



Effect of Organic Manures and Nano Zinc on Growth and Yield of Baby Corn (*Zea mays* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i193603

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/105382>

Original Research Article

Received: 16/06/2023

Accepted: 22/08/2023

Published: 25/08/2023

ABSTRACT

A field experiment was conducted during *kharif* 2022 at CRF (Crop Research Farm), Department of Agronomy, SHUATS, Prayagraj, (UP). To study the "Effect of organic manures and Nano zinc on growth and yield of baby corn". The soil of the experimental field is sandy loam in texture. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. The treatments consisted of three levels of Nano zinc (0.5 ml/l, 1 ml/l, 1.5 ml/l) and three levels of organic manures whose effect is observed in baby corn. The results revealed that the treatment with application of poultry manure 3.3 t/h + Nano zinc 1.5ml/l recorded higher plant height (191 cm), plant dry weight (99.60 g), number of cobs (3.73), cob length 21.95 cm, cob weight with husk 10.88 g, cob yield without husk 6.38 t/h, green fodder yield 36.10 t/h and harvest index (39.03%). The

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economics viz., maximum gross returns (1,81,170.00 INR/ha), net returns (1,20,155.00 INR/ha) and B:C (1.97) was also recorded in treatment 9 with application of poultry manure 3.3t/h + Nano zinc 1.5 ml/l.

Keywords: *Baby corn; nano zinc; organic manure; growth; yield.*

1. INTRODUCTION

“Maize (*Zea mays* L.) is the most versatile crop with wider adaptability in varied agro- ecological conditions. It is an annual C4 plant belonging to the family- poaceae with its origin Central America. Maize being one of the most important cereals crop in the world agricultural economy, it is cultivated throughout the world as it has highest genetic yield potential than any other cereal crop and there is no cereal on earth which has so immense potential and hence referred to as “Queen of cereals” or miracle crop” [1].

“Baby corn (also known as young corn, mini corn or candle corn) is the ear of maize (*Zea mays* L.) plant harvested young, when the silks have either not emerged or just emerged and no fertilization has taken place. Baby corn is one of the most important dual-purpose crops grown round the year in India” [2-7].

“Neem cake known as non edible oil cake organic manure. The composition of Neem cake is 5.2 % N, 1.0% P, 1.4% K. Neem cake also act as a nematicide. Neem cake act as a nitrogen inhibitor means reduce the nitrification. It supplies the available nitrogen for a long time in the soil” [8].

“vermicompost provides all nutrients in readily available form and also enhances uptake of nutrients by plants” [9]. “vermicomposting is a chemical and biological process for recycling nutrients with the aid of earthworms and microorganisms. Thus, vermicompost is considered as a high nutrient biofertilizer with diverse microbial communities” (Pathma and Sakthivel, 2013).

Poultry manure is the faces of chickens used as an organic fertilizer, particularly for nitrogen-deficient soil; it contains the most nitrogen, phosphate, and potassium of any animal manure. The samples include 0.8 per cent potassium, 0.4 per cent to 0.5 per cent phosphorus and 0.9 per cent to 1.5 per cent nitrogen (Deksissa et al., 2008).

“The nano fertilizers or nano encapsulated nutrients might have the properties that are effective to crops, release the nutrients on

demand, controlled release of chemical fertilizers that regulate the plant growth and enhanced target activity” (De Rosa et al. 2010) [10-23]. “Foliar application of Zn may significantly increase Zn accumulation in the grain as compared to soil fertilization. Foliar Zn application has been proved to be an effective practice to overcome the problems of Zn binding, and fixation in soil though the timing of application is of prime concern. The efficacy of the applied Zn fertilizer after the appearance of the Zn-deficiency symptoms in the crop plant can be limited. Therefore, zinc oxide nanoparticles (ZnONPs), a product of a multidisciplinary field of science, nanotechnology (NT) can be a possible assertive alternative Zn-deficiency remediation fertilizer [24-28]. Application of ZnONPs is anticipated to provide zine to plants effectively due to their small size, easy solubility, and diffusible nature that renders for rapid and complete absorption/uptake by the plant catering the nutritional needs and deficiencies in the crop plant” (Pathma and Sakthivel, 2013).

2. MATERIALS AND METHODS

The present field experiment entitled, “Effect of organic Manures and Nano Zinc on growth and yield of baby corn (*Zea mays* L.)”, was conducted during *Kharif* season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.).

