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Uptake of Micronutrients by Barley Plant Influenced by Organic and Bio Fertilizers

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ABSTRACT

A pot experiment was carried out for investigating the possibility of partial or entire replacement of mineral nitrogen fertilizers with organic and biofertilizers, aiming to improve the efficiency of nitrogen fertilization for barley plant (*Hordeum vulgare* Giza 123) grown in sandy calcareous soil collected from Agriculture Research Station in Nubariya. Mineral nitrogen fertilizer was added at the rates 30, 60, 90 and 120 mg N kg soil^{-1}. Phosphorus and potassium were added at the recommended rates of 15 mg P and 30 mg K kg soil^{-1}, respectively. Organic fertilizers were added from different sources "compost, chicken manure and pigeon dung " at a rate of 30 mg kg N soil^{-1} based on their nitrogen content. Bio fertilization was achieved through the addition of 5g pot^{-1} serialin or /and 5g pot^{-1} phosphorene; mixed thoroughly with soil. Upon the observed data, the highest Fe uptake was observed when soil was treated with "chicken manure + serialin" combined with mineral-N at addition level of 90 mg N kg soil^{-1}. The highest Mn uptake was recorded when soil was treated with " chicken manure + serialin + phosphorine " combined with mineral-N at addition level of 60 mg mineral N kg soil^{-1}. The highest Zn uptake was obtained when soil was treated with "chicken manure + phosphorene" combined with mineral-N at addition level of 90 mg mineral N kg soil^{-1}. The highest biological yield was recorded when soil was treated with "chicken manure + serialin" combined with mineral-N at addition level of 60 mg mineral N kg soil^{-1}.

Keywords: Micronutrients uptake, barley, sandy calcareous, organic and biofertilizers

1. Introduction

Barley is considered the fifth most versatile universal cereal grain dry matter yield and is considered an essential source of food worldwide, (Gupta *et al.,* 2010). Because barley contains β-glucans, which have been shown in recent research to have various health benefits, including barley in human food should be strongly recommended, (Kaur and Das, 2015).

Sand calcareous soils have high content of calcium carbonate and are mostly found in both hemispheres' semi-arid and arid subtropics, (Wahba *et al.,* 2019). Sand calcareous soils usually have low levels of available nitrogen and organic matter. Additionally, owing to its high pH, phosphate, zinc, and iron are unavailable (Fuehring, 1973).

Mineral N fertilizers are applied to boost the natural soil nutrient supply and compensate for the minerals lost by plant product removal, leaching, or gaseous loss to supplement the needs of crops with high yield potential and provide commercially viable yields, (IFIA, 2000). Farmers focus has shifted to organic fertilizers owing to the rising costs of inorganic fertilizers. These organic sources improve soil fertility by potentially enhancing the physicochemical qualities of the soil, which include nutrient availability and plant absorption, (Muhammad and Khattab 2009).

Organic manures are used aiming to raise soil organic matter content, lowering pH and EC, and providing the nutrient elements for plant growth, (Mahmoud *et al.,* 2004). Compost is one type of organic soil amendment that can supplement and even replace chemical fertilizer by providing both macro and micronutrients that help crops absorb nutrients more effectively (Martin and Macrae, 2014).

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Bio fertilization is made up mostly of sufficient amounts of patent strains of microorganisms. These bacteria play specific positive roles in seedling growth and soil fertility in the rhizosphere, (Saber, 1993). Biofertilizer inoculation can lower the need for mineral fertilizers and is an advantageous method for soil development, lowering agricultural expenditures, and increasing crop output since it gives crops access to readily available nutrients (Metin *et al.,* 2010). To minimize negative effects on the soil, minimize intensive chemical fertilizer usage, and optimize soil fertilizer use efficiency, it is believed that integrating bio fertilizers with mineral fertilizers is the optimum choice (Singh *et al.,* 1999).

To improve the nitrogen fertilization for barley plants grown in sandy calcareous soil, the current study investigated the possibility of substituting organic and bio fertilizers for mineral nitrogen fertilizers, either entirely or in part, for barley plant fertilization under various levels of mineral-N.

2. Materials and Methods

Investigating the possibilities of partially or completely replacing organic and bio fertilizers for barley plant fertilization at varying levels of mineral-N, we carried out a pot experiment in a greenhouse. Uptake of micronutrients, biological yield, and weight of 1000 grain barley plant (*Hordeum vulgare* Giza 123) were measured.

2.1. Soil characteristics

Soil texture was sandy loam contented (16.5 %) calcium carbonate and (0.31%) organic matter. The collection of soil samples was done from Nubaria Stations, Agriculture Research Center which is located at the East side of Cairo-Alexandria road, Egypt. Some physical and chemical properties of the soil used are shown in Tables (1, 2 and 3).

Table 1: Physical properties of the soil used

Mechanical analysis					$CaCO_3$ (%)	OM (%)	F.C (%)
Clay (%)	Silt (%)	Coarse sand (%)	Fine sand (%)	Textural Class			
12.3	18.2	21.4	48.1	Sandy Loam	16.5	0.31	17.1

Table 2: Chemical properties of the soil used

EC* (dsm^{-1})	pH**	Soluble ions (me L^{-1}) *							
		Cations				Anions			
8.63	7.95	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	HCO_3^-	CO_3^{2-}	SO_4^{2-}
		41.30	5.42	23.16	19.25	49.71	15.62	Nil	23.80

*In soil paste extract **Suspension 1:2.5 Soil: Water

Table 3: Nutrients concentration of the soil used

Available Macro nutrients (mg kg^{-1} soil)			Total Micro nutrients (mg kg-1 soil)		
Nitrogen	Phosphorus	Potassium	Iron	Manganese	Zinc
277	11.5	8.6	523	19.2	1.6

2.2. Mineral Fertilizers

The recommended addition rates for potassium and phosphorus were 15 mg P and 30 mg K kg soil^{-1}, respectively. Nitrogen was added as ammonium nitrate (33.5 % N) at rates of 30, 60, 90 and 120 mg N kg soil^{-1}.

