essential nutrient or toxic material, as selenium known earlier merely as carcinogenic and toxic material (Whanger, 2002) found even if in small amount to be essential for animals at the end of the 1950's (Schwarz and Foltz, 1957), since selenium is an essential component of more than 30 selenoproteins and selenoenzymes, in animals (Rayman, 2002).Properties and biological functions of around 15 selenoenzymes including the antioxidant glutathione-peroxidases (GPx) were discovered, three forms of thioredoxin reductases playing important role in regeneration of the antioxidant system of the organism and contributing to the establishment of the intracellular redox status.

Selenium content in food and forage crops can be increased by the addition of selenium to the soil-crop systems, a practice termed agronomic biofortication. The best example is the Finnish practice of adding sodium selenate to all multi-element fertilizers, which has occurred since 1984 (Eurola et al.,1991; Hartikainen, 2005; YlÄaranta, 1990). Initially, 6 mg Se/kg fertilizer for grass and hay crops and 16 mg Se/kg fertilizer for cereals were used. These levels of addition provided approx. 3 and 8 g Se/ha for grass and cereals, respectively Selenium concentrations in plants, animal products, soils, water and human sera have been monitored regularly, and the results have been used to adjust the amount of selenium addition. Between 1991-1997 the lower level (6 mg Se/kg fertilizer) was used for all crops. Since 1998 the selenium concentration has been raised to 10 mg Se/kg fertilizer (Hartikainen, 2005).

Forms of selenium found in soils influence its mobility,uptake, and metabolism by plants. The major forms in alkaline,oxidizing environments which are available for plant uptake are selenium-VI(selenate) and selenium-IV(selenite,').

The major influences on uptake are soil pH and salinity. High salinity and pH favor selenium anion adsorption onto clays and metal oxides. Selenite is adsorbed much more strongly than selenate leaving selenate as the major form available for plant uptake. Some soil anions, such as phosphate, increase plant selenium uptake because increased soil-solution anion concentrations compete with selenium anions for adsorption sites. Other anions, such as chloride or sulfate, actually enhance or inhibit uptake by affecting plant metabolism.Inorganic selenides and elemental selenium are mostly insoluble except under conditions of low pH in moist, reducing environments.

Farmyard manure is an output function of aerobic fermentation of cattle dung and other animal waste. Such organic manure protects the environment from pollution as a result of rationalization of consumption of mineral fertilizers, producing the obtaining a sustainable agriculture as well as clean food. Thus, it is generally believed that combining organics with inorganic fertilizer will increase synchrony and reduce losses by converting N-inorganic into organic forms. Studies have shown that it is not always true. For example, Janzen and Schaalji (1992) found that N-fertilizer losses were twice as large as when green manure plus fertilizer was applied to barley. Their interpretation was that green manure promoted high levels of nitrate and available C in the soil, enhancing de-nitrification. However, losses were reduced with smaller repeated applications of green manure, implying that the use of high quality green manure as partial substitution for inorganic fertilizer rather than addition to inorganic fertilizer may increase nutrient use efficiency.

Xu *et al*. (1993) and Jones *et al*. (1997) found large losses of 25 to 41% of N added from leucaena prunings, and it could be attributed to the de-nitrification process. It was also found that losses were greater when materials were incorporated rather than surface applied. Ganry *et al*. (1978) and Shah *et al.* (2002) also concluded that large applications of low quality straw can result in large losses of N-fertilizer through de-nitrification. These results thus indicate that N losses can be quite high from both organic and inorganic sources, contrary to the popular belief that application of organic resources will result in fewer losses. According to Zia *et al.* (2000), continuous use of chemical fertilizers even in balanced proportion will not.

The objective of the current study is to evaluate the integrated effect of farmyard manure as a soil amendment and selenium additions on available nutrients status as well as the growth parameters of wheat plant, yield and grain quality.