The experiment was conducted during *Kharif* season of 2022 at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The Crop Research Farm is situated at 25.570 N latitude, 87.190 E longitude and at an altitude of 98 m above mean sea level. The soil of the experimental field constituting a part of central Gangetic alluvium and is neutral and deep. The soil was sandy loam in texture, low in organic carbon and medium in available nitrogen, phosphorus and low in potassium. The experiment was conducted in Randomized Block Design with 10 treatments each replicated thrice. The plot size of each treatment was 3 m x 3 m. Factors are three

levels of Organic manure (Neem cake 2t/ha, Vermicompost 6.6 t/ha and Poultry manure 3.3 t/ha) and the Nano Zinc 0.5 ml/l, 1 ml/l and 1.5 ml/l and a control. The treatment details are as follows, T1 -(Neem cake 2 t/ha + Nano Zinc 0.5 ml/l), T2 -(Neem cake 2 t/ha + Nano Zinc 1 ml/l), T3 – (Neem cake 2 t/ha + Nano Zinc 1.5 ml/l), T4 - (Vermicompost 6.6 t/ha + Nano Zinc 0.5 ml/l) T5 - (Vermicompost 6.6 t/ha + Nano Zinc 1 ml/l), T6 - (Vermicompost 6.6 t/ha + Nano Zinc 1.5 ml/l), T7 - (Poultry manure 3.3 t/ha + Nano Zinc 0.5 ml/l), T8 - (Poultry manure 3.3 t/ha + Nano Zinc 1 ml/l), and T9 - (Poultry manure 3.3 t/ha + Nano Zinc 1.5 ml/l), T10 - (Control – N:P:K 100:60: 40). The observations were recorded for plant height, dry weight, crop growth rate, relative growth rate, number of cobs per plant, cob length (cm), cob weight (g) with husk, cob weight (g) without husk, Cob yield (t/ha) with husk, cob yield (t/ha) without husk, green fodder yield (t/ha), net return and B:C ratio.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Plant Height (cm): At 60 DAS, significantly higher plant height (191.08 cm) was recorded in treatment 9 (Poultry manure 3.3t/h + Nano Zinc 1.5 ml/l). However, treatment 5 (Vermicompost 6.6 t/h + Nano Zinc 1 ml/l) , treatment 6 (Vermicompost 6.6 t/h + Nano Zinc 1.5 ml/l), treatment 7 (Poultry manure 3.3t/h + Nano Zinc 0.5ml/l), treatment 8 (Poultry manure 3.3t/h + Nano Zinc 1 ml/l) were statistically at par with treatment 9 (Poultry manure 3.3t/h + Nano Zinc 1.5 ml/l).

Significant and maximum plant height was observed with the application of (Poultry manure 3.3t/h + Nano Zinc 1.5ml/l) might be due to Zinc plays a critical role because it is needed to produce chlorophyll and is necessary for cell elongation. The synthesis of growth hormones and certain cell proteins also relies on sufficient zinc levels. Improvement in plant height with significant variation is due to in time availability of the needed nutrients to the plant by application of zinc which has led to production of IAA resulting in increased plant height Meena et al. (2013) and Iqbal et al. [29].

Plant Dry Weight (g/plant): At 60 DAS, significantly higher plant dry weight (99.60 g/ plant) was recorded in treatment 9 (Poultry manure 3.3t/h+ Nano zinc 1.5 ml/l). However, treatment 5 (Vermicompost 6.6 t/h + Nano Zinc 1 ml/l), treatment 7 (Poultry manure 3.3t/h + Nano

Zinc 0.5 ml/l), treatment 8 (Poultry manure 3.3t/h + Nano Zinc 1 ml/l) were statistically at par with treatment 9 (Poultry manure 3.3 t/h + Nano Zinc 1.5 ml/l).

Significant and maximum plant dry weight was observed with the application of treatment 9 (Poultry manure 3.3t/h + Nano Zinc 1.5ml/l). The production of more dry matter per plant might be due to higher levels of zinc application which might have helped in utilizing the natural resources viz., light, nutrients and soil moisture more efficiently which may converted into organic constituents and also attributed to enhanced plant height and leaf area led to attain dry mass. These findings were reported by Alka Jyoti Sharma et al. [30]; Meena et al. (2013); Balwinder kumar et al. [31] and Rakesh kumar and Bohra [32].

