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Influence of different levels of zinc, iron and vermicompost on profitability of hybrid maize (*Zea mays* L.)

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Abstract
A field experiment was conducted on student instructional farm (SIF) at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during the *Kharif* season 2019 and 2020, In the present experiment 32 treatments, were laid out in factorial randomized block design (FRBD) with three replications. Maize variety Pioneer 3377 was taken for study. The results revealed that the profitability of hybrid maize respond significantly with the different treatment combination. The highest cost of cultivation (52700 & 52700 rupees) was obtained with the application of 2.5 tonne vermicompost + 7.5 kg Zinc + 15 kg iron ha^{-1}, gross return (87794.5 & 92072.7 rupees) was obtained with 2.5 tonne vermicompost + 5.0 kg Zinc + 10 kg iron ha^{-1}, net return (39553.5 & 41238.5 rupees) and benefit cost ratio (2.08 & 2.13) was obtained with the application of 5.0 kg zinc + 10 kg iron ha^{-1} during both the years. The treatment combination $M_0Zn_2Fe_2$ was gave superior result in terms of net return and B:C ratio, while maximum gross return was found in treatment $M_1Zn_2Fe_2$ during 2019 and 2020.

Keywords: Hybrid maize, iron, zinc, profitability, vermicompost

1. Introduction

Maize (*Zea mays* L.), a food crop belonging to natural order Graminae is known as corn, *makka* or *makki* stands third among cereals only after paddy and wheat. Maize (*Zea mays* L.) is produced largely worldwide than any other cereal grain and it has a pivotal role in increasing the income of both subsistence and commercial farmers. The primary center of maize is considered to be Central America and Mexico. In India production of maize probably occurred in the beginning of the seventeenth century, during the early days of the East India company. This crop has been developed into a multi dollar business in countries *viz*. Thailand, Taiwan, Singapore, Malaysia, USA, Canada and Germany, because of its potential as a value added product for export and a good food substitute. In India, maize is grown in an area of 9.76 million hectares with production of 28.64 million tonnes (Department of Agriculture, Cooperation and Farmers Welfare 4th Advance Estimates of Production of Food grains for 2019-20). Uttar Pradesh is the major producing state contributing 60 per cent area and 70 per cent of maize production in India. Maize crop occupies fifth place in area and third in production among cereals, its ranks third in the productivity of cereals.

Zinc and iron deficiencies are a growing public health and socio economic issue, particularly in the developing world (Welch and Graham, 2004) [15]. Maize crop is very vulnerable to Zinc deficiency on a widespread scale besides iron, which enters the food chain causing deficiencies in human diet. However, the cereal crops in general are deficient in iron and zinc together with vitamin A deficiency have been identified on the top priority global issue to be addressed to achieve a rapid and significant return for humanity and global stability. Low dietary intake of Fe and Zn appears to be the major reason for the widespread prevalence of Fe and Zn deficiencies in human populations. In countries with high incidence of micronutrients deficiencies cereal based foods represent the largest proportion of the daily diet. Cereal crops are inherently very low in grain Fe and Zn concentrations and growing them on potentially Zn and Fe deficient soils, further reduces Fe and Zn concentration in grain (Cakmak *et al.* 2010) [3]. Thus, bio-fortification of cereal crops with Fe and Zn is a high priority global issue. Iron is available to the body either as haem or non haem or both. Haem iron comes directly from non-vegetarian and non haem from vegetarian diet.

Micronutrient malnutrition affects over 2 billion people in the developed world. Iron deficiency alone affects more than 47 per cent of all pre school aged children globally, often leading to impaired physical growth, mental development and learning capacity. Zinc deficiency, like iron, is thought to affect billions of people, hampering growth and development and destroying the immune system. In many micronutrient deficiency regions, wheat is a dominant staple food making up more than 50 per cent of the diet. Biofortification is improving the genetic architecture of available varieties through plant breeding can improve the nutritional quality of food. (Cakmak *et al.*, 2010) [3] Iron functions as haemoglobin in the transport of oxygen. In cellular respiration, it functions as an essential component of enzymes involved in biological oxidation such as cytochromes *etc.* Iron in ferrous form is more soluble and is readily absorbed than the ferric form. Phytic acid and oxalic acid decreases iron absorption by forming iron phytate and iron oxalate. The absorption of iron is inhibited by profuse diarrhoea, malabsorption syndrome, achlorhydria, dissertation of small intestine and partial or total gastrectomy (Malhotra, 1998) [10].