MATERIALS AND METHODS

Two field experiments were conducted in seasons of 2011/2012 and 2012/2013 on authenticated private farm at Sidi Barrani (northern coast),Marsa Matrouh Governorate to study the effectiveness of different rates, of organic matter and different rates of selenium as a foliar spray on yield, its components and macronutrient contents of wheat plants. Some physical, chemical characteristics of the experimental soil were determined according to the standard methods outlined by Black *et al.* (1965) and Page *et al.* (1982), and the obtained data are presented in Table (1). Also, some chemical characters of used farmyard manure are shown in Table (2).

Table. Some physical and chemical characteristics of the studied soil.

Soil characteristics	Value	Soil characteristics.	Value
Particle size distribution %:		Analysis of soil paste extract:	
Sand	58.2	EC (dS/m)	5.9
Silt	18.8	Soluble cations (m molc L^{-1}):	
Clay	23.1	Ca^{++}	7.05
Texture class	Sandy loam	Mg^{++}	13.85
$CaCO_3$ %	30.6	Na^{+}	35.05
Soil available nutrients (mg kg^{-1}):		K^{+}	1.55
N	11.19	Soluble anions (m molc L^{-1}):	
P	3.6	CO_3^{--}	0.00
K	21.08	HCO_3^{-}	13.04
		Cl^{-}	37.18
		SO_4^{--}	7.29
Se	0.20	pH (1:2.5 soil water suspension)	8.59

Table 2. Some characteristics of used farmyard manure (dry weight basis).

Character				Value		
Weight of 1 m^3 (kg)				718.00		
pH (1:10 water suspension)				6.3		
EC (dS/m, 1:10 water extract)				1.58		
Moisture content %				12.35		
Organic matter %				49.0		
Organic carbon %				28.42		
C/N ratio				16.62		
Total nutrients (%)						
N	P	K	Fe	Mn	Zn	Cu
1.71	1.16	1.75	0.1	0.02	0.02	0.04

Wheat (variety Giza 168) was chosen as an indicator plant. Farmyard manure (FYM) was applied at three rates, *i.e.*, 0, 2 and 4 ton fed^{-1}, while selenium solution were applied at the rates of (0, 5, 15 and 25 g fed^{-1}) in three sprays, after 30, 45 and 60 days from planting. The experimental design was a split plot. The main plots were occupied with the applied FYM rates, meanwhile the added selenium rates were arranged among the sub-plots, and then each treatment was replicated three times. The plot area was 18 m^2 (3 × 6 m).

Farmyard manure was applied throughout the soil pluming and thoroughly mixed with the 20 cm surface layer of the soil on the 1st of November 2011. On the 16th November 2012, wheat seeds were sown (variety Giza 168) which were obtained from the Plant Breeding Department, ARC, Giza.

Superphosphate (15% P_2O_5) and potassium sulphate (48% K_2O) were applied during land preparation for planting at rates 30 kg P_2O_5 and 24 kg K_2O/ fed, respectively. Nitrogen fertilizer was applied in three equal portions, (30, 45 and 60 days from sowing) in form of ammonium sulphate (20.5 % N) at a rate of 60 kg N /fed.

Wheat yield and its components, *i.e.,* plant height, No of tillers $plant^{-1}$, No of spikes $plant^{-1}$, dry weight $plant^{-1}$, 1000 grain weight, grain and straw contents of N, P, K, Fe, Mn, Zn and Se were determined. The grains and straw were dried, ground and digested according to Peterburgski (1968). Nitrogen was determined using Microkjeldahl, P by stannous chloride method as described by A.O.A.C. (1990) and K was determined by using Flam photometer (Yamagnchi and Minges, 1956). Fe, Mn, Zn and Se were determined using Atomic Absorption Spectrophotometer Perkin Elmer 3110, according to Cottenie *et al.* (1982)

Available nitrogen forms of NH_4 and NO_3 were determined by using Techniniciam Auto Analyzer according to Markus *et al*. (1982), P and K were determined according to Jackson (1967). Also, available Fe, Mn, Zn and Se were determined according to Buckanan and Muraoks (1964).

