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Effect of Foliar Application with Nano-Micronutrients and Organic Fertilization on Snap Bean under Sandy Soil Condition

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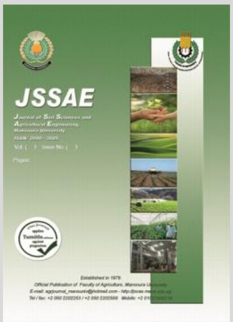

ABSTRACT

Nanotechnology presents brilliant agricultural products, which may be an achievement in addressing many common economic and ecological issues. Nano-fertilizers show special characters which do not exist in their conventional counterparts. So; this work conducted out during 2019 and 2020 seasons to investigate the effects of three forms of micronutrient Fe + Zn in foliar way (nano, EDTA and sulfate) under organic fertilization (without, chicken manure and FYM) on vegetative growth, physical, chemical and quality of pods and green yield of snap bean as well as some chemical properties of soil after harvesting. All treatments under investigation had significant effect on vegetative growth (plant height, number of branches, fresh, dry weight and chlorophyll content), pod physical quality (number, length, weight and diameter), green pod yield,nutritional value of snap bean leaves and pods (N, P, K%, Fe and Zn mg.kg^{-1}), pod chemical quality as (protein, total carbohydrates, fiber and TSS%) and soil analysis after harvest (available N, P, K FC and S.P). The results in this study showed that, applying chicken manure and foliar application with nano Fe + Zn was the most suitable treatment significantly affected in all mentioned parameters comparing with the other treatments.

Keywords: organic fertilization, micronutrients, nanotechnology and snap bean

INTRODUCTION

Economically, snap bean (*Phaseolus vulgaris* L.) which, belongs to the Fabaceae family considered as one of the major vegetable crops in Egypt for local consumption and exportation. it is substantial legume vegetable crop cultured in the dried area for its production of edible green pods and dry seeds with a high market demand, consumed as cooked vegetables rich with mineral elements (P, Ca, Mn, Mg, K, and Fe), fibers, carbohydrates and proteins (Marzouk*et al*., 2019).

Growing snap bean plants in newly reclaimed sandy soils faces numerous problems for example, unreliable rainfall, low soil organic matter content, and nutrient deficiency. To beat this, many farmers utilize organic fertilizers or large amounts of mineral feryilization(Stewart *et al*. 2005).

Problems of sandy soil can be countered by using organic fertilization as farmyard and chicken manures which enhance soil fertility through improving soil physical properties such as water holding capacity and structure and creates a suitable environment for the activity of soil microorganisms (Mwahija, 2015). Organic manures are rich in nutrients and supply all essential macronutrients (N, P, K, Mg, Ca and S) and micronutrients important for plant development. A small part of nitrogen is available and ready for uptake by plant and large part is released during and after decomposition.

Leaf feeding by foliar application with micronutrients is one of the viable methods in resolve plant's nutrition requirements for micronutrients (Wang *et al*., 2010). Recently, the continuous progress of fertilization technology introduces the nano-fertilizers. Delivering plant nutrients through nanotechnology methods are becoming an effective management in plant nutrition (Solanki *et al*., 2015 and Ghorbanpour*et al*., 2017).The nano-fertilizers involves manufacturing fertilizer materials formulating them into extremely small minute particles (1–100 nm). These nutrients show some characteristics that differ from the presence of the nutrients in the macro scale, Such technology is adopted in many fields besides fertilizer application. In which using fertilizer in the nano form has advantages including releases the nutrients at a slower rate for a longer period, consequently limiting nutrient loss from the soil and reducing soil-groundwater pollution (Naderi and Danesh-Shahraki, 2013)

Iron (Fe) and zinc (Zn) are the most important micronutrients and approximately 2 billion people suffer from Fe and Zn deficiency worldwide, which has often been claimed to be the predominant cause of anemia(Welch and Graham, 1999).Deficiency of micronutrient as iron and zinc is increasing in most of the crops because of using the modern high yielding cultivars, loss of topsoil organic matter content by erosion, burning crop residues and use of inadequate rates of micronutrients in most cropping systems.

Iron, is highly significant for growth and development of immune system (Shenkin, 2006). Globally, Fe-deficiency is the most prevalent micronutrient disorder. Iron is highly important nutrient element for plant growth and development due to its part as a cofactor in many proteins (Balk and Pilon, 2011).Access to this element extremely affects the growth and efficiency of plant (Fernández*et al*. 2016). It is generally needed in chloroplast development and mitochondria of plant cells and involved

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in chlorophyll and thylakoid synthesis. It contributes as a cofactor in few proteins of electron transport chain. Addition of nano-iron recorded better effect on faba bean seed yield than the other iron forms. Likewise, the highest iron concentration (i.e. 6g/L) had the highest grain yield and grain iron content, whereas the highest (467.7 g/m^2) and lowest (352.7 g/m^2) seed yield of faba bean connected to Nano-Iron 6 g/L and control, respectively. Expanding concentration of nano-iron had a positive and significant impact on chlorophyll content, protein percent and seed yield,so, it was concluded that the highest seed yield was obtained with spraying nano-iron(6 g/L) during the flowering period (Nadi*et al*., 2013).

Zinc, is regarded as a significant micronutrient, the deficiency of zinc which in many plants is a common issue (Ojeda-Barrios et al. 2014). It is necessary for the activity of such enzymes as aldolase, dehydrogenase, transphosphorylase, isomerase, DNA and RNA polymerase. It additionally plays a role in cell division, cell structure preservation, tryptophan synthesis, and photosynthesis. It gives rise to the synthesis of proteins, in view of its role as a cofactor in many proteins (Marschner, 2012). Nanomaterial could be utilized in plotting more soluble and diffusible sources of Zn fertilizer for increased plant productivity. The more small, higher specific surface area and reactivity of nanoparticles of Zn may significant in Zn solubility, diffusion and its availability to plants (Gomaaet al. 2020). Ideal impacts of nano-Zn application incorporate creation of active Zn phosphate inside the plant; and conversion to Zn-phosphates and ZnO which exist on plant cell tips (Lvet al. 2015). Sprays different forms of Zn as No-Zn, Zn-sulphate, Zn-chelate (Zn-DTPA) and nano-ZnO with Zn-solutions contained 50 mg Zn L-1 and found that foliar application with nano-ZnO increased all of plant height, No. of leaves, leaf area /plant and pod yield of snap bean over other treatments (Morsyet al. 2017).Marzouket al. (2019) concluded that foliar application with micronutrients as Zn and Fe on snap bean plants recorded the highest values of vegetative growth (plant length, fresh weight, number of leaves and branches), fresh pod yield, pod physical quality (length, diameter, and fresh weight), dry weight, and pod nutritional value content expressed as P, K, Zn, Mn, Fe,Cu, crude protein, total soluble solids, and fibers.