Crop Growth Rate (g/m²/day): At 45-60 DAS, significantly higher crop growth rate (55.80 g/ m² / day) was recorded in treatment 9 (Poultry manure 3.3 t/h + Nano Zinc (1.5 ml/l). However treatment 2 (Neemcake 2 t/h + Nano Zinc 1 ml/l), treatment 3 (Neemcake 2 t/h + Nano Zinc 1.5 ml/l) , treatment 5 (Vermicompost 6.6 t/h + Nano Zinc 1 ml/l) , treatment 6 (Vermicompost 6.6 t/h + Nano Zinc 1.5 ml/l), treatment 7 (Poultry manure 3.3t/h + Nano Zinc 0.5ml/l), treatment 8 (Poultry manure 3.3 t/h + Nano Zinc 1 ml/l) were statistically at par with treatment 9 (Poultry manure 3.3t/h + Nano Zinc 1.5 ml/l).

Relative Growth Rate (g/m²/day): At 45-60 DAS, highest relative growth rate (0.056 g/g/day) was recorded in treatment 8 (Poultry manure 3.3t/h + Nano Zinc 1 ml/l) and lowest (0.035g/g/day) in treatment 10 (Control- N:P:K (100:60:40) kg/ha). There was no significant difference among the treatments.

3.2 Yield Parameters

Number of Cobs/Plant: The significantly and higher number of cobs/ plant (3.73) was recorded in treatment 9 (Poultry manure 3.3 t/h + Nano Zinc 1.5 ml/l). However, treatment 7 (Poultry manure 3.3 t/h + Nano Zinc 0.5 ml/l), treatment 8 (Poultry manure 3.3 t/h + Nano Zinc 1 ml/l) were statistically at par with treatment 9 (Poultry manure (3.3t/h + Nano Zinc 1.5 ml/l).

Significant and maximum number of cobs/ plant was observed with the application of (Poultry manure 3.3 t/h + Nano Zinc 1.5 ml/l). The decrease in cobs might be due to more space per plot in the experiment. As a result cobs

present in Nano Zinc was found to be more. Similar findings were under the conformity of Sharma et al. [33].

Cob Length (cm): The significantly higher cob length (21.95 cm) was recorded in treatment 9 (Poultry manure 3.3t/h + Nano Zinc 1.5 ml/l). However, treatment 5 (Vermicompost 6.6 t/h + Nano Zinc 1 ml/l), treatment 6 (Vermicompost 6.6 t/h + Nano Zinc 1.5 ml/l), treatment 7 (Poultry manure 3.3 t/h + Nano Zinc 0.5 ml/l), treatment 8 (Poultry manure 3.3 t/h + Nano Zinc 1 ml/l) were statistically at par with treatment 9 (Poultry manure 3.3t/h + Nano Zinc 1.5 ml/l).

The use of micronutrients (Zn) increased cob length significantly which results in synergism and improvement of nutrient which leads to the formation of better cob and corn length. These findings corroborate the results of Shivay and Prasad [34]; Badiyala and Chopra et al. [35].

Cob Weight with Husk (g): The significantly and higher cobs weight with husk (45.72 g) was recorded in treatment 9 (Poultry manure 3.3 t/h + Nano Zinc 1.5 ml/l). However, treatment 5 (Vermicompost 6.6 t/h + Nano Zinc 1 ml/l), treatment 6 (Vermicompost 6.6 t/h + Nano Zinc 1.5 ml/l), treatment 7 (Poultry manure 3.3 t/h + Nano Zinc 0.5 ml/l), treatment 8 (Poultry manure 3.3 t/h + Nano Zinc 1 ml/l) were statistically at par with treatment 9 (Poultry manure 3.3 t/h + Nano Zinc 1.5 ml/l).

Cob Weight without Husk (g): The significantly higher cob weight without husk (22.60 g) was recorded in treatment 9 (Poultry manure 3.3t/h + Nano Zinc 1.5 ml/l) .However, treatment 5 (Vermicompost 6.6 t/h + Nano Zinc 1 ml/l) , treatment 6 (Vermicompost 6.6 t/h + Nano Zinc 1.5 ml/l), treatment 7 (Poultry manure 3.3 t/h + Nano Zinc 0.5 ml/l), treatment 8 (Poultry manure 3.3 t/h + Nano Zinc 1 ml/l) were statistically at par with treatment 9 (Poultry manure 3.3 t/h + Nano Zinc 1.5 ml/l).

The increase in yield attributes due to application of Nano Zinc was caused by higher chlorophyll contents this had apparently a positive effect on photosynthetic activity, synthesis of metabolites growth-regulating substances, oxidation and metabolic activities, ultimately better growth and development of crop, which led to increase in yield attributes of baby corn. The results were in conformity with Meena et al. (2013) and Rakesh Kumar and Bohra [32].

