EFFECT OF INTEGRATED ORGANIC MANURING AND BIOFERTILIZER ON GROWTH AND NUTRIENT UPTAKE OF WHEAT PLANTS GROWN IN DIVERSE TEXTURED SOILS

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Abstract

A seventy days pot experiment was conducted to study the effect of farmyard manure (FYM) and chicken manure (CM) individually and/or together combined with or without a biofertilizer(BF) of *Azospirillum brasilense* and *Bacillus megatherium phosphaticum* on wheat growth grown on sandy, calcareous and clay soils.

Results revealed that all manure treatments whether combined with or without biofertilizers led to a significant increase in wheat dry weights. Weights of plants grown on a clay soil were higher than that grown on sandy or calcareous soils. Response of wheat to organic manure treatments was more pronounced in sandy and calcareous soils than in the clay one. Although N, P and K contents of wheat were higher in the clay soil, yet the response to organic manuring was more obvious in sandy and calcareous soils.

INTRODUCTION

Most of the newly reclaimed soils in Egypt are sandy and calcareous soils of poor available nutrients. To increase their productivity, organic matter application plays an important role to retain the inorganic elements in complex and chelate forms. In this accord organic manures are well established to be involved in fertilization of plants in almost worldwide, due to their beneficial effects on the physico-chemical and biological characteristics of the soils, which in turn influence the growth and increase plants production (Youssef *et al.,* 2001). Adding organic manures as fertilizers led to decreasing soil pH, which results in increasing solubility of nutrients and nutrient availability to the plants (Salem, 1988). Besides these organic manures stimulate biodegradation through increasing the population and activities of microorganisms in the soil (Mervat and Dahdoh, 1995) and minimize the loss of nutrients by leaching (Balba, 1975). Abo-el - Defan (1990) found that addition of chicken manure increased fresh and dry yields of tomato shoots, fruits and the concentrations of N, P and K in both shoots and fruits.

Some organic materials are known to mineralize and release plant nutrients rapidly as a result of microbial attack. On the other hand, poor fertile soils would benefit from application of organic materials having a degree of microbial stability in soil and the organic materials in some cases may act as a slow release fertilizer. So, farmers in developing countries, such as Egypt, often have the occasion to use both rapidly and slow release organic fertilizers in their farming systems (Abdel-Sabour *et al.,* 1999). Both farmyard and chicken manures have been traditionally applied as a fertilizer of slowly released nutrients, for some crops and to improve the physio-chemical soil properties (Abdel-Sabour *et al.,* 1999).

This work was designed to evaluate the impact of organic manures application [farmyard manure (FYM) and chicken manure (CM)] combined with biofertilizer to sandy, calcareous and clay soils on wheat growth and nutrient uptake.

MATERIALS AND METHODS

A pot experiment was conducted in the greenhouse of the Plant Nutrition Research section; Soils, Water and Environment Research Institute, Agricultural Research Center, Giza, in the winter season of 2002. This is to study the effect of farmyard and chicken manures combined with a biofertilizer (a mixture of *Azospirillum brasilense* and *Bacillus megatherium*) on wheat (cv. Sids-1) grown on sandy, calcareous and clay soils. The organic manures were mixed thoroughly with 5 kg portion of each soil immediately before seed cultivation at the equivalent proper wheat recommended rate of N based on the total nitrogen content of each organic manure. In case of inoculation, wheat seeds were spread immediately before cultivation on a plastic sheet and thoroughly mixed with the biofertilizer inoculum and allowed to adhere to the seeds when rinsed with a liquid Arabic gum and then air dried for two hours. Each pot was sown with 10 wheat seeds, which were then thinned out to 7 healthy seedlings and watered at regular intervals to keep 55 % of saturation percentage. The added organic manures contain C% 5.44 and 26.62, total N% 0.38 and 2.20, total P% 0.15 and 1.6, total K% 0.80 and 2.00, organic matter% 9.38 and 45.90 and C/N ratio 14.30 and 12.10 for FYM and CM, respectively.

The experiment included the following treatments with 3 replicates in complete randomized blocks design:

1-Control (non-inoculated plants).
2- *Azospirillum brasilense* + *Bacillus megatherium phosphaticum* (BF).
3-Farmyard manure at a rate equivalent to 100 kg N fed^{-1} (FYM 100%)
4-FYM 100% + BF
5-Chicken manure at a rate equivalent to 100 kg N fed^{-1} (CM100 %)
6-CM 100% + BF
7-FYM 25% + CM 75%
8-FYM 25% + CM 75% + BF
9-FYM 50% + CM 50%
10-FYM 50% + CM 50% + BF
11-FYM 75% + CM 25%
12-FYM 75% +CM 25% + BF

Plants at maximum tillering stage (70 days after sowing) were then cut just above the soil surface and plant dry weight (oven dried plants at 70 ^{o}c) was determined, moreover, N (Chapman and Pratt, 1961), P and K plant contents (Jackson, 1976) were evaluated.