The available information regarding the impact of micronutrients on pulse crops is scanty. Based on this background, the present study was undertaken to study the influence of foliar application with iron and zinc in nano forms and comparing with sulphate, chelate on growth, green yield productivity, physical quality, and pod nutritional value of snap bean growing in sandy soil under addition of organic manure in form of FYM and chicken manure.

MATERIALS AND METHODS

These experiments were undertaken using seeds of snap bean(cv. Paulista) during winter seasons of 2019 and 2020 at El-Kasasin Horticultural Research Station, Ismailia Governorate, Egypt, to test the impact of foliar application with Fe and Zn in forms of nano, sulfate and chelate under organic manures as FYM and chicken manure on vegetative growth, physical, chemical and quality of pod and green yield of snap bean as well as some chemical properties of sandy soil after harvesting.

These experiments includes 9 treatments designed in split plot design with three replicates. The treatments comprised of 3 treatments of organic manure (without application, FYM and Chicken manure) as main plot and 3 forms from foliar application of Fe + Zn (nano, chelate (EDTA) and sulfate) as sub plot design. The soil physical and chemical analyses of the experimental site are presented in Table (1). Physical parameters were determined according to the methods of Haluschak (2006), while chemical was according to Reeuwijk (2002).

Table 1. Average values of physical and chemical analyses of soil field experiments for two seasons

Physical parameters			Chemical parameters	
Particle size distribution (%)	Sand	86.89	E.C dS.m^{-1} (1:5)	0.98
	Silt	8.64	pH (1:2.5)	8.12
	Clay	4.47	O.M. %	0.66
Soil texture	Sand		CEC (cmol(+) kg^{-1}))soil)	8.45
S.P %	20.15		Available N mg.kg^{-1}	38.21
Bulk density (t m^{-3})	1.63		Available P mg.kg^{-1}	4.43
			Available K mg.kg^{-1}	165.59

FYM and chicken manures were added to the soil before sowing at rate of 20 m^{3}fed^{-1} for each one, then the soils was irrigated up to saturation percentages. Chemical analysis of the organic manures used are presented in Table (2).

Table 2. Average values of chemical analysis of the organic manures used for two seasons.

Organic manure properties	FYM	Chicken manure
pH (1:10)	6.82	5.83
EC (1:10)(dSm^{-1})	4.09	3.38
Organic matter (%)	31.42	34.36
Organic carbon (%)	18.26	19.98
Total nitrogen (%)	1.23	1.51
C/N ratio	14.96	13.23
Total Phosphorus (%)	0.49	0.53
Total Potassium (%)	0.72	0.93

Fertilization with calcium super phosphate (15% P2O5) at rate of 100 kg.fed^{-1} was applied during soil preparation. Nitrogen as ammonium sulphate (20.6%N) at rate 150 kg.fed^{-1} and potassium sulphate(48% K2O) at the rate of 50 kg.fed^{-1}were added during the growth seasons.

Foliar spray with Fe and Zn at rate of 60 mg.L^{-1}for each form of EDTA, sulfate and nano. Plants received 3 sprays: the first was sprayed 20 days after planting with 15 days' interval for the second and third spray.

Before planting, all seeds used of snap bean were soaked in *Rhizobium* bacteria. Seeds of snap been (cv. Paulista) were sown in the second week of September in each season. The plot area of experiment was 10.5 m^2. Every plot consisted of 5 dripper lines 3 m in length and 0.7 m in width. Seeds were sown in hills 20 cm apart on one side of dripper lines and two seeds per hill. Thinning was done after complete seed germination (15 days after seeding) and one plant per hill were left. The normal agriculture practices of snap bean were done under drip irrigation system. So, before planting, drip lines were placed on the soil surface at the center of the soil beds.

Vegetative growth measurements: A representative sample of five plants was taken after 55 days from planting, from each plot for measuring the plant growth characters, as follows: plant height (cm), number of branches/plant, fresh (g) and dry weight (g), which, oven dried at 70 °C till constant weight reached and the dried parts were thoroughly ground and stored for chemical analysis of N, P, K % where determined according to the methods mentioned by Mertens, (2005). Fe and Zn (mg kg^{-1})were determined according to the methods mentioned by Khazaei*et al*., (2017).

Chlorophyll SPAD readings: Leaf greenness of the sixth mature leaf was measured as SPAD units using SPAD-501.

Green pod yield and its attributes: after 70 days from planting (harvest stage), green pods were collected and the following data were recorded: number of pods/plant, pod (length, weigh and diameter (cm)) and total green pod yields per plot.

Green pod quality: 30 green pods were taken to determine the following data: TSS%, fibers, total carbohydrates% and protein (%) according (A.O.A.C 2000), where protein content (%) was calculated by multiplying N percentage x 6.25.

All data were subjected to statistical analysis using CoSTATE Computer Software. The comparison among means of the different treatments was determined by methods illustrated by Gomez and Gomez, (1984). In all tables, the means were compared with the least significant difference (L.S.D) and Duncan's multiple range test.

RESULTS AND DISCUSSION

Vegetative growth:

Improvement in growth characters is considered to be pre-requisite to increase yield of any crop. Data in Table (3) indicated the effect of types of organic manures and foliar application with Fe + Zn in different forms on growth parameters as plant height, number of branches, fresh and dry weight as well as SPAD reading of chlorophyll content during seasons of 2019 and 2020.