Langeragan and Webb (1993) [9] defined the impact of zinc deficiency in relation to micronutrient availability if the N rate is high the vegetative and productive development of plants is not hampered under low zinc condition. Iron is an essential element for plants, playing critical roles in respiration, chlorophyll biosynthesis and photosynthetic electron transport. Iron uptake, homeostasis, transport and storage in plant organs are tightly controlled by various transporters and cellular regulators (Marschner, 1995) [11].

Molecular studies are available to strengthen the evidence that remobilization of major nutrients, zinc and iron from vegetative tissue to grain of the plant follows the similar genetic mechanism (Waters *et al.* 2009) [14]. The application of vermicompost may also improve the Fe and Zn content in grain. Maize are basic food of vegetarian diet, it is, therefore, crucial that these are assiduously fortified with zinc and iron to overwhelm the health problm and produce much better yield to improve socio-economic status of farmers.

2. Materials and Methods

2.1 Study Site: A field experiment was conducted at field no. 6 Student's Instructional Farm at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during the *Kharif* season 2019 and 2020. The experimental field was well drained with uniform topography and assured source of water supply through tube well. The farm is situated in the alluvial belt of the indo gangetic plain of central U.P., India.

2.2 Geographical Location: District Kanpur Nagar is situated in subtropical and semi-arid zone and lies between the parallel of 25°26'and 26°58'north latitude and 79°31' and 80°34' east longitude with an elevation of 125.9 m from sea level in the alluvial belt of Indo- gangetic plains of central Uttar Pradesh.

2.3 Experimental Details: The experiment was laid out in factorial randomized block design and replicated thrice. There are three factors comprises different levels of nutrients factor -1st two levels (No vermicompost and 2.5 tonne vermicompost ha^{-1}), factor 2nd four levels of Zinc (No Zn, 2.5 Kg Zn, 5.0 Kg Zn, and 7.5 Kg Zn ha^{-1}), factor 3rd four levels of Iron (No Fe, 5.0 Kg Fe, 10 Kg Fe and 15 Kg Fe ha^{-1}) comprising 32 treatment combinations.

Table 1: Treatment details

S. No.	Treatments	
1	(M_0 Zn_0 Fe_0)	Control
2	(M_0 Zn_0 Fe_1)	Fe @ 5 kg ha^{-1}
3	(M_0 Zn_0 Fe_2)	Fe @ 10 kg ha^{-1}
4	(M_0 Zn_0 Fe_3)	Fe @ 15 kg ha^{-1}
5	(M_0 Zn_1 Fe_0)	Zn @ 2.5 kg ha^{-1}
6	(M_0 Zn_1 Fe_1)	Zn @ 2.5 kg ha^{-1} + Fe @ 5 kg ha^{-1}
7	(M_0 Zn_1 Fe_2)	Zn @ 2.5 kg ha^{-1} + Fe @ 10 kg ha^{-1}
8	(M_0 Zn_1 Fe_3)	Zn @ 2.5 kg ha^{-1} + Fe @ 15 kg ha^{-1}
9	(M_0 Zn_2 Fe_0)	Zn @ 5.0 kg ha^{-1}
10	(M_0 Zn_2 Fe_1)	Zn @ 5.0 kg ha^{-1}+ Fe @ 5 kg ha^{-1}
11	(M_0 Zn_2 Fe_2)	Zn @ 5.0 kg ha^{-1}+ Fe @ 10 kg ha^{-1}
12	(M_0 Zn_2 Fe_3)	Zn @ 5.0 kg ha^{-1}+ Fe @ 15 kg ha^{-1}
13	(M_0 Zn_3 Fe_0)	Zn @ 7.5 kg ha^{-1}
14	(M_0 Zn_3 Fe_1)	Zn @ 7.5 kg ha^{-1} + Fe @ 5 kg ha^{-1}
15	(M_0 Zn_3 Fe_2)	Zn @ 7.5 kg ha^{-1}+ Fe @ 10 kg ha^{-1}
16	(M_0 Zn_3 Fe_3)	Zn @ 7.5 kg ha^{-1}+ Fe @ 15 kg ha^{-1}
17	(M_1 Zn_0 Fe_0)	V.C @ 2.5 ton ha^{-1}
18	(M_1 Zn_0 Fe_1)	V.C @ 2.5 ton ha^{-1}+ Fe @ 5.0 kg ha^{-1}
19	(M_1 Zn_0 Fe_2)	V.C @ 2.5 ton ha^{-1}+ Fe @ 10.0 kg ha^{-1}
20	(M_1 Zn_0 Fe_3)	V.C @ 2.5 ton ha^{-1}+ Fe @ 15.0 kg ha^{-1}
21	(M_1 Zn_1 Fe_0)	V.C @ 2.5 ton ha^{-1}+ Zn @ 2.5 kg ha^{-1}
22	(M_1 Zn_1 Fe_1)	V.C @ 2.5 ton ha^{-1}+ Zn @ 2.5 kg ha^{-1}+ Fe @ 5 kg ha^{-1}
23	(M_1 Zn_1 Fe_2)	V.C @ 2.5 ton ha^{-1}+ Zn @ 2.5 kg ha^{-1}+ Fe @ 10 kg ha^{-1}
24	(M_1 Zn_1 Fe_3)	V.C @ 2.5 ton ha^{-1} + Zn @ 2.5 kg ha^{-1}+ Fe @ 15kg ha^{-1}
25	(M_1 Zn_2 Fe_0)	V.C @ 2.5 ton ha^{-1}+ Zn @ 5.0 kg ha^{-1}
26	(M_1 Zn_2 Fe_1)	V.C @ 2.5 ton ha^{-1} + Zn @ 5.0 kg ha^{-1}+ Fe @ 5 kg ha^{-1}
27	(M_1 Zn_2 Fe_2)	V.C @ 2.5 ton ha^{-1}+ Zn @ 5.0 kg ha^{-1}+ Fe @ 10 kg ha^{-1}
28	(M_1 Zn_2 Fe_3)	V.C @ 2.5 ton ha^{-1} + Zn @ 5.0 kg ha^{-1}+ Fe @ 15kg ha^{-1}
29	(M_1 Zn_3 Fe_0)	V.C @ 2.5 ton ha^{-1} + Zn @ 5.0 kg ha^{-1}
30	(M_1 Zn_3 Fe_1)	V.C @ 2.5 ton ha^{-1} + Zn @ 5.0 kg ha^{-1}+ Fe @ 5 kg ha^{-1}
31	(M_1 Zn_3 Fe_2)	V.C @ 2.5 ton ha^{-1} + Zn @ 5.0 kg ha^{-1}+ Fe @ 10 kg ha^{-1}
32	(M_1 Zn_3 Fe_3)	V.C @ 2.5 ton ha^{-1} + Zn @ 5.0 kg ha^{-1}+ Fe @ 15 kg ha^{-1}