Results obtained were subjected to the statistical analysis according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1- Wheat dry matter content by manuring and biofertilizer

Results in Table 1 revealed that inoculation with biofertilizer alone slightly increased the dry matter weight of wheat plants grown on the different tested soils over the control treatment. Mixing the biofertilizers with both organic manures at different levels increased significantly the dry matter in sandy and calcareous soils compared with the treatments receiving organic manures only. For instance, the dry weight increased from 13.44 to 14.66 g pot^{-1} when FYM 100% treatment was inoculated with biofertilizer in the sandy soil and increased from 14.38 to 15.66 g pot^{-1} when CM 100% treatment was inoculated with biofertilizer in the calcareous soil. On the other hand, in the clay soil, mixing biofertilizer with organic manures generally caused significant decreases in the dry matter. For instance, the dry matter weight of 22.96 g pot^{-1} recorded by FYM 100% treatment was significantly decreased to 19.28 g pot^{-1} as the treatment was inoculated with biofertilizer. The increases in the dry matter noticed in both sandy and calcareous soils in response to biofertilizer inoculation are supposed to be due to the poor organic matter contents of these soils, that ensure original low indigenous microorganisms population, which in turn are not able to compete with the microbes in the biofertilizer inoculum. This behavior in sandy and calcareous soils enables the biofertilizer to add more N and P to soils through nitrogen fixation and dissolving phosphate processes and also through their ability to secrete growth promoting like substances (Hedge *et al.*, 1999). While, in clay soils with originally high organic matter content, the high number of indigenous microorganisms compete with the microbes in the biofertilizer inoculum, which consequently decrease in number, as well as biofertilizer microbes tended to immobilize the available soil nutrients to proliferate to increase their number (Cano *et al.*, 1997), and therefore the added amounts of N and P are not adequate to support the growth of the wheat plant.

In case of the sandy soil, the use of either FYM or CM alone or mixed together with or without biofertilizers significantly increased the dry matter of wheat plants in comparison with the control. The highest dry matter weight (15.9 g pot^{-1}) and the lowest one (12.27 g pot^{-1}) were achieved by the treatments receiving FYM 75% + CM 25% + BF and FYM 75% + CM 25%, respectively.

Moreover, the highest wheat biomass (15.90 g pot^{-1}) achieved due to FYM 75% + CM 25% + BF was significantly higher than those achieved due to the other treatments except that of the treatment of FYM 50% + CM 50% + BF.

In case of the calcareous soil, the use of any of the organic manures alone or mixed together with different doses of biofertilizer led to a significant increase in the dry matter of wheat plants. The highest value (15.66 g pot^{-1}) was recorded in case of applying CM 100 % + BF treatment. This treatment was significantly higher than the other treatments except the treatments receiving FYM 25% + 75 % CM + BF (15.39 g pot^{-1}) and the one that received FYM 50% + CM 50 % + BF (15.01 g pot^{-1}).

In case of the clay soil, the highest dry weights of wheat plant were 25.04, 23.84, 22.96, 22.37 and 22.08 g pot^{-1} for the respective treatments of FYM 25% + CM 75%, FYM 75% + CM 25%, FYM 100 %, FYM 50% + CM 50% and CM 100 %.

Also, it is obvious that the highest biomass (25.04 g pot^{-1}) was recorded with FYM 25% + CM 75%. It was also noticed that wheat biomass was higher in the clay soil than in the sandy and calcareous soils. This could be attributed to the higher biological activity in the clay soil than the other two soils which increase the number of microbes capable to decompose the soil organic matter as well as the added organic manures. This organic matter decomposition led to an increase in the availability of soil nutrients to the cultivated plants (Sakr *et al.*, 1992). This might reflect the different characteristics of the tested soil.

These results are in accordance with Sakr *et al.,* (1992) who found that dry matter of wheat and maize showed pronounced increases in response to organic manure application. They added that such increases were higher in plants grown in calcareous soils than alluvial ones. The dry matter yield of sunflower leaves, stems and flowers at either vegetative or flowering growth stage were significantly increased by previous single compost manure (Abdel-Sabour *et al.,* 1999). Addition of farmyard manure led to the maximum increase in plant growth and consequently wheat yield productivity (Awad *et al.,* 2000).