Cob yield with husk (t/ha): The significantly and higher cob yield with husk (10.88 t/h) was recorded in treatment 9 Poultry manure 3.3 t/h + Nano Zinc 1.5 ml/l) .However, treatment 7 (Poultry manure 3.3 t/h + Nano Zinc 0.5 ml/l), treatment 8 (Poultry manure 3.3 t/h + Nano Zinc 1 ml/l) were statistically at par with treatment 9 (Poultry manure 3.3 t/h + Nano Zinc 1.5 ml/l).

Cob Yield without Husk (t/ha): The significantly higher cob yield without husk (6.38 t/h) was recorded in treatment 9 (Poultry manure 3.3t/h + Nano Zinc 1.5 ml/l). However, treatment 5 (Vermicompost 6.6 t/h + Nano Zinc 1 ml/l), treatment 6 (Vermicompost 6.6 t/h + Nano Zinc 1.5 ml/l), treatment 7 (Poultry manure 3.3t/h + Nano Zinc 0.5ml/l), treatment 8 (Poultry manure 3.3 t/h + Nano Zinc 1 ml/l) were statistically at par with treatment 9 (Poultry manure 3.3t/h + Nano Zinc 1.5 ml/l).

Increase in cob and corn yield in baby corn might be due to the favourable influence of applied zinc on physiological and metabolic process of the plants, which ultimately enhanced baby cob and corn yield and found significant increase in all growth and yield attributes in wider intra-row spacing, concluded that narrower spacing could outstand in yield. It was observed that narrow intra-row spacing resulted higher yield than wider intra-row spacing and also application of higher level of Zinc directly related to the vegetative and reproductive growth phases of the crop. Similar results were obtained by Ganeshia et al. [36].

Green Fodder Yield: The significantly and higher green fodder yield (36.10 t/h) was recorded in treatment 9 (Poultry manure 3.3 t/h + Nano Zinc 1.5 ml/l) .However, treatment 6 (Vermicompost 6.6 t/h + Nano Zinc 1.5 ml/l), treatment 7 (Poultry manure 3.3 t/h + Nano Zinc 0.5 ml/l), treatment 8 (Poultry manure 3.3 t/h + Nano Zinc 1 ml/l) were statistically at par with treatment 9 (Poultry manure 3.3t/h + Nano Zinc 1.5 ml/l).

Application of zinc reduces the fibre and soluble carbohydrate content in fodders thereby increases digestibility [37]. Increase in green fodder yield might be due to the enhanced translocation of photosynthates with applied zinc, which resulted in higher production of green fodder in the respective levels of nutrient (S.W. Chand et al., 2017). Similar results of significantly higher fodder yield with Zn application were also reported by Mahdi et al. [38].

Table 1. Effect of organic manures and Nano Zinc on growth parameters of baby corn

S.No.	Treatment combination	60 DAS		45-60 DAS	
		Plant Height (cm)	Plant Dry Weight (g)	Crop growth rate (g/m ² /day)	Relative growth rate (g/g/day)
1.	Neem cake 2 t/ha + Nano zinc 0.5 ml/l.	160.98	66.43	30.16	0.041
2.	Neem cake 2 t/ha + Nano zinc 1 ml/l.	171.18	83.37	45.13	0.052
3.	Neem cake 2 t/ha + Nano zinc 1.5 ml/l.	171.14	83.67	44.15	0.051
4.	Vermicompost 6.6 t/ha + Nano zinc 0.5 ml/l.	174.08	82.33	42.04	0.048
5.	Vermicompost 6.6 t/ha + Nano zinc 1 ml/l.	181.11	88.97	47.55	0.051
6.	Vermicompost 6.6 t/ha + Nano zinc 1.5 ml/l.	176.78	84.50	42.93	0.048
7.	Poultry manure 3.3 t/ha + Nano zinc 0.5 ml/l.	184.90	94.70	52.64	0.055
8.	Poultry manure 3.3 t/ha + Nano zinc 1 ml/l.	186.08	97.77	54.88	0.056
9.	Poultry manure 3.3 t/ha + Nano zinc 1.5 ml/l.	191.08	99.60	55.80	0.055
10	Control (RDF)	158.24	62.10	25.32	0.035
	F-test	S	S	S	NS
	SEm(±)	6.12	3.93	4.41	0.004
	CD(P=0.05)	18.21	11.70	13.12	-

Table 2. Effect of organic manures and Nano Zinc on yield attributes of baby corn