2.4 Application of fertilizers: The crop was fertilized as per treatment. The recommended dose of nutrient i.e. N, P, and K was applied @ 150: 80: 60 kg ha^{-1} respectively.

Table 2: Composition of nutrient applied

S. No.	Nutrient applied	Source	Nutrient content
1	Nitrogen	Urea	46% N
2	Phosphorus	DAP	18% N and 46% P_2O_5
3	Potassium	MOP	60% K_2O
4	Zinc	$ZnSO_4.7H_2O$	21% Zn and 11-18% S
5	Iron	$FeSO_4.7H_2O$	19% Fe and 10.5% S
6.	Organic Manure	Vermicompost	0.50-1.5% N, 0.10-0.30% P and .0.15-0.56% K

2.5 Economics
Economics of the treatment is very important to find out the most profitable treatment and for determining the overall profit from a practical point of view. For computing the economics, different variable cost items were considered. The expenditure on seeds, manures, fertilizers, plant protection, irrigation and labour charges were calculated at prevailing market price during 2020.
Labour requirement was worked out on the basis of labours engaged for performing different field operations. So, economics of different treatments were worked out in terms of cost of cultivation, gross return, net return and benefit: cost ratio (B:C Ratio) to ascertain economic variability of the treatments.

2.5.1 Cost of Cultivation: Analyed the cost of cultivation on the basis of different inputs used for raising the crops under different treatments.

2.5.2 Gross Return: The gross return was calculated plot wise. For this purpose, grain yield was converted into rupees $hectare^{-1}$ at prevailing market price of maize.

2.5.3 Net return: It is the total income obtained after subtracting the cost of cultivation of each treatment from the gross income of the respective treatment plot. Monetary value gained after compensating the spent money can be said as net return. Net return = Gross return – Cost of cultivation

2.5.4 Benefit: Cost Ratio: It is an indicator that attempts to summarize the overall value for money of cultivation. It is the ratio of benefit or net income, expressed in monetary value, relative to the cost of cultivation. It was calculated by dividing the net income of a treatment plot to the cost of cultivation of that particular treatment.

2.6 Statistical Analysis: The experiment was laid out in factorial randomized block design and replicated thrice. The data on various characters studied during the course of investigation were statistically analyzed for factorial randomized block design. Wherever treatment differences were significant ("F" test), critical differences were worked out at five per cent probability level. The data obtained during the study were analyzed statistically using the methods advocated by Chandel (1990) [5].