2.3. Organic fertilizers

Organic N sources; compost (13.3 g N kg^{-1}), chicken manure (25.8 g N kg^{-1}) and pigeon dung (32.1 g N kg^{-1}) were added at the rate of 30 mg N kg soil^{-1}. The applied quantities of these sources were calculated according to their total N content. Some chemical analyses of these organic fertilizers are shown in Table (4).

Table 4: Chemical analysis of different organic fertilizers used

Characteristic / Organic fertilizers	EC* (dSm^{-1})	pH**	Organic matter ($g\ kg^{-1}$)	C/N Ratio	Total N ($g\ kg^{-1}$)	Total P ($g\ kg^{-1}$)	Total K ($g\ kg^{-1}$)
Compost	3.74	7.55	316.4	14.65	13.3	9.6	9.3
Chicken Manure	3.75	6.37	538.7	12.43	25.8	4.1	3.1
Pigeon dung	3.03	6.60	184.2	10.76	32.1	2.8	9.4

* Water extract of 1: 10 organic fertilizers: water ** Suspension of 1: 10 organic fertilizers: water

2.4. Bio fertilizers

Bio fertilizers were commercially produced at Soil Microbiology Unit, Research Institute of Soil, Water and Environments, Agricultural Research Center. Bio fertilization was achieved through the addition of 5g pot^{-1} serialin or /and 5g pot^{-1} phosphorene; mixed thoroughly with soil, "5 cm depth from the surface". Serialin contains strains of (Azotobacter, Azosprillum and Bacillus polymixa) and Phosphorein contains the active phosphate dissolving bacteria (Bacillus megatherium var. phosphaticum).

2.5. Treatments of the study

Treatments were arranged as the simplest possible combination between organic fertilizer, bio-fertilizer and mineral N fertilizer as following:

1	Mineral nitrogen	**6**	Chicken manure + Phosphorene
2	Compost + Serialin	**7**	Chicken manure + Serialin + Phosphorene
3	Compost + Phosphorene	**8**	Pigeon dung + Serialin
4	Compost + Serialin + Phosphorene	**9**	Pigeon dung + Phosphorene
5	Chicken manure + Serialin	**10**	Pigeon dung + Serialin + Phosphorene.

Seven kilograms of dirt were placed into closed-bottom plastic pots with internal measurements of 25 and 20 centimeters. Twenty barley grains were planted in each pot then after germination; plants were reduced to five plants for each pot. Adjustment of the content of soil moisture was done after germination to suit soil field capacity.

2.6. Experimental Design

A randomized complete block "factorial" design with three replicates was used, involving two factors which are:

1) Nitrogen sources "mineral - organic - bio".
2) Mineral-N addition rates.

2.7. Plant samples

Three different stages of growth: 45, 75, and 140 days after planting, which correspond to tillering and booting respectively, were selected to collect plant samples. Dried plant samples as well as grains were wet digested for determining macronutrients (Fe, Mn, and Zn).

2.8. Methods of Analysis

The analyses of soil, organic fertilizers and plant samples were conducted as the following methods:

I. Soil analysis

To determine the organic matter content of the soil , the modified Walkley and Black method was used (Page *et al.,* 1982). The MgO-Devarda alloy was used in a steam-distillation procedure to measure the amount of available nitrogen, following the procedures outlined by Bremner and Keency (Black, 1982). 0.5 N $NaHCO_3$ with a pH adjustment to 8.5 was used to extract the available phosphorus, which was then measured calorimetrically using ascorbic acid techniques (Watanabe and Olsen, 1965). According to Jackson (1973), available potassium was extracted using 1 N ammonium acetate with a pH adjustment to 7.0 and measured using a flame photometer.

II. Fertilizers analysis

Water suspension of organic fertilizer was used to determine pH using a glass electrode pH meter in a ratio of 1: 10. (Jackson, 1973). The organic fertilizer's electric conductivity (EC) was determined using water extracts at a ratio of 1:10 as described by (Jackson, 1973). The traditional micro Kjeldahl method was used to calculate total nitrogen (Jackson, 1973). At a wavelength of 882 nm, total phosphorus was measured using a calorimetric method as per (Olsen, and Sommers, 1982). A flame photometer was used to determine the total potassium content in accordance with (Jackson, 1973). As per (Hesse, 1971) description, Walkley and Black's method was utilized to determine the total carbon content (g kg^{-1}).

III. Plant analysis

Trace elements (Fe, Mn and Zn) were extracted by digestion with concentrated H_2SO_4 + $HClO_4$ and measure by ICP according to Chapman and pratt, (1978).

2.9. Statistical analysis

Data were evaluated using statistical methods in accordance with (Snedecor and Cochran, 1988). The treatment means were compared using the least significant method. The significance level for the Differences (LSD) test was set at 0.05 (Waller and Duncan, 1969). The analysis of variance technique of the computer software package (MSTAT-C, 1991) was used to do statistical analysis.

3. Results and Discussion

3.1. Micronutrients uptake of barely as affected by organic and bio fertilization under different levels of mineral-N at different growth stages

3.1.1. Iron uptake

Concerning the effect of mineral nitrogen, data presented in Tables (5, 6, 7 and 8) reveal that the individual addition of mineral nitrogen up to the level of 120 mg N Kg $soil^{-1}$ generally increased the Fe uptake; and this was found true at all growth stages under study. In this regard, Mohamed *et al.,* (2006) noted that the Fe concentration and uptake of wheat increased with increasing N applications rate from 107 to 179 kg N ha^{-1}. According to Shi *et al.,* (2010), when nitrogen (0, 130, and 300 kg N ha-1) was applied, an increase in the iron content of the wheat plant was observed when compared to the control. According to Rattan (2015), iron is absorbed by plants as ferrous ions (Fe^{2+}), with a dry matter content that varies from 100 to 500 mg kg^{-1}. According to Stepien *et al.,* (2019), winter wheat grain's Fe concentration varied from 42.8 to 72.1 mg kg^{-1} in response to 150 and 200 kg N ha^{-1} of N fertilizer, respectively.