Determination of total carbohydrates

Acid hydrolysis of plant material was carried out in sealed tube using accrete known of sample (0.2 g) and 10.0 ml of 1.0 M H_2SO_4 solution. Opening sealed tube was put in boiling water bath for 10 h. after complete hydrolysis, hydrolysate was neutralized by addition of barium carbonate and the precipitate was separated by filtering the solution through whatman No.1 filter paper. After filtration, the clear solution was made up to a known volume. The total carbohydrates were determined in acid using phenol-sulfuric acid method as described by DoBois et al. (1956) as follows: A known volume of hydrolysate (1.0 ml) was transferred into a clean dry test tube. 1.0 ml of henol solution (5%) and 5.0 ml of H2SO4 were added. The yellow orange color was measurd at 490 nm using sepectrophotometer against blank.

The obtained data were statistically analyzed using L.S.D. at 0.05 as described by Snedecor and Cochran (1980).

Some metrological data of the investigated area are shown in table 3.

Table 3. Some Average metrological data of the investigated area (2006-2012).

Month	Temp. mean max. (°C)	Temp. mean min. (°C)	Temp. average (°C)	Night time (°C)	Relative humidity (%)	Wind speed 2m (m/ sec)	Rain fall (mm)	Possible sunshine duration (hr)
January	18.4	10.0	13.9	12.5	67	3.7	26.1	10.3
February	19.2	10.2	14.4	12.8	62	4.3	12.1	11.0
March	21.0	11.7	16.2	14.3	62	4. 1	3.1	11.9
April	23.1	14.0	18.4	16.5	65	4.0	0.5	12.8
May	24.3	15.5	20.0	17.9	63	3.4	0.3	13.0
June	28.5	20.1	24.5	22.4	69	3.7	0.0	14.0
July	29.8	22.2	26.2	24.5	72	4.1	0.0	13.9
August	30.4	22.6	26.8	25.0	72	3.5	0.0	13.2
September	29.8	21.4	25.8	24.0	65	3.4	0.2	12.2
October	27.6	18.5	23.0	21.1	63	3.3	2.6	11.4
November	23.4	14.2	18.6	16.7	65	3.2	8.2	10.5
December	17.1	9.7	13.1	11.7	53	3.2	11.0	8.4

RESULTS AND DICUSSION

The characteristics of the experimental soil:

The field work and analytical data (Table,1,2,3) of the representative soil sample leads to a good knowledge about the main characteristics of the experimental site. The climatic conditions are characterized by a long hot rainless summer and short mild winter, with scare amounts of rainfall. The ground water table did not appeared till 150 cm depth from ground surface due to the presence of an efficient field ditches, which were limited the current soil depth. Also, it is characterized by sandy loam in texture, moderated-saline (i.e., ECe=5.9 dS/m), calcareous in nature ($CaCO_3$=30.6 %).

Wheat growth, yield and grain quality as affected by the applied treatments:

Data in Table (4) reveal that wheat growth parameters (*i.e.*, plant height, No. of spike length, kernels weight and number /plant), grain quality (*i.e.*, grains weight/plant and 1000 grain weight) and biological yield (*i.e.*, grain and straw yields) were significantly and positive affected by the applied treatments, particularly for the combined ones of (FYM +SELENIUM) and with increasing the applied rates of both organic and selenium.

Table (4): Effect of the different applied rates of farmyard manure and Selenium application on wheat yield and its components under rain fed soil.

FYM, (A) (ton/fed)	Selenium, (B) (g/fed)	Growth parameter					Biological yield		
		Plant height, cm	No. of spike/ m^2	Kernels weight/ spike (g)	Kernels number /spike	Spike length (cm)	Grain yield, ton/fed	Straw yield, ton/fed	1000 grain weight, g
0	0	38.20	148	0.57	14.80	4.40	0.347	0.596	40.70
	5	40.60	160	0.65	18.00	4.90	0.431	0.753	36.25
	15	44.10	178	0.77	24.60	5.80	0.572	1.020	33.94
	25	37.70	127	0.49	10.60	4.40	0.261	0.392	45.70
Mean		40.15	153	0.62	17.0	4.88	0.403	0.690	39.15
2	0	40.80	163	0.63	16.00	4.90	0.431	0.724	39.17
	5	43.50	176	0.74	20.60	5.60	0.546	0.962	35.88
	15	49.20	204	0.89	28.20	6.70	0.758	1.366	33.55
	25	37.90	131	0.53	12.80	4.60	0.291	0.473	44.17
Mean		42.9	169	0.70	19.3	5.45	0.507	0.881	38.19
4	0	44.70	171	0.69	18.40	5.20	0.495	0.841	38.83
	5	48.80	188	0.83	22.00	6.00	0.654	1.157	35.20
	15	56.40	215	0.97	34.60	7.20	0.871	1.590	34.95
	25	38.60	137	0.56	13.20	4.90	0.322	0.507	43.81
Mean		47.13	178	0.76	22.1	5.82	0.586	1.023	38.19
L.S.D. at 0.05	A	3.52	14.9	0.37	N.S	0.08	1.024	0.585	N.S
	B	4.82	7.23	0.56	3.25	0.06	0.062	0.031	4.31
	A x B	N.S	N.S	N.S	N.S	N.S	0.108	0.054	N.S