3. Results
3.1 Biofortification effect of organic manure, zinc and iron on economics of hybrid maize
Economics considered as an effective measure to decide the economic feasibility in order to adjudge the efficiency of different nutrients. Maize is the most important high value crop of central plain zone of uttar pradesh in the current studies organic manure, zinc and iron were ascertained in different combinations in the economics of operation cost including the cost of cultivation, gross return, net return and benefit cost ratio were worked out treatment wise in different combination during both the years to assess the affectivity and feasibility of hybrid maize crop.

3.1.1 Cost of cultivation of hybrid maize
3.1.1.1 Effect of organic manure on cost of cultivation of hybrid maize
It is visualised from the data given in table 3 showed wide variations in cost of cultivation within no vermicompost and application of 2.5 tonne vermicompost ha^{-1} during both the years. Maximum cost of cultivation in rupees 48762.5 was recorded with the application of 2.5 tonne vermicompost ha^{-1} and minimum rupees 35278.1 at control (no organic) during 1st year and 2nd year, respectively.

3.1.1.2 Effect of zinc on cost of cultivation of hybrid maize
Data in regard to cost of cultivation given in table 3 showed narrower and significantly increase in cost of cultivation with the different levels of zinc application during both the years. Highest cost of cultivation rupees 44075 noted with its highest level (7.5 Kg zinc ha^{-1}) and minimum rupees 40200 at control during 1st year and 2nd year, respectively.

3.1.1.3 Effect of iron on cost of cultivation of hybrid maize
It is obvious from the mean data in the table 3 that the cost of cultivation of hybrid maize increased with the increasing levels of iron maximum rupees 43931.25 and its highest level 15 Kg Iron ha^{-1} and minimum 40012.50 at control during both the years. It was also observed that application of different levels of iron showed significant effect on cost of cultivation of hybrid maize during both the years.

3.1.1.4 Effect of interactions on cost of cultivation of hybrid maize
A critical observation of data furnished in table 3 revealed that interactions between O.M X Zn, O.M X Fe, Zn X Fe, O.M X Zn X Fe influenced cost of cultivation significantly except O.M X Zn during both the years. Highest cost of cultivation rupees 52700 was recorded with the application of 2.5 tonne vermicompost + 7.5 Kg zinc + 15 Kg iron ha^{-1} and minimum rupees 31200 at control during 1st year and 2nd year, respectively.

Table 3: Effect of organic manure, zinc and iron on cost of cultivation of hybrid maize

		1st year					2nd year				
Treatments		Zn_0	Zn_1	Zn_2	Zn_3	Mean	Zn_0	Zn_1	Zn_2	Zn_3	Mean
M_0	Fe_0	31200.0	32575.0	33700.0	35450.0	33231.2	31200.0	32575.0	33700.0	35450.0	33231.2
	Fe_1	32950.0	34175.0	35050.0	36700.0	34718.7	32950.0	34175.0	35050.0	36700.0	34718.7
	Fe_2	34200.0	35425.0	36300.0	37950.0	35968.7	34200.0	35425.0	36300.0	37950.0	35968.7
	Fe_3	35450.0	36675.0	37450.0	39200.0	37193.7	35450.0	36675.0	37450.0	39200.0	37193.7

	Mean	33450.0	34712.5	35625.0	37325.0	35278.1	33450.0	34712.5	35625.0	37325.0	35278.1
M_1	Fe_0	44700.0	46325.0	47200.0	48950.0	46793.7	44700.0	46325.0	47200.0	48950.0	46793.7
	Fe_1	46450.0	47575.0	48450.0	50200.0	48168.7	46450.0	47575.0	48450.0	50200.0	48168.7
	Fe_2	47700.0	48825.0	49700.0	51450.0	49418.7	47700.0	48825.0	49700.0	51450.0	49418.7
	Fe_3	48950.0	50075.0	50950.0	52700.0	50668.7	48950.0	50075.0	50950.00	52700.0	50668.7
	Mean	46950.0	48200.0	49075.0	50825.0	48762.5	46950.0	48200.0	49075.0	50825.0	48762.5

Factors	SE(m)	C.D at 5%	SE (m)	C.D at 5%
Organic manure (O.M)	9.775	27.640	7.336	20.743
Zinc	13.824	39.089	10.375	29.335
Iron	13.824	39.089	10.375	29.335
(O.M)Xzinc	19.551	NS	14.672	NS
(O.M)Xiron	19.551	55.280	14.672	41.486
ZincXiron	27.649	78.178	20.749	58.669
(O.M)XZinc X Iron	39.101	110.561	29.344	82.971

3.1.2 Gross return of hybrid maize

3.1.2.1 Effect of organic manure on gross return of hybrid maize

Data in respect to gross return given in the table 4 showed that application of 2.5 tonne vermicompost ha^{-1} significantly increased gross return over control (no organic) during both the years. Gross return of hybrid maize varied from rupees 70391.17 to 78964.96 and 71094.82 to 81705.35 with the application of 2.5 tonne vermicompost ha^{-1} over no organic during 1st year and 2nd year, respectively.