It is quite clear from the results presented in Table (3) that the effect difference between the two types of organic manures (FYM and Chicken manure comparing with without fertilization) on plant growth parameters and chlorophyll content indicated a significant effect during both seasons, except number of branches in the second one. Moreover, the application of chicken manure recorded the highest values for all traits over FYM and control. With application of chicken manure, it can supply adequate nutrient content more than FYM in soil required by plants. Additionally, increasing water holding capacity without damage of soil and providing macro and micro nutrients. In addition, manures enhance soil microbiology activities, cation exchange capacity and improve soil structure (Syekhfani, 2000).The state of planting media that strongly supports the growth of green bean plants is seen in vegetative growth by showing the number of branches and diameter of the stem that grows well/large and this makes the system of nutrient transgress and photosynthesis results in green beans plant is good. The positive effect of organic manure on vegetative growth parameters comes along with results reported by Feleafel and Mirdad (2014), Morsy*et al*. (2017), and Sitinjak and Purba (2018).

Table 3. Plant growth parameters and chlorophyll content as affected by organic manures and micro-nutrient in spray way during 2019 and 2020 seasons.

Treatments		Plant height, cm		Number of branches/plant		Fresh weight, g/plant		Dry weight, g/plant		Chlorophyll SDAP readings	
		2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
A: Organic fertilization (main effect)											
Without		40.94^{c}	41.94^{c}	3.67^{c}	4.33^{b}	102.72^{c}	106.60^{c}	15.90^{c}	18.18^{c}	32.17^{c}	32.34^{c}
Chicken manure		48.55^{a}	49.44^{a}	5.56^{a}	6.67^{a}	115.43^{a}	119.55^{a}	18.41^{a}	21.25^{a}	35.32^{a}	35.70^{a}
FYM		45.96^{b}	46.95^{b}	4.89^{b}	6.00^{a}	111.54^{b}	116.08^{b}	17.64^{b}	20.43^{b}	34.31^{b}	34.98^{b}
LSD at 5%		0.92	0.94	0.25	0.76	0.09	0.45	0.35	0.41	0.01	0.13
B: Foliar application (sub effect)											
Fe + Zn (Nano)		47.06^{a}	48.17^{a}	5.22^{a}	6.22^{a}	113.10^{a}	117.36^{a}	17.93^{a}	20.71^{a}	34.74^{a}	35.03^{a}
Fe + Zn (EDTA)		45.56^{b}	46.45^{b}	4.78^{ab}	5.89^{a}	110.63^{b}	114.74^{b}	17.46^{b}	20.17^{b}	34.14^{b}	34.61^{b}
Fe + Zn (Sulfate)		42.82^{c}	43.71^{c}	4.11^{b}	4.89^{b}	105.95^{c}	110.13^{c}	16.55^{c}	18.97^{c}	32.92^{c}	33.38^{c}
LSD at 5%		0.64	0.64	0.81	0.76	0.54	0.52	0.24	0.27	0.16	0.15
Combinations effects											
organic	Foliar										
Without	Fe + Zn (Nano)	42.33^{f}	43.18^{f}	4.00^{cde}	4.67^{cd}	105.22^{g}	108.55^{f}	16.40^{f}	18.87^{e}	32.71^{g}	32.89^{f}
	Fe + Zn (EDTA)	40.97^{g}	42.20^{f}	3.67^{de}	4.33^{d}	102.80^{h}	107.29^{g}	15.91^{g}	18.16^{f}	32.15^{h}	32.34^{g}
	Fe + Zn (Sulfate)	39.52^{h}	40.43^{g}	3.33^{e}	4.00^{d}	100.14^{i}	103.97^{h}	15.38^{h}	17.50^{g}	31.66^{i}	31.80^{h}
Chicken manure	Fe + Zn (Nano)	51.04^{a}	52.32^{a}	6.33^{a}	7.33^{a}	119.37^{a}	123.84^{a}	19.20^{a}	22.10^{a}	36.36^{a}	36.57^{a}
	Fe + Zn (EDTA)	49.41^{b}	49.95^{b}	5.67^{ab}	7.00^{a}	116.85^{b}	120.37^{b}	18.69^{b}	21.70^{a}	35.75^{b}	36.22^{b}
	Fe + Zn (Sulfate)	45.20^{d}	46.06^{d}	4.67^{b-e}	5.67^{bc}	110.07^{e}	114.45^{d}	17.36^{d}	19.93^{d}	33.86^{e}	34.30^{e}
FYM	Fe + Zn (Nano)	47.82^{c}	49.02^{b}	5.33^{abc}	6.67^{ab}	114.72^{c}	119.68^{b}	18.21^{c}	21.15^{b}	35.14^{c}	35.63^{c}
	Fe + Zn (EDTA)	46.30^{d}	47.19^{c}	5.00^{a-d}	6.33^{ab}	112.26^{d}	116.56^{c}	17.80^{c}	20.66^{c}	34.53^{d}	35.26^{d}
	Fe + Zn (Sulfate)	43.76^{e}	44.64^{e}	4.33^{b-e}	5.00^{cd}	107.64^{f}	111.99^{e}	16.91^{e}	19.47^{d}	33.25^{f}	34.03^{e}
LSD at 5%		1.10	1.11	n.s	n.s	0.94	0.90	0.42	0.47	0.28	0.27

The results obtained in Table (3) showed that plant height, fresh and dry weights as well as SPAD reading of chlorophyll content were significantly affected by foliar application with different forms of Fe + Zn except number of branches in 2019 and 2020.Data also cleared that, spraying plants with Fe + Zn (nano) at rate of 60 mg.L^{-1} gave higher growth parameters and chlorophyll content than forms of EDTA or sulfate. Usually, deficiency of micronutrient problems are found especially in poor soils. Thus, micronutrient sprayed on leaves are greater, as foliar application nutrients supplied for plants faster compared with fertilizer addition to soil. Vegetative growth increment could be attributed to the stimulatory effects of nano micronutrients specially Fe on the production of chlorophyll, mitochondrial respiration, photosynthesis, and the role of both Fe and Zn in endogenous hormone biosynthesis, e.g. gibberellic acid, ethylene, and jasmonic acid (Hänsch and Mendel 2009) which answerable for promoting of plant growth. Many investigators have obtained similar results such as Morsy*et al*. (2017);Marzouk*et al*. (2019)on snap bean and Gomaa*et al.* (2020) on maize.