That was true, since the integrated effect for using selenium and FYM on the plant height achieved a maximum plant height of 56.4 cm at the highest rates of FYM (4ton/fed) and selenium (15 g/fed).The corresponding relative increase percentages were 22.7 and 40.6 % over the control treatment, respectively, with a slightly difference of 17.9 % vs a pronounced reduction in the applied N-mineral of selenium reached about one third percent. Such results clearly obvious the effective role of the applied organic manure that is more attributed to nutrients slow release during its decomposition and mineralization processes as well as minimizing their possible lose from the soil. These positive effects were extended to dry weight plant^{-1}, No. of spike (kernels weight, number, length) spike plant^{-1}, where such growth characters showed significantly greatest values at the applied highest rates of FYM (4 ton/fed) and selenium (*i.e.*,10 g/fed), as shown in Table (4). It is noteworthy to mention that the obtained data showed that a partial substitution of N-mineral by FYM as shown in the treatment (4 tonFYM/fed + 15 g selenium/fed) led to an almost similar plant growth parameters, These results are in harmony with those results obtained by Amanullah and Maimoona (2007).

Undoubtedly, these favourable conditions have been reflected positively on soil productivity of wheat biological yield (*i.e*., grain and straw yields) and grain quality. However, the results in Table (4) showed a significantly increased in the biological yield of wheat as compared with the control treatment. The greatest value of biological yield reached of 0.87 ton/fed (*i.e*., 5,8 ardab/fed of grain ≈ 1.59 ton/fed of straw) was obtained at treatment receiving selenium and FYM of 15 g/fed and 4 ton/fed, followed by that receiving the same rate of FYM and 15 g selenium/fed.

These results revealed that wheat biological yield was more in response to the combined application of selenium and FYM with a ratio 4 ton FYM/fed:15 g selenium/fed, indicate that combined treatment was supporting higher biological yield of wheat. These findings are in agreement with Negi and Mahajan (2000) and Mishra (2000) who reported that a significant increase was achieved in wheat grain and straw yields with addition of FYM combined with N-inorganic fertilizers. That was true, since farmyard manure plays an effective role for supporting N-source as a quick and more potent source of nitrogen released. These results are in harmony with those results obtained by Amanullah and Maimoona (2007).

Grain and straw nutrient contents as affected by the applied treatments:

Data in Table (5) indicated that the applied different rates of FYM and selenium significantly increased nitrogen, phosphorus, potassium, iron manganese and zinc in wheat grain and straw yields. The greatest values were recorded with the applied highest rates of FYM (4 ton/fed) combined with selenium (15 g/fed), with slightly differences for the same applied rate of FYM plus selenium rate of 10 g/fed. These results are in line with those obtained by Mohammed (2004) who reported that organic substances are capable to produce some organic acids during microbial decomposition of added organic manure encouraged in the solubilization of macro and micronutrient in available forms from either native or added sources. Also, the organic matter tended to improved physical, chemical and biological soil properties, and consequently increased plant growth and grain yield. Similar results were also obtained by Dahdouh *et al*. (1999) and Ahmed *et al.* (2004). Concerning the integrated effect for the applied different rates of selenium and FYM on the nutrients uptake by wheat grain and straw yields, it can be seen that the obtained results are in agreement with the findings of Vyas *et al.* (1997) who reported that application of FYM significantly increased nutrients uptake and grain and straw yields of wheat.