3.1.2.2 Effect of zinc on gross return of hybrid maize

Data in regard to gross return was given in table 4 showed wide variations with the different levels of zinc application during both the years. Maximum gross return rupees 77779.96 to 80140.55 and 71094.82 and 81705.35 were recorded with the application of 5.0 Kg zinc ha^{-1}and at control (no zinc) during 1st and 2nd year, respectively.

3.1.2.3 Effect of iron on gross return of hybrid maize

It is evident from the data delineate in the table 4 that likewise application of different levels of iron also influenced the value of gross return significantly over its control during both the years. Maximum gross return rupees 77787.50 and 79659.25 was noted with the application of 10 Kg iron ha^{-1} and after increasing levels of iron up to 15 Kg ha^{-1} showed non significant decrease in gross return during both the years. Maximum value of gross return rupees 69399.88 and 69918.38 was recorded in control during 1st year and 2nd year, respectively.

3.1.2.4 Effect of interactions on gross return of hybrid maize

Data given in table 4 in regard to the effect of organic manure, zinc, iron and their interactions on gross return showed significant increase in the value of gross return during both the years. Highest value of gross return rupees 78547.83 and 92072.72 was noted with the application of 2.5 tonne vermicompost, 5 Kg Zinc, 10 Kg Iron ha^{-1} and minimum rupees 61576.91 and 60610.96 at in treatment $M_0Zn_0Fe_0$ during 1st year and 2nd year, respectively.

Table 4: Effect of organic manure, zinc and iron on the gross return of hybrid maize

		1st year					2nd year				
Treatments		**Zn_0**	**Zn_1**	**Zn_2**	**Zn_3**	**Mean**	**Zn_0**	**Zn_1**	**Zn_2**	**Zn_3**	**Mean**
M_0	Fe_0	61576.9	65262.1	67725.1	67410.1	65484.3	61610.9	65484.4	68021.2	67409.9	65632.3
	Fe_1	65872.9	69817.3	72447.0	72113.5	70058.0	65925.3	70169.0	73465.3	72983.2	70631.8
	Fe_2	68964.7	73094.3	75853.5	75501.5	73353.5	69242.3	74075.6	77538.5	76853.1	74427.3
	Fe_3	68335.4	72428.1	75168.7	74816.6	72687.2	68631.5	73427.8	76853.6	76168.2	73761.0
	Mean	66187.52	70150.5	72798.6	72446.5	70391.1	66354.0	70779.9	73965.0	73298.1	71094.8
M_1	Fe_0	65261.8	70484.1	74410.1	73761.7	70965.5	65594.9	72150.6	76743.3	76076.4	72632.0
	Fe_1	71798.6	77539.3	81835.6	81131.7	78076.3	72798.4	80076.2	85168.8	84427.8	80613.2
	Fe_2	77020.0	83186.6	87794.5	87019.6	83742.1	78704.9	86576.3	92072.7	91297.1	87148.6
	Fe_3	76372.2	82464.8	84507.3	86257.8	83038.8	78038.6	85835.0	91297.8	90519.8	86408.9
	Mean	72613.1	78409.5	82761.3	82038.87	78964.9	73779.6	81150.0	86316.0	85585.7	81705.3

Factors	SE(m)	C.D at 5%	SE (m)	C.D at 5%
Organic manure (O.M)	10.082	28.508	9.393	26.560
Zinc	14.259	40.317	13.284	37.561
Iron	14.259	40.317	13.284	37.561
(O.M)Xzinc	20.165	57.017	18.786	53.120
(O.M)Xiron	20.165	57.017	18.786	53.120
ZincXiron	28.517	80.634	26.568	75.122
(O.M)XZinc X Iron	40.329	114.034	37.573	106.239

3.1.3 Net return of hybrid maize

3.1.3.1 Effect of organic manure on net return of hybrid maize

Data in regard to net return depicted in table 5 showed wide variations within no organic and organic combinations during both the years. Maximum net return 35113.04 and 35816.69 was recorded in control without organic manure treatment which was significantly higher with the application of 2.5 tonne vermicompost ha^{-1} 29849.61 and 32942.85 during 1st year and 2nd year, respectively.