Obtained data also indicate that, at tillering and booting stages the highest values of Fe uptake "31.2 and 398 µg pot^{-1}, respectively" were observed under the addition level of 120 mg N kg $soil^{-1}$; while the lowest values "17.1 and 231 µg pot^{-1}" observed under the addition level of 30 mg N kg $soil^{-1}$. Regarding to maturity stage the highest Fe uptake of straw and grains "947 and 978 µg pot^{-1} respectively" were obtained under the addition level of 90 mg N kg soil-1; while the lowest values "387 and 515 µg pot^{-1}" obtained under the addition level of 30 mg N kg $soil^{-1}$. According to Timsina (2013), grains' Fe concentration increased significantly when the N application rate was increased from 80 or 120 to 160 kg N ha^{-1}. Manzeke-Kangara *et al.* (2021) reported that the highest grain Fe concentration of 48.4 mg kg^{-1} was observed when the soil treated with addition rate of 45 kg N ha^{-1}.

With respect to the effect of organic and bio fertilizers, data show that the Fe uptake by plant was significantly increased at all growth stages under study. In this regard, Madlain *et al.* (2002) stated that inoculation of barley seeds with serialin combined with 7.5 m^3 FYM fed^{-1} increased Fe uptake by barley plant. El Sharawy *et al.* (2003) found that applying compost considerably raised the content of iron in wheat plants. According to Alakhdar *et al.,* (2020), using biofertilizers along with humic acid to wheat plants resulted in the maximum Fe concentration of 103.1 mg kg^{-1}.

Regarding the highest value of Fe uptake as affected by N fertilization treatment, the maximum values " 233.8 and 2198 µg pot^{-1}" at tillering and booting stages, respectively were observed under the treatment of " compost + serialin " at the addition level of 120 mg mineral N kg soil^{-1} compared with 31.2 and 398 mg pot^{-1} under the addition of individual mineral-N. With respect to maturity stage, the maximum Fe uptake of straw and grains " 3717 and 4170 µg pot^{-1} " were observed under the addiion of " chicken manure + serialin " at the addition level of 90 mg mineral N kg soil^{-1} compared with 947 and 978µg pot^{-1} under the addition of individual mineral-N. These results are in harmony with Walia and Kler (2010) found that Fe uptake by wheat plant was significantly higher over the recommended dose of chemical fertilizer when FYM added at the rate of 20 t ha^{-1}. Manal *et al.* (2019) found that when compost was added at a rate of 10 m^3 fed^{-1} along with azotobacter, the amount of Fe content in wheat plants grown in freshly reclaimed soil reached its maximum value of "295.50 mgkg^{-1}".

Table 5: Iron uptake (µg pot^{-1}) of barley at tillering stage as influenced by organic and biofertilization under different levels of mineral-N

Nitrogen Source / Mineral - N rate	30 mg N kg soil^{-1}	60 mg N kg soil^{-1}	90 mg N kg soil^{-1}	120 mg N kg soil^{-1}	Mean
Mineral – N	17.1	24.8	25.5	31.2	24.7
Compost + Serialin	91.6	119.1	167.3	233.8	153.0
Compost + Phosphorene	45.3	68.1	74.1	106.6	73.5
Compost + Serialin+ Phosphorene	88.1	101.6	148.2	185.8	130.9
Chicken manure + Serialin	44.3	46.8	89.5	90.3	67.7
Chicken Manure + Phosphrene	36.3	41.8	81.4	93.5	63.3
Chicken Manure + Serialin + Phosphorene	30.8	57.2	58.4	116.5	65.7
Pigeon dung + Serialin	41.4	41.9	46.1	58.5	47.0
Pigeon dung + Phosphrene	23.2	31.6	37.1	43.9	34.0
Pigeon dung + Serialin+ Phosphorene	33.9	35.6	43.3	52.6	41.4
Mean	45.2	56.9	77.1	101.3	
L.S.D	***NT 2.0671**	****NR 1.3073**	**NT×NR 4.1341**		

*NT: nitrogen treatments ** NR: nitrogen rates

Table 6: Iron uptake (µg pot^{-1}) of barley at booting stage as influenced by organic and biofertilization under different levels of mineral-N

Nitrogen Source / Mineral - N rate	30 mg N kg soil^{-1}	60 mg N kg soil^{-1}	90 mg N kg soil^{-1}	120 mg N kg soil^{-1}	Mean
Mineral – N	231	277	392	398	325
Compost + Serialin	1382	1631	2128	2198	1835
Compost + Phosphorene	680	1108	1599	1791	1295
Compost + Serialin+ Phosphorene	1143	1511	1709	1963	1582
Chicken manure + Serialin	905	1260	1873	2048	1522
Chicken Manure + Phosphrene	266	392	1136	552	587
Chicken Manure + Serialin + Phosphorene	313	1359	1576	1709	1239
Pigeon dung + Serialin	348	406	447	1605	702
Pigeon dung + Phosphrene	263	346	392	794	449
Pigeon dung + Serialin+ Phosphorene	374	379	549	688	498
Mean	591	867	1180	1375	
L.S.D	**NT 0.6173**	**NR 0.3904**	**NT×NR 1.2347**		

Table 7: Iron uptake (µg pot^{-1}) of barley straw as influenced by organic and biofertilization under different levels of mineral-N

Mineral - N rate / Nitrogen Source	30 mg N kg $soil^{-1}$	60 mg N kg $soil^{-1}$	90 mg N kg $soil^{-1}$	120 mg N kg $soil^{-1}$	Mean
Mineral – N	387	815	947	809	740
Compost + Serialin	1488	2587	2766	2037	2220
Compost + Phosphorene	1182	1375	2104	1184	1461
Compost + Serialin+ Phosphorene	1699	2133	2907	2087	2207
Chicken manure + Serialin	2012	3043	3717	2379	2788
Chicken Manure + Phosphrene	1207	1871	3350	1555	1996
Chicken Manure + Serialin + Phosphorene	1049	2699	3517	1650	2229
Pigeon dung + Serialin	1204	2668	3169	1372	2103
Pigeon dung + Phosphrene	615	1060	1164	953	948
Pigeon dung + Serialin+ Phosphorene	878	1431	1537	1198	1261
Mean	1172	1968	2518	1522	
L.S.D	**NT 4.4336**	**NR 2.3323**		**NT×NR 11.553**	