2- Wheat nitrogen content as affected by manuring and biofertilizer

Concerning the nutrient uptake by wheat plants in case of the sandy soil (Table 2), the highest N-uptake value (373.85 mg N pot-1) was attributed to CM 100 % + BF followed by 364.65, 364.60, 343.5, 341.38, 333.39, 328.77, 305.46, 300.49 and 289.46 mg N pot-1 for the treatments of FYM 50% + CM 50%, CM 100%, FYM 75% + CM 25%, FYM 25% + CM 75%, FYM 50% + CM 50%+ BF, FYM 25% + CM 75%+ BF, FYM 75% + CM 25% + BF, FYM 100 %, and FYM 100 % + BF, respectively.

It is worthy to state that inoculation with biofertilizer did not cause any significant increase in nitrogen uptake of wheat plants grown in the sandy soil. This could be attributed to the immobilization of the available nitrogen by the inoculated bacteria which need to proliferate and to build their cellular protoplasm, this in turn decrease nitrogen plant uptake (Zaghloul *et al.*, 1996).

In case of the calcareous soil, all the studied treatments exerted significant effect on nitrogen uptake by plants and gave significantly a higher N-content compared to control or control + BF treatments.

However, the highest N-uptake (457.76mg N pot^{-1}) was obtained in case of CM 100% application. This was significantly higher than and different from the other treatments except those of FYM 50% + CM 50% and FYM 100% + BF.

In case of the clay soil, the addition of organic manure increased significantly the N-uptake over the control treatment or the control + BF treatment. The highest value (686.74) mg N pot^{-1} was observed in case of applying FYM 25 % +CM 75 %. This was significantly higher than the uptake of plants receiving either organic manure alone or in combination with biofertilizer. The lowest N-uptake (446.35 mg N pot^{-1}) existed in case of FYM 75 % + CM 25 % + BF treatment.

3- Wheat phosphorus content as affected by manuring and biofertilizer

Regarding the effect of organic manures on phosphorus uptake by wheat plants grown in the sandy soil (Table 3), application of organic materials combined with BF increased significantly P-uptake over both the control or control + BF treatments.

The highest P-uptake (25.58 mg P pot^{-1}) was recorded in case of treatment FYM 25 % + CM 75 % + BF. This value was significantly higher than recorded by the treatments of FYM or CM alone or together with or without the biofertilizer. However, applying the treatments of FYM 50 % + CM 50 % + BF, FYM 75 % + CM 25 %, FYM 50 % + CM 50% and CM 100 % resulted in values which are not significantly different from the highest one. The corresponding P-uptake values were 25.23, 23.31, 23.15 and 22.21 mg P pot^{-1}, respectively.

In case of the calcareous soil, P-uptake by wheat plants of the manured treatments was significantly higher than those of the control or control + BF treatment.

The highest P-uptake value (27.8 mg P pot^{-1}) resulted in case of CM 100% treatment. Biofertilizer application with organic manuring treatments did not result in any significant increase in P-uptake over organic manuring only.

However, it should be pointed out that the organic manure treatments receiving biofertilizer showed no increase in P-uptake. On the contrary, a decrease in P-uptake occurred when the organic manure treatment was combined with biofertilizer. Such decreases in P-uptake were significant in some treatments. For example, a significant decrease in P-uptake was recorded in case of treatment of CM 100 % receiving BF inoculation, that decrease was from 27.8 to 21.93 mg P pot^{-1}.

Regarding the clay soil, all treatments receiving organic manures tended to increase significantly the P-uptake of wheat plants over the control and/or + BF treatments. The addition of BF to treatments receiving organic manure exhibited different effects on P-uptake of wheat. A significant reduction in P-uptake from 41.87 to 27.79 mg P pot^{-1} occurred when the treatment FYM 25 % + CM 75 % was combined with BF. While a significant increase from 24.44 to 30.75 mg P pot^{-1}

occurred when the treatment FYM 50 % + CM 50 % was provided with BF. The highest value of P-uptake (41.87 mg P pot^{-1}) existed in case of FYM 25 % + CM 75 %.

4- Wheat potassium content as affected by manuring and biofertilizer

Concerning K- uptake in the sandy soil, manuring led to significant increases over the control treatment (Table 4). The highest K plant uptake of 329.15 mg K pot^{-1} was recorded by the application of CM 100 %. This high K- uptake was different from those of other treatments except for CM 100 % + BF treatment where corresponding K- uptake was 311.22 mg K pot^{-1}.