3.1.3.2 Effect of zinc on net return of hybrid maize

Data furnished in table 5 showed that application of different levels of zinc influenced significantly net return over control during both the years. Maximum net return rupees 35429.96 and 37790.55 recorded with the application of 5.0 kg zinc ha^{-1} and minimum rupees 29200.34 and 29866.82 at control during 1st year and 2nd year, respectively. It was also observed that application of zinc above 5.0 Kg ha^{-1} showed negative effect on net return up to its higher level 7.5 Kg zinc ha^{-1} during both the years.

3.1.3.3 Effect of iron on net return of hybrid maize

Data in evident to the effect of different levels of iron application on net return given in table 5 revealed significant increased in net return at all the levels of iron over control during both the years. Highest values of net return rupees 35854.08 and 38094.27 was obtained with application of 10 Kg iron ha^{-1} and minimum value of rupees 28212.46 and 29119.72 was noted at control during 1st year and 2nd year, respectively.

3.1.3.4 Effect of interactions on net return of hybrid maize

The data shown in the table 5 in regard to interaction between O.M X Zn, O.M X Fe, Zn X Fe, O.M X Zn X Fe showed significant increase in net return during both the years. Maximum net return in rupees 38094.50 and 42372.72 was recorded with no organic manure + 5 Kg zinc + 15 Kg iron ha^{-1} and minimum value rupees 30376.91 and 30413.96 with the application of 2.5 tonne vermicompost + no zinc + no iron combination during 1st year and 2nd year, respectively.

Table 5: Biofortification effect of organic manure, zinc and iron on the net return of hybrid maize

		1st year					2nd year				
Treatments		**Zn_0**	**Zn_1**	**Zn_2**	**Zn_3**	**Mean**	**Zn_0**	**Zn_1**	**Zn_2**	**Zn_3**	**Mean**
M_0	Fe_0	30376.9	32687.1	34025.1	31960.1	32253.1	30413.9	32909.4	34321.2	31959.9	32401.1
	Fe_1	32922.9	35642.3	37397.0	35413.5	35339.3	32975.3	35994.0	38415.3	36283.2	35913.1
	Fe_2	34764.7	37669.3	39553.5	37551.5	37384.8	35042.3	38650.6	41238.5	38903.1	38458.6
	Fe_3	32885.4	35753.1	37718.7	35616.6	35493.4	33181.5	36752.8	39403.6	36968.2	36567.3
	Mean	32737.5	35438.0	37173.6	35121.5	35113.0	32904.0	36067.4	38340.0	33973.1	35816.6
M_1	Fe_0	20561.8	24159.1	27210.1	24811.7	24171.8	20894.0	25825.6	29543.3	27126.4	25838.3
	Fe_1	25348.6	29964.3	33385.6	30931.7	29907.6	26348.4	32501.2	36718.8	34227.8	32444.4
	Fe_2	29320.0	34361.6	38094.5	35569.6	34336.3	31004.9	37751.3	42372.7	39847.1	37729.9
	Fe_3	27422.2	32389.8	33557.3	33557.8	32370.0	29088.6	35760.0	40347.8	37819.8	35740.2
	Mean	25663.1	30209.5	32311.9	31213.8	29849.6	26829.6	32950.0	37241.0	34750.7	32942.8

Factors	SE(m)	C.D at 5%	SE (m)	C.D at 5%
Organic manure (O.M)	11.492	32.495	11.860	33.534
Zinc	16.252	45.955	16.772	47.425
Iron	16.252	45.955	16.772	47.425
(O.M)Xzinc	22.984	64.989	23.720	67.069
(O.M)Xiron	22.984	64.989	23.720	67.069
ZincXiron	32.505	91.909	33.545	94.850
(O.M)XZinc X Iron	45.969	129.979	47.440	134.138

3.1.4 Effect of organic manure, zinc and iron on benefit cost ratio of hybrid maize

3.1.4.1 Effect of organic manure on benefit cost ratio of hybrid maize: The data concerning the effect of organic manure application on benefit cost ratio showed negative impact on benefit cost ratio during both the years. Highest benefit cost ratio 1.99 and 2.01 was recorded with the without application of organic manure treatment and minimum benefit cost ratio 1.61 and 1.67 with application of 2.5 tonne vermicompost during 1st and 2nd year, respectively. (Table 6)

3.1.4.2 Effect of Zinc on benefit cost ratio of hybrid maize

The visualised data given in the table 6 revealed that application of different levels of zinc showed significant increasing effect on benefit cost ratio over its control (no zinc) during both the years. Highest benefit cost ratio 1.86 and 1.91 was recorded with the application of 5.0 Kg zinc ha^{-1} and minimum 1.75 and 1.77 at control (no zinc) during 1st year and 2nd year, respectively.