Table 5. Effect of selenium enrichment on nutrients percentage of Straw and Grains of wheat plants under rain-fed conditions irrigation.

FYM, (A) (ton/fed)	Selenium, (B) (g/fed)	Macro nutrient contents in straw % and Se mg/kg				Macro nutrient contents in grain % and Se mg/kg			
		N	P	K	Se	N	P	K	Se
0	0	0.18	0.16	0.98	0.081	1.73	0.47	0.18	0.011
	5	0.21	0.17	1.06	0.325	1.81	0.50	0.20	0.173
	15	0.27	0.22	1.17	0.473	1.92	0.55	0.25	0.257
	25	0.18	0.17	1.02	0.686	1.70	0.44	0.19	0.384
Mean		0.21	0.18	1.06	0.391	1.74	0.49	0.21	0.206
2	0	0.20	0.19	1.02	0.088	1.82	0.53	0.19	0.014
	5	0.24	0.19	1.16	0.582	1.94	0.59	0.23	0.220
	15	0.30	0.26	1.28	0.796	2.07	0.64	0.29	0.311
	25	0.19	0.19	1.04	1.061	1.76	0.46	0.21	0.475
Mean		0.23	0.21	1.13	0.632	1.90	0.56	0.23	0.255
4	0	0.23	0.21	1.07	0.093	1.89	0.55	0.23	0.017
	5	0.27	0.23	1.18	0.717	2.05	0.61	0.25	0.308
	15	0.33	0.31	1.36	0.934	2.25	0.78	0.31	0.442
	25	0.21	0.19	1.10	1.272	1.79	0.49	0.22	0.631
Mean		0.26	0.24	1.18	0.754	2.0	0.61	0.25	0.350
L.S.D. at 0.05	A	N.S	0.04	N.S	0.226	0.10	0.07	N.S	N.S
	B	0.05	0.03	0.10	0.156	0.07	0.09	N.S	0.110
	A x B	N.S	N.S	N.S	0.073	N.S	N.S	N.S	0.121

The application of FYM and selenium significantly improved the grain and straw yields of wheat. Also, these findings are in accordance with those of Metwally and Khamis (1998) who reported that combination of organic manure and N-inorganic resulted in greater values of apparent net nutrients release than those obtained when each was applied singly. They also reported that N-requirements of wheat could not be met by solely applied FYM, meanwhile the best results were achieved due to application of a mixture between organic and inorganic N-sources. These results suggested that integrated use of selenium and FYM performed better than the use of selenium or FYM alone in terms of improving nutrients uptake by biological yield of wheat despite the fact that the recommended selenium dose, i.e., 15 g selenium fed^{-1} could be partial substitution by FYM-Selenium combinations. The combined application of FYM at a rate of 4 ton/fed with selenium source at the rates of 15 g/fed based on net produced an excellent result.

Grain carbohydrate, sugar and protein contents as affected by the applied treatments:

Data in Table (6) showed that total soluble carbohydrates and non-soluble carbohydrate in wheat grain significantly increased with increasing the applied rates of FYM and selenium, where the greatest values were found at the highest rates of FYM (4 ton/fed) and Se (15 g/fed), with an almost similar values were recorded at the same rate of FYM and Se at a rate of 10 g/fed. It is noteworthy to mention that a parallel trend for increased both reducing and non-reducing sugar contents in wheat grain took place with the trend of carbohydrate fractions, where the greatest values were recorded when soil treated with 4 ton of FYM and either 10 g of urea/fed.

The positive integrated effects of both previous applied combined treatments were extended to the pronounced increases in wheat grain protein content %. The effective role of these combination between the added farm yard manure and Se could be interpreted on the bases that the released active organic acids due to decaying FYM increasingly facilitate the mobility and uptake of nutrients in the soil, Accordingly, the plant vegetative growth status could be enhanced due to increasing the process of photosynthesis that leads to increase carbohydrates, sugars and protein contents in plant organs.

Table 6. Effect of the different applied rates of farm yard manure and selenium on grain contents of carbohydrates, sugars and protein under rain-fed conditions irrigation.