In case of the calcareous soil, all manured plants with or without biofertilizer showed higher K- uptake than the control treatment. The highest K-uptake amount (384.98 mg K pot^{-1}) was recorded by applying CM 100 % treatment.

However, Application of either FYM or CM accompanied with BF or not in case of clayey soil, led to a significant increase in K- uptake compared to control treatment. The highest K- uptake of 800.26 mg K pot^{-1} resulted by applying FYM 25 % + CM 75 %, this high K-uptake was significantly higher than the other manure treatments with or without biofertilizer.

The application of organic manure to all soils had enhanced the NPK uptake by wheat plants in different degrees, which is almost equal in both sandy and calcareous soils. However, the NPK- uptake enhancement was higher in the clay soil than those of the sandy and calcareous soils. This could be attributed to organic manure application which enhance the metabolic activity within plants and promote the migration of the metabolites through roots and stems toward leaves, thereby it may increase the percentage of nutrients in leaves and stems (Sikander, 2001). On the other hand, it is well known that the marginal soil such as sandy and calcareous soils are very poor in nutrients and posses low organic matter content. Small amounts of organic matter can modify the soil properties as well as strongly affect chemical, physical and biological features (Zia *et al.*, 2001). Organic manures improve moisture retention and nutrient use efficiency and thereby contribute to enhance nutrients availability to plants.

Addition of compost to sandy soils increased N, P and K concentrations in all plant organs, as most of them reached the level of significance (EL-Sirafy *et al.*, 1989). Cucumber plants fertilized with chicken manure and cattle manure had higher

N, P and K than those grown in a sandy soil free from manuring (Eissa, 1996). Farmyard manure and/or Chicken manure and their mixture had significantly increased N, P and K contents in cucumber leaves (Alphonse and Saad, 2000). In addition Eneji *et al.* (2001) stated that organic manures (chicken manure, cattle manure and swine manure or their mixture) applied to rice plants had increased significantly the N, P and K contents of plants. They added that the general increases in rice nutrients uptake in manured pots indicates that manure mineralization soon after application resulted in greater pool of plant available nutrients.

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Table 1. Dry weight of wheat plants (g pot^{-1}) as affected by different types of manures and soil types

Treatments	Soil type			Mean
	Sandy	Calcareous	Clay	
Control	2.70	5.38	15.30	7.79
Control + BF	4.65	7.61	13.64	8.63
FYM 100%	13.44	13.70	22.96	16.70
FYM 100%+ BF	14.66	13.88	19.28	15.94
CM 100%	12.88	14.38	22.08	16.45
CM 100% +BF	13.60	15.66	16.40	15.22
FYM 25% + CM 75%	12.45	14.05	25.04	17.18
FYM 25% +CM 75% + BF	14.47	15.39	17.52	15.79
FYM 50% + CM 50%	13.39	14.07	22.37	16.61
FYM 50% + CM 50% + BF	14.34	15.01	19.65	16.50
FYM 75% + CM 25%	12.27	12.86	23.84	16.32
FYM 75% + CM 25% + BF	15.90	13.55	18.96	16.14
Mean	12.10	12.96	19.75	14.94

L.S.D. (P 0.05)

Soil (s)	0.44
Treatment (T)	0.87
S x T	1.51

Table 2 . Nitrogen uptake of wheat plants (mg N pot^{-1}) as affected by different types of manures and soils

Treatments	Soil type			Mean
	Sandy	Calcareous	Clay	
Control	75.42	166.26	417.46	219.71
Control + BF	86.55	131.99	362.59	193.71
FYM 100%	300.49	360.44	582.29	414.41
FYM 100%+ BF	289.46	388.63	474.52	384.20
CM 100%	364.60	457.76	535.45	452.60
CM 100% +BF	373.85	370.61	355.70	366.72
FYM 25% + CM 75%	341.38	358.11	686.74	462.08
FYM 25% +CM 75% + BF	328.77	315.34	455.65	366.59
FYM 50% + CM 50%	364.65	396.61	551.79	437.68
FYM 50% + CM 50% + BF	333.93	257.62	523.97	371.84
FYM 75% + CM 25%	343.51	336.95	493.66	391.37
FYM 75% + CM 25% + BF	305.46	333.43	446.35	361.75
Mean	292.34	322.81	490.51	368.56

L.S.D. (P 0.05)