The same Table, also demonstrates the combination among treatments under investigation on plant growth parameters and chlorophyll content. Differences among treatments significantly affected all traits, where the highest values were obtained from foliar application by nano Fe + Zn under applying chicken manure during both seasons. These results come in accordance with Morsy*et al*. (2017) who found that plant height, No. of leaves and leaf area plant^{-1}of snap bean increased due to Zn-nano spray under compost fertilization. Also, Gomaa*et al*. (2020) showed that vegetative growth parameters of maize were, significantly, affected by organic manure and nano- micronutrients fertilization.

Pod physical quality and green pod yield:

Pod physical quality expressed in pods (number, length, weight and diameter) and green pod yield as affected by types of organic manures (without, chicken manure and FYM) and different forms of Fe + Zn (nano, EDTA and sulfate) sprayed on plants were indicated in Table (4) during 2019 and 2020 seasons.

It's clear from Table (4), that pod physical quality and green pod yield were significantly affected by applying of different types of organic manure during both seasons. The highest values of pods (number, length, weight and diameter) and green pod yield were recorded with utilize the chicken manure comparing with FYM and untreated plants. Chicken manure had low C:N ratio which made it readily available to the plant through abundant supply of nutrients to the soil with comparatively lesser retention in roots and more easier translocation to the aerial parts for protoplasmic proteins and synthesis of other compounds.The superiority in the number of pods per plant and yield.pot^{-1} resulted from chicken manure application (Table 4) owes directly to the increase in the vegetative growth traits (Table 3) and nutrient availability for plant to go forward and accelerate the photosynthetic rate, consequently, increased pods yield. The yield of snap bean plants was highly positively correlated with the plant height, number of branches fresh and dry weight, number of green pods, pod weight and nutrient uptake. These results are consistent with those of Feleafel and Mirdad (2014); Kamble*et al.* (2016); Sitinjak and Purba (2018) and Mahmoud and Gad (2020).

Table 4. Pods physical quality and green pod yield as affected by organic manures and micro-nutrient in spray way during 2019 and 2020 seasons.

Treatments		Number of pods /plant		Pod length, cm		Pod weight, g/plant		Pod diameter, cm		Total yield, kg/plot	
		2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
A: Organic fertilization (main effect)											
Without		29.61^{c}	30.31c	9.84^{c}	11.25^{c}	5.54^{c}	5.67^{c}	0.40^{c}	0.43^{c}	12.31^{c}	12.11^{c}
Chicken manure		34.29^{b}	35.96^{b}	12.05^{b}	13.86^{b}	6.36^{b}	6.50^{b}	0.61^{b}	0.65^{b}	16.39^{b}	17.56^{b}
FYM		32.75^{a}	34.15^{a}	11.33	13.11^{a}	6.10^{a}	6.23^{a}	0.55^{a}	0.59^{a}	15.00^{a}	15.99^{a}
LSD $_{at\ 5\%}$		0.50	0.11	0.04	0.15	0.01	0.01	0.02	0.01	0.22	0.08
B: Foliar application (sub effect)											
Fe + Zn (Nano)		33.36^{a}	34.93^{a}	11.65^{a}	13.43^{a}	6.20	6.34^{a}	0.58^{a}	0.62^{a}	15.59^{a}	15.91^{a}
Fe + Zn (EDTA)		32.44^{b}	33.85^{b}	11.19^{b}	12.93^{b}	6.04^{b}	6.17^{b}	0.54^{b}	0.57^{b}	14.77^{b}	15.75^{b}
Fe + Zn (Sulfate)		30.85^{c}	31.65^{c}	10.38^{c}	11.85^{c}	5.76^{c}	5.89^{c}	0.45^{c}	0.48^{c}	13.34^{c}	14.00^{c}
LSD $_{at\ 5\%}$		0.35	0.12	0.05	0.21	0.10	0.10	0.01	0.01	0.22	0.27
Combinations effects											
organic	Foliar										
Without	Fe + Zn (Nano)	30.27^{g}	31.25^{g}	10.27^{g}	11.81^{f}	5.67^{ef}	5.78^{e}	0.45^{g}	0.49^{g}	12.87^{g}	11.21^{g}
	Fe + Zn (EDTA)	29.44^{h}	30.43^{h}	9.84^{h}	11.21^{g}	5.54^{fg}	5.67^{ef}	0.41^{h}	0.43^{h}	12.23^{h}	12.94^{h}
	Fe + Zn (Sulfate)	29.14^{h}	29.26^{i}	9.41^{i}	10.73^{h}	5.42^{g}	5.55^{f}	0.34^{i}	0.37^{i}	11.83^{i}	12.17^{i}
Chicken manure	Fe + Zn (Nano)	35.83^{a}	37.73^{a}	12.77^{a}	14.69^{a}	6.62^{a}	6.75^{a}	0.68^{a}	0.74^{a}	17.80^{a}	19.11^{a}
	Fe + Zn (EDTA)	34.86^{b}	36.75^{b}	12.32^{b}	14.32^{b}	6.46^{ab}	6.60^{ab}	0.64^{b}	0.66^{b}	16.88^{b}	18.18^{b}
	Fe + Zn (Sulfate)	32.18^{e}	33.42^{e}	11.06^{e}	12.58^{e}	6.01^{cd}	6.15^{c}	0.52^{e}	0.55^{e}	14.50^{e}	15.41^{e}
FYM	Fe + Zn (Nano)	33.97^{c}	35.81^{c}	11.91^{c}	13.81^{c}	6.32^{b}	6.48^{b}	0.61^{c}	0.64^{c}	16.10^{c}	17.41^{c}
	Fe + Zn (EDTA)	33.03^{d}	34.36^{d}	11.41^{d}	13.27^{d}	6.13^{c}	6.25^{c}	0.56^{d}	0.60^{d}	15.19^{d}	16.12^{d}
	Fe + Zn (Sulfate)	31.24^{f}	32.28^{f}	10.66^{f}	12.24^{e}	5.84^{de}	5.96^{d}	0.50^{f}	0.52^{f}	13.69^{f}	14.44^{f}
LSD $_{at\ 5\%}$		0.61	0.21	0.08	0.35	0.17	0.18	0.01	0.02	0.38	0.47