Table 8: Iron uptake (µg pot^{-1}) of barley grains as influenced by organic and biofertilization under different levels of mineral-N

Mineral - N rate / Nitrogen Source	30 mg N kg $soil^{-1}$	60 mg N kg $soil^{-1}$	90 mg N kg $soil^{-1}$	120 mg N kg $soil^{-1}$	Mean
Mineral – N	515	840	978	797	782
Compost + Serialin	1674	1896	2785	1809	2041
Compost + Phosphorene	855	1195	2118	1188	1339
Compost + Serialin+ Phosphorene	680	1713	2186	893	1368
Chicken manure + Serialin	1758	3338	4170	2644	2978
Chicken Manure + Phosphrene	673	1801	1877	1485	1459
Chicken Manure + Serialin + Phosphorene	1113	2470	2613	2179	2094
Pigeon dung + Serialin	871	1740	1799	1308	1430
Pigeon dung + Phosphrene	639	834	1042	632	787
Pigeon dung + Serialin+ Phosphorene	661	993	1580	964	1050
Mean	938	1682	2115	1390	
L.S.D	**NT 6.6775**	**NR 4.2232**	**NT×NR 13.355**		

3.1.2. Manganese uptake

Regarding the effect of mineral nitrogen, data in Tables (9, 10, 11 and 12) show that the individual addition of mineral nitrogen up to the level of 120 mg N Kg $soil^{-1}$ generally increased the Mn uptake; and this was found true at all growth stages under study. In this regard, Shi *et al.,* (2010) revealed that an increase in Mn content of wheat plant was observed under nitrogen application of 0, 130, and 300 kg N ha^{-1}. Stepien *et al.,* (2019) stated that Mn content of winter wheat grain was 20.6 and 38.5 mg kg^{-1} when soil treated with 150 and 200 kg N ha^{-1} respectively.

Presented data also reveal that, at tillering stage the highest value of Mn uptake "1.23µg pot^{-1}" was observed under the addition level of 120 mg N kg^{-1} soil; while the lowest value "0.61µg pot^{-1}" was observed under the addition level of 30 mg N kg $soil^{-1}$. Regarding to booting stage, the highest value of Mn uptake "28.4 µg pot^{-1}" was recorded under the addition level of 90 mg N kg^{-1}soil; while the lowest value" 8.2 µg pot^{-1}" recorded under the addition level of 30 mg N kg^{-1} soil. Concerning at maturity stage, the highest, Mn uptake of straw and grains " 93.1 and 140.0 µg pot^{-1}, respectively " were obtained under the addition of 60 level mg N kg^{-1}soil; while the lowest values " 43.6 and 109.0 µg pot^{-1} " were obtained under the addition level of 30 mg N kg^{-1} soil. Mohamed *et al.* (2006) observed similar outcomes and discovered that the treatment of 134 kg N ha^{-1} produced the highest Mn uptake in wheat plants.

The use of bio fertilizers in conjunction with humic acid produced the maximum concentration of Mn (22.40 mg kg^{-1}) in wheat plants, according to Alakhdar *et al.* (2020).

Concerning the effect of organic and bio fertilizers, data clear that the Mn uptake by plant was significantly increased at all growth stages under study. El-Sayed *et al.* (2005) discovered that the application of compost had a noteworthy favorable impact on the uptake of Mn. El-Sirafy *et al.* (2006) found that bio fertilizer inoculations (*Azotobacter, Azosirillum and Bacillus megaterium*) increased Mn concentration in wheat tissue. Nassr (2007) concluded that concentration of Mn in wheat at harvesting stage was significantly increased due to the application of 10 mg $fed.^{-1}$of straw compost.

Table 9: Mn uptake (µg pot^{-1}) of barley at tillering stage as influenced by organic and biofertilization under different levels of mineral-N

Mineral - N rate Nitrogen Source	30 mg N kg $soil^{-1}$	60 mg N kg $soil^{-1}$	90 mg N kg $soil^{-1}$	120 mg N kg $soil^{-1}$	Mean
Mineral – N	0.61	0.91	1.01	1.23	0.94
Compost + Serialin	7.45	9.51	9.96	10.54	9.37
Compost + Phosphorene	2.98	5.57	6.05	7.36	5.49
Compost + Serialin+ Phosphorene	6.93	7.62	8.71	13.53	9.198
Chicken manure + Serialin	1.94	1.97	2.59	4.96	2.87
Chicken Manure + Phosphrene	1.62	2.19	2.39	4.56	2.69
Chicken Manure + Serialin + Phosphorene	2.24	2.81	3.95	6.45	3.86
Pigeon dung + Serialin	1.09	1.18	1.57	1.69	1.38
Pigeon dung + Phosphrene	1.55	1.82	2.12	3.10	2.15
Pigeon dung + Serialin+ Phosphorene	2.12	2.22	3.07	3.29	2.68
Mean	2.85	3.58	4.14	5.67	
L.S.D	**NT 0. 0.3456**	**NR 0.2186**	**NT ×NR 0. 0.6912**		

Table 10: Mn uptake (µg pot^{-1}) of barley at booting stage as influenced by organic and biofertilization under different levels of mineral-N