FYM, A (ton/fed)	Se, B (g/fed)	Carbohydrates (%)		Sugars (%)		Protein %
		Soluble	Non-soluble	Reducing	Non-Reducing	
0	0	1.95	53.86	0.23	2.22	10.95
	5	2.36	58.65	0.27	2.11	11.01
	10	2.77	52.84	0.29	2.22	11.04
	15	2.37	50.01	0.30	2.21	9.68
Mean		2.36	55.78	0.27	2.19	10.66
2	0	2.43	51.27	0.26	2.3	10.90
	5	2.78	47.63	0.30	2.4	11.55
	10	3.08	55.32	0.34	2.7	11.90
	15	2.88	61.11	0.30	2.5	11.73
Mean		2.75	54.83	0.30	2.35	11.52
4	0	2.56	55.18	0.32	2.42	11.87
	5	3.03	54.73	0.34	2.41	11.79
	10	3.30	55.35	0.35	2.83	12.94
	15	3.16	54.26	0.31	2.70	11.56
Mean		3.01	54.90	0.33	2.59	12.04
L.S.D. at 0.05	A	0.11	3.37	0.05	0.09	0.63
	B	0.13	N.S	0.06	0.004	0.75
	A x B	0.28	N.S	0.10	0.18	N.S

Thus it can be concluded that the economical point of view, the results of this study showed that the integrated effect of the combined treatment of (4 ton FYM/fed+15g selenium/fed) was recorded best values for all the aforementioned plant parameters, taking into consideration the possible adverse fears of human health through environmental risks as a result of the excessive use of nitrogenous fertilizers and selenium.

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التأثير المتكامل للاسمدة البلدية والسيلينوم على محصول القمح وجودة الحبوب تحت نظام الزراعة المطرية

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أجريت تجربة حقلية على تربة رملية طميية القوام ، سيدى برانى ، محافظة مرسى مطروح ، مصر خلال الموسم الشتوى ٢٠١٢-٢٠١٣ لدراسة التاثير التكاملى لاستخدام المخصب العضوى (سماد بلدى) كمحسن للتربة، والسلينيوم على انتاجية نباتات القمح (*Triticum aestivium* L.,Giza 168.)، وجودة حبوبه. حيث تم إضافة السماد البلدى (F) بمعدلات ٠، ٢، ٤ طن/فدان، بينما أضيف السيلينوم بمعدلات ٠، ٥،١٥، ٢٥ جرام / فدان. وكان تصميم التجربة بنظام القطع المنشقة Split plot، وقد تم توزيع معدلات السماد البلدى على القطع التجريبية الرئيسية (Main plots)، بينما تم توزيع معاملات السلينيوم على القطع التجريبية تحت الرئيسية (Sup-plots)، حيث تم تكرار كل معاملة ثلاث مرات. وكانت مساحة القطعة التجريبية ١٨م٢ (٣ * ٦م).

أظهرت النتائج أن إضافة مختلف معدلات التسميد البلدى والسلينيوم قد أدت الى تحسن معنوى فى كل من القياسات النباتية للقمح فى مرحلة النمو (طول النبات، عدد التفريعات أو السنابل/نبات) وعند الحصاد (المحصول البيولوجى للحبوب والقش، ومحتواهما من المغذيات الكبرى والصغرى (N, P, K, Fe, Mn and Zn)، وكذلك جودة الحبوب (وزن الـ١٠٠٠ حبة، محتوى الحبوب من البروتين والكربوهيدرات والسكريات المختزلة وغير المختزلة). كما وأن تلك التأثيرات المفيدة للمعاملات تحت الدراسة من الناحية الاقتصادية أظهرت نتائج هذه الدراسة أن تأثير المتكامل من التسميد المعدنى إلى جانب التسميد العضوى (٤ طن FYM / فدان + ١٥جرام السيلينيوم / فدان) أفضل القيم لجميع المعاملات مع الأخذ فى التاثير الضار على صحة الإنسان من خلال المخاطر البيئية نتيجة الاستخدام المفرط للأسمدة الآزوتية و السيلينيوم.