Data in Table (4)show that the three treatments of spray with micro-nutrient (nano, EDTA and sulfate) caused a significant increase in pod physical quality and green pod yield. However, this increase was significant among the three forms of micronutrient fertilizer treatments, while the treatment of Fe + Zn (nano) recorded the highest values of above mentioned traits during two seasons over the treatments of EDTA then sulfate. The increase in pod physical quality and green pod yield could be due to the role of foliar application of nano- micronutrients which led to an increase in vegetative growth, cell divisions, and finally increasing dry matter accumulation and consequently higher production which reflected on the quality. Moreover, the iron and zinc utilization could possibly be due to the enhanced synthesis of protein and carbohydrates and their transport to the site of pod formation. Also, zinc as a carbonic unhydrase component as well as several dehydrogenase and auxin production which in turn enhances the growth. in addition, Fe is necessary for biosynthesis of chlorophyll and cytochrome leading to improving plant height and number of branches This explanation agrees also with other findings of Morsy*et al.* (2017); Bhamare*et al.* (2018) and Marzouk*et al.* (2019).

The different comparisons between the mean values of pod physical quality and green pod yield as affected by the combination between organic fertilizer types and micronutrients foliar application are presented in Table (4). Data clearly showed that; all types of organic fertilization and foliar with different forms of Fe + Zn recorded a significant stimulation effect on the mentioned parameters. The highest mean values were obtained with the treatment of spray with Fe + Zn (nano) and using chicken manure as organic fertilization. The same trend was true during two seasons. Many workers studied the response of pods physical quality and green yield to the application of micronutrients Fe + Zn in presence of organic manures and their reports are in a good accordance with those obtained by (Morsy*et al.* 2017 and Gomaa*et al*. 2020).

Nutritional value of snap bean leaves and pod:

Snap bean leaves and pods were affected by different types of organic manures and foliar application with Fe + Zn (nano, EDTA and sulfate) for nutrients absorbtion N, P, K%, Fe and Zn (mg.kg^{-1}) and the results are tabulated in Tables (5 and 6), respectively during 2019 and 2020seasons.

Results dealing with the effect of types of organic manures on nutritional value of snap bean leaves and pod are showed in Tables (5 and 6). ANOVA of the data detected a significant effect of all studied treatments (without, FYM and chicken manure) on N, P, K%, Fe and Zn (mg.kg^{-1}) of snap bean leaves and pod. Also, the highest values of above mentioned parameters were affected with soil application of chicken manure followed by FYM comparing with the untreated plants during both seasons.Chicken manure abundant supply of nutrients to the soil with comparatively lesser retention in roots and more easier translocation to the aerial parts. The increase in nutrient values of snap bean leaves and pods according to organic manures were found that organic manures such as chicken manure make all nutrients already in available forms and also enhance uptake of nutrients by plants. These results are in conformity with the findings of Feleafel and Mirdad (2014);Fouda*et al.* (2017) and Abd El Lateef*et al.* (2018).

It is clear from the data illustrated in Tables (5 and 6), the effect of spray with micronutrients on N, P, K%, Fe and Zn (mg.kg^{-1}) of snap bean leaves and pods. Feeding with micronutrient (Fe + ZN) in three forms (nano, EDTA and chelate) applied by foliar way significantly affected above mentioned parameters during both seasons of the experiments. The highest mean values were realized with planted supplied with nano Fe + Zn at rate of 60 mg.L^{-1} over both EDTA and sulfate. Enhancement of nutritional values by nano micronutrient may be explained by increasing nutrient availability for plants leaves (Marzouk *et al*. 2019).

Nano fertilizer with high surface areas are sufficiently and particle size less than the pore size of the plant leaves and thus have the potential of absorbing nutrients in large quantities, which can increase penetration into the plant tissues from applied surface and improve uptake and nutrient use efficiency of the nutrients (Qureshi *et al.,* 2018). This explanation agrees with those findings obtained by Morsy*et al.* (2017) and Marzouk*et al.* (2019).

Table 5. N, P, K%, Fe and Zn (mg.kg^{-1}) of snap bean leaves as affected by organic manures and micro-nutrient in spray way during 2019 and 2020 seasons.