Mineral - N rate Nitrogen Source	30 mg N kg $soil^{-1}$	60 mg N kg $soil^{-1}$	90 mg N kg $soil^{-1}$	120 mg N kg $soil^{-1}$	Mean
Mineral – N	8.2	13.3	28.4	25.3	18.8
Compost + Serialin	80.1	96.2	187.6	153.3	129.3
Compost + Phosphorene	80.3	91.5	175.2	120.7	116.9
Compost + Serialin+ Phosphorene	90.1	137.5	196.1	163.7	146.9
Chicken manure + Serialin	15.4	53.4	130.2	58.3	64.3
Chicken Manure + Phosphrene	30.9	31.2	76.6	32.1	42.7
Chicken Manure + Serialin + Phosphorene	23.1	27.9	146.2	110.8	77.0
Pigeon dung + Serialin	10.4	19.2	31.8	21.5	20.7
Pigeon dung + Phosphrene	17.5	19.9	38.6	31.1	26.8
Pigeon dung + Serialin+ Phosphorene	26.3	27.4	128.3	30.8	53.2
Mean	38.2	51.8	113.9	74.8	
L.S.D	**NT 2.5980**	**NR 1.6431**	**NT × NR 5.1961**		

Table 11: Mn uptake (µg pot^{-1}) of barley straw as influenced by organic and biofertilization under different levels of mineral-N

Mineral - N rate / Nitrogen Source	30 mg N kg $soil^{-1}$	60 mg N kg $soil^{-1}$	90 mg N kg $soil^{-1}$	120 mg N kg $soil^{-1}$	Mean
Mineral – N	43.6	93.1	87.1	76.5	75.1
Compost + Serialin	63.5	187.5	155.7	90.4	124.3
Compost + Phosphorene	65.3	173.6	113.2	73.4	106.4
Compost + Serialin+ Phosphorene	67.6	216.4	149.1	77.8	127.7
Chicken manure + Serialin	82.9	195.5	180.6	118.7	144.4
Chicken Manure + Phosphrene	53.5	169.3	139.5	87.6	112.5
Chicken Manure + Serialin + Phosphorene	105.2	222.7	207.8	121.5	164.3
Pigeon dung + Serialin	53.7	141.7	133.2	80.9	102.4
Pigeon dung + Phosphrene	46.1	147.9	108.9	90.4	98.3
Pigeon dung + Serialin+ Phosphorene	78.1	167.7	150.1	80.3	119.1
Mean	66	171.5	142.5	89.8	
L.S.D	**NT 2.0542**	**NR 1.2992**	**NT×NR 4.1084**		

Table 12: Manganese uptake (µg pot^{-1}) of barley grains as influenced by organic and biofertilization under different levels of mineral-N

Mineral - N rate / Nitrogen Source	30 mg N kg $soil^{-1}$	60 mg N kg $soil^{-1}$	90 mg N kg $soil^{-1}$	120 mg N kg $soil^{-1}$	Mean
Mineral – N	109	140	136	117	126
Compost + Serialin	250	337	407	260	314
Compost + Phosphorene	171	453	335	243	301
Compost + Serialin+ Phosphorene	341	1018	510	453	581
Chicken manure + Serialin	308	1516	461	415	675
Chicken Manure + Phosphrene	242	1017	299	296	464
Chicken Manure + Serialin + Phosphorene	340	1864	547	496	812
Pigeon dung + Serialin	133	339	205	199	219
Pigeon dung + Phosphrene	121	246	200	198	191
Pigeon dung + Serialin+ Phosphorene	169	422	401	295	322
Mean	218	735	350	297	
L.S.D	**NT 56.505**		**NR 35.737**		**NT×NR 113.01**

With respect to the maximum value of Mn uptake as affected by N fertilization treatment, the maximum value 13.53 µg pot^{-1} at tillering stage was observed under the treatment of " compost + serialin + phosphorine " at the addition level of 120 mg mineral N kg $soil^{-1}$ compared with 1.23 µg pot^{-1} under the addition of individual mineral-N. Concerning at booting stage, the maximum value of Mn uptake 196.1 µg pot^{-1} was observed under the treatment of " compost + serialin + phosphorine " at the addition level of 90 mg mineral N kg $soil^{-1}$ compared with 28.4 µg pot^{-1} under the addition of individual mineral-N. However, at maturity stage, the maximum Mn uptake of straw and grains "222.7and 1864 µg pot^{-1}, respectively" were obtained under the treatment of " chicken manure + serialin + phosphorine " at the addition level of 60 mg mineral N kg $soil^{-1}$ compared with 93.1 and 140 µg pot^{-1} under the addition of individual mineral-N. In this respect, Ashok Kumar *et al.* (2017) reported that co-inoculation of three rhizobacteria performed as the best treatment of Mn uptake by wheat among the rhizobacterial treatment.

3.1.3. Zinc uptake

With respect to the effect of mineral nitrogen, data presented in Tables (15,16,17 and 18) indicate that the individual addition of mineral nitrogen up to the level of 120 mg N Kg $soil^{-1}$ generally increased the Zn uptake; and this was found true at all growth stages under study. According to Andreini *et al.* (2006), the concentration of zinc in plants ranged from 25 to 150 mg kg^{-1} of dry matter, and the majority

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of proteins in the biological system require zinc. Timsina (2013) found that total Zn uptake by plant was higher when N rate increased from 80 to 120 kg N ha^{-1}, but decreased at 160 kg N ha^{-1}. Shiwakoti *et al.* (2019) revealed that total Zn in wheat grains increased by 7% with application inorganic N at the rate of 90 kg ha^{-1} compared to FYM application. According to Stepien *et al.* (2019), winter wheat grain's Zn concentration varied from 14.9 to 40.4 mg kg^{-1} in response to 150 and 200 kg N ha^{-1} of N fertilizer, respectively.