S.No.	Treatment combination	Yield attributes and yield							
		No. of cob/ plant (No.)	Cob length (cm)	Cob weight with husk (g)	Cob weight without husk (g)	Cob yield with husk (t/ha)	Cob yield without husk (t/ha)	Green fodder yield (t/ha)	Harvest index (%)
1.	Neem cake 2 t/ha + Nano zinc 0.5 ml/l.	1.66	15.48	26.88	16.17	6.68	4.37	26.27	38.74
2.	Neem cake 2 t/ha + Nano zinc 1ml/l.	1.81	16.74	28.18	17.42	6.86	4.30	28.63	39.03
3.	Neem cake 2 t/ha + Nano zinc 1.5ml/l.	1.96	17.92	29.09	18.60	7.56	4.51	29.17	37.13
4.	Vermicompost 6.6 t/ha + Nano zinc 0.5 ml/l.	2.16	18.15	30.65	18.83	7.92	4.69	29.73	37.11
5.	Vermicompost 6.6 t/ha + Nano zinc 1 ml/l.	2.60	18.99	32.99	19.67	8.15	5.06	30.42	38.36
6.	Vermicompost 6.6 t/ha + Nano zinc 1.5 ml/l.	2.67	19.45	34.04	20.13	8.48	5.42	31.63	38.86
7.	Poultry manure 3.3 t/ha + Nano zinc 0.5 ml/l.	3.46	19.69	38.81	20.38	10.15	5.65	32.07	35.61
8.	Poultry manure 3.3 t/ha + Nano zinc 1 ml/l.	3.69	20.25	42.62	20.93	10.48	5.98	35.63	36.24
9.	Poultry manure 3.3 t/ha + Nano zinc 1.5 ml/l.	3.73	21.95	45.72	22.60	10.88	6.38	36.10	36.92
10.	Control (RDF)	1.61	13.72	25.36	14.40	6.63	4.24	24.22	36.82
	F-test	S	S	S	S	S	S	S	NS
	SEm(±)	0.28	1.20	4.33	1.21	0.68	0.48	1.62	9.29
	CD(P=0.05)	0.85	3.59	12.89	3.60	2.02	1.43	4.83	-

Table 3. Economics of baby corn as influenced by organic manures and Nano Zinc

S. No.	Treatment combination	Economics	
		Net return (INR/ha)	B:C ratio
1.	Neem cake 2 t/ha + Nano zinc 0.5 ml/l.	68595.00	1.37
2.	Neem cake 2 t/ha + Nano zinc 1 ml/l.	70681.67	1.40
3.	Neem cake 2 t/ha + Nano zinc 1.5 ml/l.	76745.00	1.50
4.	Vermicompost 6.6 t/ha + Nano zinc 0.5 ml/l.	76575.00	1.35
5.	Vermicompost 6.6 t/ha + Nano zinc 1 ml/l.	85775.00	1.50
6.	Vermicompost 6.6 t/ha + Nano zinc 1.5 ml/l.	94738.33	1.64
7.	Poultry manure 3.3 t/ha + Nano zinc 0.5 ml/l.	101825.00	1.70
8.	Poultry manure 3.3 t/ha + Nano zinc 1 ml/l.	109955.00	1.82
9.	Poultry manure 3.3 t/ha + Nano zinc 1.5 ml/l.	120155.00	1.97
10.	Control (RDF)	59771.67	1.33

Harvest Index (%): The significantly higher harvest index (39.03%) was recorded in treatment 2 (Neemcake 2t/h + Nano Zinc 1 ml/l) and lowest (35.61) was recorded in treatment 7 (Poultry manure 3.3 t/h + Nano zinc 0.5 ml/l). There was no significant difference among the treatments.

Economics: The maximum net return (59183.00 INR/ha) and highest benefit cost ratio (1.86) was also recorded in treatment 9 with the application of Poultry manure 3.3 t/ha + Nano zinc 1.5 ml/l. (T₉) when compared to other treatments.

4. CONCLUSION

It is concluded that among different organic manures and Nano Zinc studied in baby corn, soil application of Poultry manure 3.3 t/ha + Nano zinc 1.5 ml/l.(T₉) recorded higher yield.

Maximum gross returns (Rs. 1,81,170.00 INR/ha), net returns (Rs. 1,20,155.00 INR/ha) and benefit: cost ratio (1.97) was also obtained with Poultry manure 3.3 t/ha + Nano zinc 1.5 ml/l. These findings are based on one season therefore; further trials may require for further confirmation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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