Treatments		Leaves									
		N%		P%		K%		Fe (mg.kg^{-1})		Zn (mg.kg^{-1})	
		2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
A: Organic fertilization (main effect)											
Without		3.30^{c}	3.38^{c}	0.382^{c}	0.395^{c}	2.10^{c}	2.21^{c}	102.59^{c}	104.92^{c}	26.64^{c}	30.48^{c}
Chicken manure		4.04^{a}	4.10^{a}	0.448^{a}	0.463^{a}	2.73^{a}	2.86^{a}	141.81^{a}	144.52^{a}	41.81^{a}	48.21^{a}
FYM		3.83^{b}	3.92^{b}	0.430^{b}	0.447^{b}	2.54^{b}	2.67^{b}	131.58^{b}	134.25^{b}	36.94^{b}	42.74^{b}
LSD at 5%		0.08	0.01	0.010	0.005	0.01	0.01	0.12	0.42	0.25	0.71
B: Foliar application (sub effect)											
Fe + Zn (Nano)		3.91^{a}	4.01^{a}	0.436^{a}	0.449^{a}	2.60^{a}	2.72^{a}	134.71^{a}	136.85^{a}	38.88^{a}	44.86^{a}
Fe + Zn (EDTA)		3.77^{b}	3.83^{b}	0.424^{b}	0.439^{b}	2.49^{b}	2.63^{b}	127.67^{b}	130.72^{b}	36.08^{b}	41.61^{b}
Fe + Zn (Sulfate)		3.49^{c}	3.57^{c}	0.401^{c}	0.417^{c}	2.28^{c}	2.39^{c}	113.60^{c}	116.12^{c}	30.44^{c}	34.95^{c}
LSD at 5%		0.05	0.06	0.004	0.005	0.04	0.04	0.64	0.57	0.54	0.58
Combinations effects											
organic	Foliar										
Without	Fe + Zn (Nano)	3.45^{g}	3.54^{f}	0.397^{g}	0.410^{e}	2.24^{g}	2.34^{f}	111.13^{g}	113.34^{g}	29.27^{g}	33.64^{g}
	Fe + Zn (EDTA)	3.31^{h}	3.40^{g}	0.380^{h}	0.393^{f}	2.10^{h}	2.20^{g}	102.83^{h}	104.96^{h}	26.57^{h}	30.30^{h}
	Fe + Zn (Sulfate)	3.15^{i}	3.22^{h}	0.370^{i}	0.382^{g}	1.98^{i}	2.09^{h}	93.80^{i}	96.46^{i}	24.10^{i}	27.48^{i}
Chicken manure	Fe + Zn (Nano)	4.28^{a}	4.37^{a}	0.466^{a}	0.479^{a}	2.91^{a}	3.02^{a}	152.37^{a}	153.82^{a}	46.67^{a}	53.65^{a}
	Fe + Zn (EDTA)	4.13^{b}	4.13^{b}	0.456^{b}	0.475^{a}	2.80^{b}	2.95^{b}	145.77^{b}	148.73^{b}	43.77^{b}	50.72^{b}
	Fe + Zn (Sulfate)	3.71^{e}	3.81^{d}	0.422^{e}	0.435^{d}	2.48^{e}	2.62^{d}	127.30^{e}	131.00^{e}	35.00^{e}	40.25^{e}
FYM	Fe + Zn (Nano)	4.01^{c}	4.11^{b}	0.444^{c}	0.459^{b}	2.67^{c}	2.81^{c}	140.63^{c}	143.39^{c}	40.70^{c}	47.30^{c}
	Fe + Zn (EDTA)	3.87^{d}	3.97^{c}	0.435^{d}	0.448^{c}	2.58^{d}	2.74^{c}	134.40^{d}	138.48^{d}	37.90^{d}	43.80^{d}
	Fe + Zn (Sulfate)	3.60^{f}	3.68^{e}	0.410^{f}	0.433^{d}	2.37^{f}	2.46^{e}	119.70^{f}	120.88^{f}	32.23^{f}	37.12^{f}
LSD at 5%		0.09	0.11	0.007	0.008	0.07	0.08	1.11	0.99	0.94	1.01

The results of the present experimentation showed beneficial effect of different organic manures combination with foliar application with micronutrient Fe + Zn as indicated in Tables (5 and 6). Data revealed that all treatments under study significantly affected N, P, K%, Fe and Zn (mg.kg^{-1}) of snap bean leaves and pods. Soil addition of chicken manure recorded high values over other treatments of foliar application, but it was found that spray with Fe + Zn in form of nano was the highest one over EDTA or sulfate. So, the treatments of nano Fe+ Zn under chicken manure were the best treatment which gave the highest values of N, P, K%, Fe and Zn (mg.kg^{-1}) of snap bean leaves and pods during both seasons of the experiment.

Table 6. N, P, K%, Fe and Zn (mg.kg^{-1})of snap bean pods as affected by organic manures and micro-nutrient in spray way during 2019 and 2020 seasons.

Treatments		Pods									
		N%		P%		K%		Fe , mg.kg^{-1}		Zn, mg.kg^{-1}	
		2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
A: Organic fertilization (main effect)											
Without		2.92^{c}	3.09^{c}	0.315^{c}	0.323^{c}	1.44^{c}	1.51^{c}	68.89^{c}	70.45^{c}	26.48^{c}	26.89^{c}
Chicken manure		3.36^{a}	3.49^{a}	0.399^{a}	0.406^{a}	2.16^{a}	2.27^{a}	90.23^{a}	92.09^{a}	35.57^{a}	35.71^{a}
FYM		3.23^{b}	3.34^{b}	0.371^{b}	0.380^{b}	1.95^{b}	2.04^{b}	83.29^{b}	85.13^{b}	32.66^{b}	33.16^{b}
LSD at 5%		0.06	0.05	0.008	0.002	0.01	0.01	0.23	1.67	0.61	1.310.
B: Foliar application (sub effect)											
Fe + Zn (Nano)		3.27^{a}	3.39^{a}	0.382^{a}	0.391^{a}	2.02^{a}	2.12^{a}	86.28^{a}	88.08^{a}	33.86^{a}	33.98^{a}
Fe + Zn (EDTA)		3.19^{b}	3.34^{b}	0.367^{b}	0.373^{b}	1.90^{b}	1.99^{b}	82.12^{b}	83.84^{b}	32.20^{b}	32.75^{b}
Fe + Zn (Sulfate)		3.04^{c}	3.20^{c}	0.336^{c}	0.345^{c}	1.63^{c}	1.71^{c}	74.01^{c}	75.75^{c}	28.64^{c}	29.02^{c}
LSD at 5%		0.03	0.04	0.005	0.003	0.03	0.03	0.41	1.17	0.45	0.44
Combinations effects											
organic	Foliar										
Without	Fe + Zn (Nano)	3.01^{g}	3.15^{f}	0.328^{g}	0.337^{g}	1.56^{g}	1.63^{g}	72.90^{g}	74.33^{g}	28.23^{g}	28.57^{f}
	Fe + Zn (EDTA)	2.92^{h}	3.09^{fg}	0.314^{h}	0.323^{h}	1.43^{h}	1.50^{h}	69.23^{h}	70.84^{h}	26.60^{h}	27.10^{g}
	Fe + Zn (Sulfate)	2.84^{i}	3.03^{g}	0.303^{i}	0.310^{i}	1.33^{i}	1.40^{i}	64.53^{i}	66.18^{i}	24.60^{i}	24.98^{h}
Chicken manure	Fe + Zn (Nano)	3.49^{a}	3.61^{a}	0.426^{a}	0.435^{a}	2.38^{a}	2.50^{a}	97.30^{a}	99.14^{a}	38.47^{a}	38.00^{a}
	Fe + Zn (EDTA)	3.41^{b}	3.53^{b}	0.411^{b}	0.412^{b}	2.26^{b}	2.37^{b}	92.87^{b}	94.68^{b}	36.77^{b}	37.37^{a}
	Fe + Zn (Sulfate)	3.18^{e}	3.32^{d}	0.362^{e}	0.372^{e}	1.85^{e}	1.94^{e}	80.53^{e}	82.45^{e}	31.47^{e}	31.76^{d}
FYM	Fe + Zn (Nano)	3.32^{c}	3.40^{c}	0.394^{c}	0.402^{c}	2.12^{c}	2.23^{c}	88.63^{c}	90.77^{c}	34.87^{c}	35.38^{b}
	Fe + Zn (EDTA)	3.25^{d}	3.39^{cd}	0.375^{d}	0.385^{d}	2.01^{d}	2.10^{d}	84.27^{d}	85.99^{d}	33.23^{d}	33.79^{c}
	Fe + Zn (Sulfate)	3.11^{f}	3.24^{e}	0.344^{f}	0.353^{f}	1.70^{f}	1.80^{f}	76.97^{f}	78.62^{f}	29.87^{f}	30.32^{e}
LSD at 5%		0.04	0.08	0.009	0.005	0.06	0.06	0.70	2.02	0.78	0.76