Observed data also show that, at tillering and booting stages the highest values of Zn uptake " 2.98, 15.1 µg pot^{-1}, respectively " were observed under the addition level of 120 mg N kg^{-1} soil; while the lowest values " 1.06 , 7.6 µg pot^{-1} " observed under the addition level of 30 mg N kg^{-1} soil. Concerning at maturity stage, the highest Zn uptake of straw and grains " 45.1, 190 µg pot^{-1}, respectively " were obtained under the addition level of 90 mg N kg^{-1} soil; while the lowest values " 27.6 , 67 µg pot^{-1} " obtained under the addition level of 30 mg N kg^{-1} soil. According to Bruns and Ebelhar (2006), the increased amounts of these enzymes that contain minerals are probably what caused the greater zinc concentrations in maize leaves resulting from an increase in N supply. Mohamed *et al.* (2006) who stated that when the soil was treated with 134 kg N ha^{-1} gave the highest Zn uptake of wheat plant.

Table 13: Zinc uptake (µg pot^{-1}) of barley at tillering stage as influenced by organic and biofertilization under different levels of mineral-N

Mineral - N rate Nitrogen Source	30 mg N kg soil^{-1}	60 mg N kg soil^{-1}	90 mg N kg soil^{-1}	120 mg N kg soil^{-1}	Mean
Mineral – N	1.06	1.07	1.14	2.98	1.56
Compost + Serialin	5.15	6.21	7.54	24.37	10.82
Compost + Phosphorene	17.29	21.12	38.40	43.10	29.98
Compost + Serialin+ Phosphorene	6.92	7.22	29.13	35.47	19.69
Chicken manure + Serialin	2.47	2.65	3.41	5.23	3.44
Chicken Manure + Phosphrene	2.57	3.18	13.35	13.51	8.15
Chicken Manure + Serialin + Phosphorene	1.98	5.48	8.11	15.34	7.73
Pigeon dung + Serialin	1.36	1.45	3.08	3.21	2.28
Pigeon dung + Phosphrene	1.66	2.62	3.62	3.76	2.92
Pigeon dung + Serialin+ Phosphorene	1.85	2.96	2.98	3.65	2.86
Mean	4.23	5.40	11.08	15.06	
L.S.D	**NT 0.7942**	**NR 0.5023**	**NT×NR 1.5885**		

Table 14: Zinc uptake (µg pot^{-1}) of barley at booting stage as influenced by organic and biofertilization under different levels of mineral-N

Mineral - N rate Nitrogen Source	30 mg N kg soil^{-1}	60 mg N kg soil^{-1}	90 mg N kg soil^{-1}	120 mg N kg soil^{-1}	Mean
Mineral – N	7.6	10.2	12.8	15.1	11.4
Compost + Serialin	46.1	46.8	95.5	126.8	78.8
Compost + Phosphorene	74.9	83.4	146.3	155.3	115.o
Compost + Serialin+ Phosphorene	52.6	69.7	93.8	108.6	81.2
Chicken manure + Serialin	10.4	14.7	18.6	61.3	26.3
Chicken Manure + Phosphrene	20.8	78.1	80.3	137.3	79.1
Chicken Manure + Serialin + Phosphorene	12.6	61.1	98.1	117.5	72.3
Pigeon dung + Serialin	9.4	14.2	18.1	43.9	21.3
Pigeon dung + Phosphrene	13.1	25.2	30.3	48.8	29.4
Pigeon dung + Serialin+ Phosphorene	13.4	13.8	28.6	49.2	26.3
Mean	26.1	41.7	62.2	86.38	
L.S.D	**NT 0.4706**	**NR 0.2976**	**NT×NR 0.9412**		

Table 15: Zinc uptake (µg pot^{-1}) of barley straw as influenced by organic and biofertilization under different levels of mineral-N

Mineral - N rate / Nitrogen Source	30 mg N kg $soil^{-1}$	60 mg N kg $soil^{-1}$	90 mg N kg $soil^{-1}$	120 mg N kg $soil^{-1}$	Mean
Mineral – N	27.6	44.2	45.1	36.9	38.5
Compost + Serialin	42.3	65.8	69.4	58.6	59.00
Compost + Phosphorene	55.1	130.4	191.2	81.7	114.6
Compost + Serialin+ Phosphorene	46.6	82.8	245.8	52.3	106.9
Chicken manure + Serialin	42.5	73.5	76.3	54.4	61.7
Chicken Manure + Phosphrene	66.1	278.1	336.5	217.3	224.5
Chicken Manure + Serialin + Phosphorene	40.9	110.7	311.7	61.6	131.2
Pigeon dung + Serialin	32.0	48.3	69.6	42.1	48.0
Pigeon dung + Phosphrene	40.7	95.4	168.3	72.9	94.3
Pigeon dung + Serialin+ Phosphorene	41.9	52.3	75.4	49.5	54.8
Mean	43.6	98.1	158.9	72.7	
L.S.D	**NT 0.5854**	**NR 0.3702**	**NT×NR 1.1708**		

Table 16: Zinc uptake (µg pot^{-1}) of barley grains as influenced by organic and biofertilization under different levels of mineral-N

Mineral - N rate / Nitrogen Source	30 mg N kg $soil^{-1}$	60 mg N kg $soil^{-1}$	90 mg N kg $soil^{-1}$	120 mg N kg $soil^{-1}$	Mean
Mineral – N	67	121	190	78	114
Compost + Serialin	137	222	256	199	204
Compost + Phosphorene	238	581	726	337	471
Compost + Serialin+ Phosphorene	140	280	584	233	309
Chicken manure + Serialin	153	429	916	231	432
Chicken Manure + Phosphrene	331	852	1165	521	717
Chicken Manure + Serialin + Phosphorene	215	432	885	390	481
Pigeon dung + Serialin	81	133	207	92	128
Pigeon dung + Phosphrene	284	448	631	286	412
Pigeon dung + Serialin+ Phosphorene	97	139	210	121	142
Mean	174	364	577	249	
L.S.D	**NT 0.6825**	**NR 0.4316**	**NT × NR 1.3650**		

Concerning the effect of organic and bio fertilizers, data indicate that the Zn uptake by plant was significantly increased at all growth stages under study. In this concern, Madlain *et al.* (2002) who noted that inoculation of barley seeds with cerealin combined with 7.5 m^3 FYM fed^{-1} increased uptake of Zn by barley straw and grains. El-Sirafy *et al.* (2006) found that bio fertilizer inoculations increased Zinc concentration in wheat tissue. Nassr (2007) concluded that concentration of Zn in wheat at harvesting stage was significantly increased due to the application of 10 ton $fed.^{-1}$ of straw compost. According to Kumawat *et al.* (2017), bacteria like Bacillus spp. have the capacity to dissolve micronutrients like zinc, making them useful as biofertilizers.