Soil (s) 22.57

Treatment (T) 45.15

S x T 78.19

Table 3. Phosphorus uptakeof wheat plants (mg P pot^{-1}) as affected by different types of manures and soils

Treatments	Soil type			Mean
	Sandy	Calcareous	Clay	
Control	2.60	7.48	17.58	9.22
Control + BF	4.19	6.09	18.16	9.48
FYM 100%	11.66	14.36	27.43	17.82
FYM 100%+ BF	11.70	13.20	26.96	17.29
CM 100%	19.32	27.80	30.16	25.76
CM 100% +BF	22.21	21.93	30.77	24.97
FYM 25% + CM 75%	16.19	22.95	41.87	27.00
FYM 25% +CM 75% + BF	25.58	23.53	27.79	25.63
FYM 50% + CM 50%	23.15	21.04	24.44	22.88
FYM 50% + CM 50% + BF	25.23	19.46	30.75	25.15
FYM 75% + CM 25%	23.31	17.14	23.84	21.43
FYM 75% + CM 25% + BF	21.17	17.62	26.54	21.78
Mean	17.19	17.72	27.19	20.70

L.S.D. (P 0.05)

Soil (s)	1.00
Treatment (T)	2.00
S x T	3.46

Table 4. Potassium uptake of wheat plants (mg K pot^{-1}) as affected by different types of manures and soils

Treatments	Soil type			Mean
	Sandy	Calcareous	Clay	
Control	74.39	133.90	395.67	201.32
Control + BF	83.32	155.29	404.50	214.37
FYM 100%	232.02	334.05	691.92	419.33
FYM 100%+ BF	237.99	319.11	576.41	377.84
CM 100%	329.15	384.98	639.43	451.19
CM 100% +BF	311.22	350.39	466.66	376.09
FYM 25% + CM 75%	252.46	352.16	800.26	468.29
FYM 25% +CM 75% + BF	259.44	328.58	543.90	377.31
FYM 50% + CM 50%	281.11	363.44	579.23	407.93
FYM 50% + CM 50% + BF	257.79	302.10	627.38	395.76
FYM 75% + CM 25%	269.01	327.08	550.89	382.33
FYM 75% + CM 25% + BF	256.05	347.34	549.55	384.31
Mean	237.00	308.20	568.82	371.34

L.S.D. (P 0.05)

Soil (s)	21.49
Treatment (T)	42.97
S x T	74.43

أثر التكامل بين التسميد العضوى و التسميد الحيوى على نمو نبات القمح ومحتواه من العناصر والنامى فى اراضى مختلفة القوام

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فى هذه الدراسة أجريت تجربة فى صوبة تغذية النبا ت-معهد بحوث الأراضى والمياة والبيئة بالجيزة وذلك لدراسة أثر استخدام التسميد العضوى الكامل مع التسميد الحيوى (*Azospirillum brasilense + Bacillus megatherium phosphaticum*) أو بدونه على نمو نبا ت القمح وكذلك محتواه من العناصر مثل النيتروجين والفوسفور والبوتاسيوم. تمت زراعة بذور القمح (صنف سدس) فى أصص تم تعبئتها بثلاثة أنواع من التربة هى الرملية والجيرية والطينية وسمدت كاملا باى من السماد البلدى أو سماد الدواجن أو مخلوط منهما باضافة أو بدون اضافة التسميد الحيوى. بعد سبعين يوما من الزراعة تم قطع النباتات من فوق سطح التربة مباشرة ثم جففت لتقدير الوزن الجاف لنباتات القمح وكذا محتواها من كل من النيتروجين والفوسفور والبوتاسيوم.

كانت أهم النتائج المتحصل عليها كما يلى:

١- أدى استخدام التسميد العضوى مع التسميد الحيوى او بدونه الى زيادة معنوية فى الوزن الجاف لنباتات القمح وذلك بالمقارنة مع معاملة المقارنة بدون اى تسميد.

٢- كان الوزن الجاف لنباتات القمح المنزرعة فى االتربة الطينية اعلى من المنزرعة فى اى من التربة الرملية او الجيرية.

٣- كانت الاستجابة للتسميد العضوى أكثر وضوحا فى التربة الرملية والجيرية عنها فى التربة الطينية.

٤- بالنسبة لمحتوى نباتات القمح من النيتروجين والفوسفور والبوتاسيوم فانه بالرغم من ارتفاعها فى حالة النباتات المنزرعة فى التربة الطينية فان الاستجابة للتسميد العضوى كان أكثر وضوحا فى التربة الرملية والجيرية.