Pod chemical quality:

Data in Table (7) indicated the effect of different types of organic manures and foliar application with Fe + Zn (nano, EDTA and sulfate) on pod chemical quality as (protein, total carbohydrates, fiber and TSS%) during 2019 and 2020.

In the same Table, the statistical analysis of the data showed that applying organic manures significantly affect protein, total carbohydrates, fibers and TSS%. during both seasons. The data revealed that application of chicken manure recorded the highest values of previous parameters than that obtained from the other treatments.This increase may be attributed to soil organic matter impact on the functional soil chemical , physicaland biological properties and to play an important role in nutrient cycling (Murphy, 2014), which ultimately resulted in better root growth and increased physical activity of roots to absorb the nutrients through decomposition of organic manures that led to an increase in their contents and reflect on pod quality.This result was in harmony with previous findings of Fouda*et al.* (2017) and Mahmoud and Gad (2020).

Table 7. Pod chemical quality of snap bean pods as affected by organic manures and micro-nutrient in spray way during 2019 and 2020 seasons.

Treatments		Pods							
		Protein %		Total carbohydrates %		Fiber %		TSS%	
		2019	2020	2019	2020	2019	2020	2019	2020
A: Organic fertilization (main effect)									
Without		18.28^{c}	19.30^{c}	31.33^{c}	34.36^{c}	12.91^{c}	14.10^{c}	5.86^{c}	5.99^{c}
Chicken manure		20.99^{a}	21.81^{a}	39.65^{a}	42.45^{a}	14.82^{a}	15.87^{a}	7.07^{a}	7.21^{a}
FYM		20.17^{b}	20.90^{b}	37.09^{b}	40.11^{b}	14.24^{b}	15.32^{b}	6.74^{b}	6.89^{b}
LSD at 5%		0.35	0.31	0.03	0.96	0.14	0.31	0.02	0.14
B: Foliar application (sub effect)									
Fe + Zn (Nano)		20.44^{a}	21.16^{a}	38.12^{a}	41.65^{a}	14.41^{a}	15.70^{a}	6.83^{a}	6.97^{a}
Fe + Zn (EDTA)		19.96^{b}	20.85^{b}	36.53^{b}	39.60^{b}	14.12^{b}	15.23^{b}	6.66^{b}	6.80^{b}
Fe + Zn (Sulfate)		19.03^{c}	19.99^{c}	33.42^{c}	35.67^{c}	13.44^{c}	14.35^{c}	6.18^{c}	6.33^{c}
LSD at 5%		0.16	0.27	0.18	0.39	0.20	0.21	0.11	0.09
Combinations effects									
organic	Foliar								
Without	Fe + Zn (Nano)	18.79^{g}	19.67^{f}	32.90^{g}	36.49^{f}	13.21^{e}	14.47^{de}	6.09^{f}	6.21^{f}
	Fe + Zn (EDTA)	18.27^{h}	19.31^{fg}	31.33^{h}	34.43^{g}	12.86^{f}	14.16^{e}	5.85^{g}	5.98^{g}
	Fe + Zn (Sulfate)	17.77^{i}	18.92^{g}	29.77^{i}	32.15^{h}	12.68^{f}	13.67^{f}	5.65^{h}	5.79^{h}
Chicken manure	Fe + Zn (Nano)	21.79^{a}	22.56^{a}	42.27^{a}	46.46^{a}	15.37^{a}	16.92^{a}	7.34^{a}	7.48^{a}
	Fe + Zn (EDTA)	21.29^{b}	22.08^{b}	40.65^{b}	43.13^{b}	15.08^{a}	15.97^{b}	7.31^{a}	7.45^{a}
	Fe + Zn (Sulfate)	19.88^{e}	20.77^{d}	36.02^{e}	37.78^{e}	14.03^{c}	14.72^{d}	6.56^{d}	6.71^{d}
FYM	Fe + Zn (Nano)	20.75^{c}	21.25^{c}	39.19^{c}	42.00^{c}	14.66^{b}	15.72^{bc}	7.06^{b}	7.23^{b}
	Fe + Zn (EDTA)	20.31^{d}	21.17^{cd}	37.60^{d}	41.24^{d}	14.43^{b}	15.56^{c}	6.82^{c}	6.96^{c}
	Fe + Zn (Sulfate)	19.44^{f}	20.27^{e}	34.47^{f}	37.10^{f}	13.62^{d}	14.67^{d}	6.33^{e}	6.47^{e}
LSD at 5%		0.28	0.47	0.31	0.67	0.35	0.35	0.19	0.16