With respect to the maximum value of Zn uptake as affected by N fertilization treatment, the highest values " 43.10 and 155.3 µg pot^{-1}" at tillering and booting stages, respectively were observed under the treatment of " compost + phosphorine " at the addition level of 120 mg mineral N kg $soil^{-1}$ compared with 2.98 and 15.1 µg pot^{-1} under the addition of individual mineral-N. Concerning at harvest stage, the maximum Zn uptake of straw and grains " 336.5 , 1165 µg pot^{-1} " were observed under the treatment of " chicken manure + phosphorine " at the addition level of 90 mg kg $soil^{-1}$ compared with 45.1 and 190 µg pot^{-1} under the addition of individual mineral-N. Similar results were published by. According to Cathy *et al.* (2019), the crop treated with straw as an amendment had higher concentrations of micronutrients, especially zinc. Ashok Kumar *et al.* (2017) reported that among the rhizobacterial

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treatment, co-inoculation of rhizobacteria performed as the best of Zn uptake by wheat. Azad *et al.* (2022) noted that application of organic amendments " poultry manure and cow dung " to wheat plant resulted in highest Zn concentration (13.23 ppm), while the lowest Zn concentration (10.78 ppm) was observed for untreated plants.

3.2. Biological yield

Concerning the effect of mineral nitrogen addition, data presented in Table (19) reveal that the individual addition of mineral nitrogen up to the level of 120 mg N Kg soil^{-1}generally increased the biological yield under all nitrogen treatments. Mehasen (1999) observed in this regard that the benefits of N on all yield component features, namely weight 0f 1000 grain, account for the majority of the improvements in biological yields, or "grain and straw yields". In their 2014 study, Khalid *et al.,* investigated the effects of five different nitrogen (N) levels on wheat yield: zero, 50, 100, 150, and 200 kg N ha^{-1}. They discovered that, up to 100 kg N ha^{-1}, biological yields ha^{-1} responded favorably to N levels.

Table 19: Biological yield (g pot^{-1}) of barley as influenced by organic and biofertilization under different levels of mineral-N

Mineral - N rate / Nitrogen Source	30 mg N kg soil^{-1}	60 mg N kg soil^{-1}	90 mg N kg soil^{-1}	120 mg N kg soil^{-1}	Mean
Mineral – N	7.53	12.66	11.41	10.49	10.52
Compost + Serialin	10.24	18.82	15.96	14.97	14.99
Compost + Phosphorene	12.36	15.85	14.24	13.23	13.92
Compost + Serialin+ Phosphorene	12.63	16.71	15.52	14.17	14.69
Chicken manure + Serialin	13.16	20.62	18.19	16.18	17.04
Chicken Manure + Phosphrene	11.18	17.62	14.49	13.07	14.09
Chicken Manure + Serialin + Phosphorene	11.23	19.17	16.32	15.23	15.49
Pigeon dung + Serialin	11.83	16.24	15.16	13.96	14.30
Pigeon dung + Phosphrene	9.06	13.54	12.33	11.22	11.54
Pigeon dung + Serialin+ Phosphorene	9.97	13.06	12.01	11.61	11.66
Mean	10.92	16.43	14.54	13.41	
L.S.D	**NT 0.4601**	**NR 0.2910**	**NT×NR 0.9203**		

The biological yield of wheat rose significantly with nitrogen application at 120 kg N ha^{-1} over 90, 60, and 30 kg N ha^{-1}, as observed by Ahmad-Latiefa and Kaleem (2015). According to Fadel *et al.,* (2016), biological yield fed-1 was greatly boosted by increasing the nitrogen fertilizer level to 120 kg fed^{-1}. The study examined the effects of N levels (60, 90, and 120 kg N fed^{-1}) on wheat.

Presented data also show that, the maximum biological yield" 12.66 g pot^{-1}" was obtained under the addition level of 60 mg N kg soil^{-1}; while the lowest value " 7.53 gpot^{-1} " obtained under the addition level of 30 mg N kg soil^{-1}. These results are in harmony with that observed by Shekoofa and Emam (2008) who stated that maximum biological yield (25.471 ton ha^{-1}) of wheat was obtained with 200 kg N ha^{-1} as compared with the control. According to Shafi *et al.,* (2011), the wheat plant produced its optimum biological yield when nitrogen was treated at a rate of 60 kg ha^{-1}. According to Iqbal *et al.,* (2012), the highest biological yield of wheat, 9695 kg ha^{-1}, was found at nitrogen levels of 125, 100, and 150 kg N ha^{-1}, respectively, while the lowest biological yield, 8243 kg ha^{-1}, was recorded at zero nitrogen. According to Abdel Khalek *et al.,* (2015), there was a substantial difference in the biological yield of wheat when 75 and 90 kg N fed^{-1} were applied. The highest value was obtained when 90 kg N fed^{-1} was added.

Regarding the effect of organic and bio fertilizers treatments, data show that the biological yield was significantly increased. This increasing may be attributed to organic fertilizers supply plants with macro and micronutrients, improve soil fertility, chemical properties, soil pH, microbial activity, root distribution, and in tern of biological yield. Additionally, the use of biofertilizers promotes the synthesis of plant growth hormones like auxins and gibberellins, which may enhance root development, nitrogen fixation, soil chemistry and biology, and ultimately boost biological yield. In this regard, Negm *et al.*

(2002) noticed that the production of wheat grains, straw and whole plants increased by addition of compost. The mean values of grains, straw and whole plants increased by 55.8, 20.9 and 31.8%, respectively by addition of 2.4 Mg compost ha^{-1}. According to Davari *et al.* (2012), adding FYM considerably increased total biomass, which in turn greatly increased wheat grain and straw yield above the control. El Hamdi *et al.* (2012) investigated the effects of adding compost at 0, 5, and 10 tons of $fed.^{-1}$ on wheat yield and observed that 10 tons of compost increased the wheat yield.