3.1.4.3 Effect of Iron on benefit cost ratio of hybrid maize

Data putative the effect of discreate levels of iron application on the benefit cost ratio embodied in the table 6 revealed that application of different levels of iron significantly influenced the benefit cost ratio during both the years. Highest value of benefit cost ratio 1.86 and 1.91 was noted at the level of iron 10 Kg ha^{-1} and minimum value 1.74 and 1.76 at control during 1st year and 2nd year, respectively.

3.1.4.4 Effect of interactions on benefit cost ratio of hybrid maize

Data in regard to interaction effect of O.M X Zn, O.M X Fe, Zn X Fe, O. M X Zn X Fe given in table 6 showed significant impact on benefit cost ratio during both the years. Highest value of benefit cost ratio 2.08 and 2.13 was noted with no organic manure + 5.0 Kg Zinc + 10 Kg Iron ha^{-1} and minimum 1.45 and 1.46 with the application of 2.5 tonne vermicompost + no zinc + no iron combination during 1st and 2nd year, respectively.

Table 6: Biofortification effect of organic manure, zinc and iron on benefit cost ratio of hybrid maize

		1st year					2nd year				
Treatments		**Zn_0**	**Zn_1**	**Zn_2**	**Zn_3**	**Mean**	**Zn_0**	**Zn_1**	**Zn_2**	**Zn_3**	**Mean**
M_0	Fe_0	1.97	2.00	2.00	1.90	1.97	1.97	2.01	2.01	1.90	1.97
	Fe_1	1.99	2.04	2.05	1.96	2.01	2.00	2.05	2.09	1.98	2.04
	Fe_2	2.01	2.06	2.08	1.98	2.03	2.02	2.09	2.13	2.02	2.06
	Fe_3	1.92	1.97	2.00	1.90	1.95	1.93	2.00	2.05	1.94	1.98
	Mean	1.97	2.02	2.04	1.94	1.99	1.98	2.03	2.07	1.96	2.01

M_1	Fe_0	1.45	1.52	1.57	1.50	1.50	1.46	1.55	1.62	1.55	1.55
	Fe_1	1.54	1.62	1.68	1.61	1.62	1.56	1.68	1.75	1.68	1.67
	Fe_2	1.61	1.70	1.65	1.69	1.69	1.64	1.77	1.85	1.77	1.76
	Fe_3	1.56	1.64	1.59	1.63	1.63	1.59	1.71	1.79	1.71	1.70
	Mean	1.54	1.62	1.68	1.61	1.61	1.57	1.68	1.75	1.68	1.67
Factors		SE(m)			C.D at 5%		SE (m)			C.D at 5%	
Organic manure (O.M)		0.001			0.002		0.001			0.002	
Zinc		0.001			0.003		0.001			0.003	
Iron		0.001			0.003		0.001			0.003	
(O.M)Xzinc		0.001			0.004		0.001			0.004	
(O.M)Xiron		0.001			0.004		0.001			0.004	
ZincXiron		0.002			0.005		0.002			0.006	
(O.M)XZinc X Iron		0.003			0.008		0.003			0.008	

4. Discussion

Economics of hybrid maize is embodied in table 3 to 6 on cost of cultivation (Rs.), gross return (Rs.), Net return (Rs.), Benefit: Cost ratio reveal that application of different levels of organic manure, zinc and iron alone or in combination affect on cost of cultivation (Rs.), gross return (Rs.), Net return (Rs.), Benefit: Cost ratio during both the years.

Maximum cost of cultivation (48762.5 & 48762.5 rupees) and gross return (78964.9 & 81705.3 rupees) was recorded with the application of 2.5 tonne vermicompost ha^{-1} over no organic manure application while maximum net return (29849.6 & 32942.8 rupees) and benefit: cost ratio (1.61 & 1.67) was recorded with no organic manure application over application of 2.5 tonne vermicompost ha^{-1} during both the years.

Application of different levels of zinc reflected significantly cost of cultivation (Rs.), gross return (Rs.), Net return (Rs.), Benefit: Cost ratio during both the years. Maximum cost of cultivation (44075 & 44075 rupees) was recorded with the application of highest level of zinc 7.5 Kg ha^{-1} while maximum gross return (77779.9 & 80140.5 rupees), Net return (35429.9 & 37790.5 rupees), Benefit: Cost ratio (1.86 & 1.91) was noted with the application of 5.0 Kg zinc ha^{-1} and minimum at control (Zn_0) during both the years.

Likewise zinc maximum cost of cultivation (42931.2 & 42931.2 rupees) was also recorded with the application of 15 Kg iron ha-1 and maximum gross return (78547.8 & 80788.0 rupees), Net return (35854 & 38094.2 rupees), Benefit: Cost ratio (1.81 & 1.91) was recorded with the application of 10 Kg iron ha^{-1} and minimum at control during both the years.