Regarding the pod chemical quality, data in Table (7) showed the effect of foliar application with micronutrients (Fe + Zn) in form of (nano, EDTA and sulfate) on protein, total carbohydrates, fibers and TSS% during both seasons. All treatments significantly affect the traits and the highest values were recorded with using Fe + Zn in form of nano over both EDTA and sulfate.In this respect, high content of protein and carbohydrates may be a direct result for high rates of photosynthesis with great efficiency. Fouda and Abd-Elhamied (2017) noticed that spraying cowpea plants with Fe + Zn nutrients enhanced significantly protein, total carbohydrates and fibers % also, it may be duo to zinc addition might be share in its involvement in nitrogen metabolism of plants and its vital role in stabilizing RNA and DNA structure, and involves in biosynthesis of growth promoting hormones such as IAA and gibberellins.Pingoliya*et al.* (2014) reported that with application of 4 kg Fe ha^{-1} to mung bean plants an increase in the protein content in seeds was significantly obtained comparing with their lower levels. Morsy*et al*. (2017) found an increase in protein and carbohydrate contents of snap bean according to application of Zn-nano.

It is evident from Table (7) that the combination of organic manures and foliar application of micronutrients Fe + Zn affected significantly on pod chemical quality. Application of chicken manure and spray with nano Fe + Zn was found to be the most profitable treatment in snap bean recording the highest mean values of protein, total carbohydrates, fibers and TSS% in 2019 and 2020.

Soil analysis:

Data presented in Table (8) showed soil samples analysis which were after snap bean harvest from selected plots (control, FYM and chicken manure).

Table 8. Average values of soil properties as affected by organic manures and micro-nutrients in spray way during 2019 and 2020 seasons.

Treatments		mg.kg^{-1}			%	
		N	P	K	S.P	F.C
Without	Fe + Zn (Nano)	43.21	9.38	221.84	25.82	12.60
	Fe + Zn (EDTA)	44.17	9.69	229.08	23.39	11.72
	Fe + Zn (Sulfate)	45.01	10.03	236.10	21.25	11.02
Chicken manure	Fe + Zn (Nano)	45.89	10.33	242.65	32.59	19.27
	Fe + Zn (EDTA)	46.69	10.58	249.42	31.64	18.25
	Fe + Zn (Sulfate)	47.60	10.86	255.54	30.79	17.20
FYM	Fe + Zn (Nano)	48.44	11.24	261.48	29.29	16.25
	Fe + Zn (EDTA)	49.33	11.56	268.63	28.39	15.35
	Fe + Zn (Sulfate)	50.18	11.91	275.13	27.57	14.25

Referring the effect of different types of organic manures, data in Table (8) obvious that; available N, P, K (mg.kg^{-1}), FC and S.P in the soil after harvesting were increased with application of organic manures comparing with before planting. The highest mean values of available N, P, K (mg.kg^{-1}), FC and S.P were recorded with using chicken manure more than FYM. The regular addition of organic amendments to soil is very important. Addition of organic manures improves soil field capacity, soil tilth, and infiltration rate; contributes nutrients to the crop and it is an important source of raw or partially decomposed organic matter (Abd El Lateef*et al*. 2018). The value of organic amendments in crop production is centered on the ability of it to provide nutrients and improving the chemical, physical and biological properties of soils.Chicken manure was readily available because of low C: N ratio, abundant supply of nutrients availably to the soil with comparatively lesser retention in roots and more easier translocation to the aerial parts for protoplasmic proteins and synthesis of other compounds. The increase in chemical analysis of soil due to utilization of organic manures agree with those obtained by Fouda*et al*. (2017) who found that available N, P and K (mg.kg^{-1})increased in soil after harvesting due to application of organic manures.

CONCLUSION

Nanotechnology presents brilliant agricultural products, which consider an achievement in addressing many common economic and ecological issues. Nano-fertilizers show special characters which do not exist in their conventional counterparts. Under the same condition, it could be concluded that, foliar application with nano Fe + Zn with addition of chicken manure were effective treatment in increasing vegetative growth, green pod yield, pod physical quality and nutritional value.

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تأثير الرش الورقي بأسمدة النانو والتسميد العضوي على نبات الفاصوليا تحت ظروف الأراضي الرملية

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تقوم تقنيه النانو بتقديم منتجات رائعة، والتي قد تكون إنجازا في معالجه العديد من القضايا الاقتصادية والبيئية. تظهر أسمدة النانو صفات خاصه لا توجد في غيرها. أجريت تجربتان خلال ٢٠١٩ و٢٠٢٠ لدراسة تأثير ثلاث صور من الرش بالعناصر الصغرى حديد ومنجنيز في صوره (نانو، مخلبيه، كبريتات) تحت التسميد العضوي (بدون، سماد زرق الدواجن والسماد البلدي) على النمو الخضري والصفات الفيزيائية والكيميائية والجودة لقرون نبات الفاصوليا والمحصول الأخضر بالإضافة الى بعض الصفت الكيميائية للتربة بعد الزراعة. جميع المعاملات تحت الدراسة أثرت معنويا على الصفات الخضرية مثل (طول النبات، عدد الفروع، الوزن الطازج والجاف ومحتوى النبات من الكلوروفيل)، الجودة الفيزيائية للقرون (عدد، طول، وزن، قطر)، المحصول الأخضر للقرون، المحتوى الكيميائي للأوراق والقرون (النسبة المئوية للنيتروجين، الفوسفور، البوتاسيوم، محتوى الحديد والزنك)، وصفات الجودة للقرون (بروتين، كربوهيدرات، ألياف، السكر) بالإضافة الى صفات التربة بعد الزراعة (محتواها من العناصر المتاحة، السعه الحقلية، السعة التشعبية). أظهرت النتائج أن إضافة زرق الدواجن كذلك الرش بالعناصر الصغرى في صورة نانو سجلت أفضل النتائج بالمقارنة بين المعاملات الأخرى تحت الدراسة.