With respect to the highest value of biological yield as affected by N fertilization treatments; The highest value "20.62 g pot^{-1}" was observed under the treatment of " chicken manure + serialin" at the addition level of 60 mg mineral N kg $soil^{-1}$ compared with "12.66 mg pot^{-1}" under the addition of individual mineral-N. Similar results were reported by Abo Habaga (2011) reported that the effects of adding organic matter (rice straw) on crop productivity. The crop yields of wheat increased by about 20 % over control treatments. Abdou *et al.* (2018) found that the combination inoculation of phosphorein and cerealine at a rate of 500 grams fed produced the highest mean value of biological yield (7.02 mg fed^{-1}), followed by inoculation with either phosphorein or cerealine alone. According to Jamal and Fawad (2018), the use of organic manures greatly increased the wheat crop's biological output. When 10 mg ha^{-1} of poultry were treated, the greatest biological yield of 13.66 t ha^{-1} was recorded. According to Lamlom *et al.* (2023), the application of azotobacter and mycorrhizae together produced the best biological yield value (13.4 mg ha^{-1}).

4. Summary

The research used a pot experiment to study the possibility of partial or entire replacement of mineral nitrogen fertilizers with organic and bio fertilizers, with the aim of improving the efficiency of nitrogen fertilization for barley plant (*Hordeum vulgare* Giza 123) grown in sandy calcareous soil obtained from Agriculture Research Station in Nubariya.

Mineral nitrogen fertilizer was added at the rates 30, 60, 90 and 120 mg N kg $soil^{-1}$. Organic fertilizers were added from different sources "compost, chicken manure and pigeon dung" at a rate of 30 mg kg N $soil^{-1}$ based on its nitrogen content.

Biofertilization was achieved through the addition of 5g pot^{-1} serialin or /and 5g pot^{-1} phosphorene; mixed thoroughly with soil.

The most important obtained results

Uptake of micronutrients

(1) The highest values "233.8 and 2198 µg pot^{-1}, respectively" of Fe uptake at tillering and booting stages, were recorded under the treatment of "compost + serialin " at the addition level of 120 mg mineral N kg $soil^{-1}$. However, the lowest values "23.32 and 263µg pot^{-1}" were recorded under the treatment of "pigeon dung + phosphorene "at the addition level of 30 mg mineral N kg $soil^{-1}$.

(2) The highest values" 3717 and 4170 µg pot^{-1}" of Fe uptake by straw and grains, respectively at maturity stage were observed under the treatment of "chicken manure + serialin " at the addition level of 90 mg mineral N kg $soil^{-1}$, while the lowest values "615 and 639 µg pot^{-1} "were obtained under the treatment of "pigeon dung + phosphorene " at the addition level of 30 mg mineral N kg $soil^{-1}$.

(3) The highest value "13.53 µg pot^{-1} "of Mn uptake at tillering stage was obtained under the treatment of "compost + serialin + phosphorene" at the addition level of 120 mg mineral N kg $soil^{-1}$. On the other side, the lowest value "1.09µg pot^{-1}" was obtained under the treatment of "pigeon dung + serialin "at the addition level of 30 mg mineral N kg $soil^{-1}$.

(4) The highest value"196.1 µg pot^{-1}"of Mn uptake at booting stage was observed under the treatment of "compost + serialin + phosphorene" at the addition level of 90 mg mineral N kg $soil^{-1}$. However, the lowest value "10.4µg pot^{-1}" was observed under the treatment of "pigeon dung + serialin "at the addition level of 30 mg mineral N kg $soil^{-1}$.

(5) The highest values " 222.7and 1864 µg pot^{-1}" of Mn uptake by straw and grains , respectively at maturity stage were recorded under the treatment of " chicken manure + serialin + phosphorine " at the addition level of 60 mg mineral N kg $soil^{-1}$, while the lowest values " 46.1 and 121 µg pot^{-1} "were obtained under the treatment of "pigeon dung + phosphorene " at the addition level of 30 mg mineral N kg $soil^{-1}$.

(6) The highest values "43.10 and 155.3 µg pot^{-1}" of Zn uptake at tillering and booting stages, respectively were observed under the treatment of "compost + phosphorene "at the addition level of 120 mg mineral N kg soil^{-1}. However, the lowest values "1.36 and 9.4µg pot^{-1}" were recorded under the treatment of "pigeon dung + serialin "at the addition level of 30 mg mineral N kg soil^{-1}.

(7) The highest values" 336.5, 1165 µg pot^{-1} "of Zn uptake by straw and grains, respectively at maturity stage were obtained under the treatment of "chicken manure + phosphorene " at the addition level of 90 mg mineral N kg soil^{-1}. While, the lowest values " 32 and 81 µg pot^{-1}"were obtained under the treatment of "pigeon dung + serialin "at the addition level of 30 mg mineral N kg soil^{-1}.

Biological yield

(1) The highest value "20.62 g pot^{-1}" of biological yield was recorded under the treatment of "chicken manure + serialin" at the addition level of 60 mg mineral N kg soil^{-1}. However, the lowest value "9.06g pot^{-1}" was recorded under the treatment of "pigeon dung + phosphoren" at the addition level of 30 mg mineral N kg soil^{-1}.

5. Conclusion

Upon the obtained results, we can propose that under the conditions similar to the current study "soil type, N-fertilization, and crop": the recommended treatments are ["chicken manure + serialin " with the addition level of 60 mg mineral N kg soil^{-1}] which demonstrate the possibility of partially replacing mineral fertilizers with organic and bio fertilizers, aiming to improve the efficiency of nitrogen fertilization for barley plant grown in sandy calcareous soil.

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