Vermicompost (2.5 tonne) + 7.5 Kg zinc + 15 Kg iron ha^{-1} envolved in the highest cost of cultivation (52700 & 52700 rupees) and vermicompost (2.5 tonne) + 5.0 Kg zinc + 10 Kg iron ha^{-1} was recorded highest gross return (87794.5 & 92072.7) and minimum at control ($M_0Zn_0Fe_0$), while maximum Net return (38094.5 & 42372.7 rupees) and Benefit: Cost ratio (2.08 & 2.13) was recorded with 5.0 Kg zinc + 10 Kg iron ha^{-1} ($M_0Zn_2Fe_2$) minimum with the application of 2.5 tonne vermicompost ha^{-1} ($M_1Zn_0Fe_0$) during both the years.

It is interesting to report here that 5.0 Kg zinc + 10 Kg iron ha^{-1} ($M_0Zn_2Fe_2$) was found economically superior (B:C 2.08 and 2.13) in comparison to other combinations that might be due to less cost incurred and obtain maximum gross return. These findings are enlining the finding of Badiyala and Chopra (2011) [1], Bisht *et al.* (2012) [2], Chand *et al.* (2017) [4], Tahir *et al*. (2016) [13], Patil *et al*. (2017) [12] and Durgude *et al.* (2014) [8].

5. Conclusion

From the above results it can be concluded that the maximum net return and benefit cost ratio was found with the application of 5.0 kg zinc + 10 kg iron ha^{-1}, while gross return was gave superiority with 2.5 tonne vermicompost + 5.0 kg zinc + 10 kg $iron^{-1}$ application during crop seasons 2019 and 2020.

6. References

1. Badiyala D, Chopra P. Effect of zinc and FYM on productivity and nutrient availability in maize (*Zea mays*) - linseed (*Linum usitatissimum*) cropping sequence. Indian Journal of Agronomy 2011;56(2):88-91.
2. Bisht AS, Bhatnagar A, Pal MS, Singh V. Growth dynamics, productivity and economics of Quality Protein Maize (*Zea mays* L.) under varying plant density and nutrient management practices. Madras Agricultural Journal 2012;99(1-3):73-76.
3. Cakmak I, Pfeiffer WH, McClafferty B. Biofortification of durum wheat with zinc and iron. Cereal chemistry 2010;87(1):10-20.
4. Chand SW, Sucheela R, Sreelatha D, Shanti M, Hussain SA. Effect of zinc fertilization on yield and economy of baby corn (*Zea mays* L.). Journal of Phamacognosy and Phytochemistry 2017;6(5):989-992.
5. Chandel SRS. A handbook of agriculture statistics, Achal Prakashan mandir, Pandu Nagar, Kanpur 1990, 843-853.
6. DMR (Directorate of Maize Research) annual report 2011, (page no-16).
7. DMR (Directorate of Maize Research) annual report 2012, (page no-36).
8. Durgude AG, Kadam SR, Pharande AL. Effect of soil and foliar application of ferrous sulphate and zinc sulphate on nutrient availability in soil and yield of *Bt* cotton. Asian J Soil Sci 2014;9(1):82-86.
9. Langeragan JF, Webb MJ. Interaction between zinc and other nutrients affecting the growth of plants. In: Robson, A. D. (ed.). Zinc in Soils and Plants. Kulwer Academic Publishers, Dordrecht, the Netherlands 1993, 119-134.
10. Malhotra VK. Biochemistry for Students. 10th Edition, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India 1998.
11. Marschner H. Mineral Nutrition of Higher Plants (2nd Edition), Academic Press Inc., USA 1995.
12. Patil S, Girijesh GK, Nandini KM, Kiran Kumar, Pradeep LS, Ranjith Kumar TM. International Journal of Pure and Applied Biosciences 2017;5(1):246-253.

13. Tahir M, Nasir MA, Sheikh AA, Ibrahim M, Haseeb-ur-Rehman, Majeed MA. Effect of zinc sulphate as foliar application on the yield and quality of maize. Pakistan Journal of Life and Social Sciences 2016, 1-4.
14. Waters BM, Uauy C, Dubcovsky J, Grusak MA. Wheat (Triticum aestivum) NAM proteins regulate the translocation of iron, zinc, and nitrogen compounds from vegetative tissues to grain. Journal of experimental botany 2009;60(15):4263-4274.
15. Welch RM, Graham RD. Breeding for micronutrients in staple food crops from a human nutrition perspective. J Exptl. Bot 2004;55:353-364.