Original Research Article

BIOFORTICATION OF ZINC AND IRON THROUGH FORTIFIED ORGANICS ALONGWITH NPK LEVELS ON THE QUALITY, NUTRIENT UPTAKE AND PRODUCTIVITY OF BRINJAL IN COASTAL SALINE SOIL

ABSTRACT

To evaluate the response ofzinc and iron fortified organic manure along with NPK levels on nutrient content, uptake and productivity of brinjal in coastal saline soil, a field experiment was conducted infarmer's field at Ponnanthittu coastal village, near Chidambaram, Cuddalore District, Tamilnaduwith brinjal var. Annamalai during August – December 2022. The experiment was laid out in a factorial randomized block design (FRBD) with four levels of NPK (0, 100, 125, 150%) and three levels of micronutrients (Zn and Fe) fortified organics like 100% Zn Fortified Composted Coir pith (ZnFCCP), 100% Fe Fortified Composted Coir pith (FeFCCP) and 100% Zn + Fe Fortified Composted Coir pith (Zn+FeFCCP) @ 6.25 t ha^{-1} ,respectively). The result showed that individual and combined application of 150% of NPK along with 100% Zn + Fe Fortified Composted Coir pith (Zn+FeFCCP) @ 6.25 t ha^{-1}excelledover other treatments and recorded higher valueson growth (plant height, number of branches $plant^{-1}$, Dry matter production), yield (fruit and stover), nutrient content and uptake (nitrogen, phosphorus, potassium, iron and zinc)of brinjal in coastal saline soil.

Key words:*Biofortification, zinc, iron, fortified organic manures, brinjal, coastalsaline soil*

INTRODUCTION

Brinjal (or) eggplant (*Solanummelongena*.) is one of the major vegetable crops grown in almost all parts of the world in tropical season.Brinjal is considered as "poor man's vegetables" and it having medicinal properties such as the potential to reduce cholesterol levels, rich in minerals, vitamins and essential amino acids; and provide valuable nutrient supplement in the tropical diet. India is the second largest producer of vegetables in the world (ranks next to china) and accounts for about 15 per cent of the world's production of vegetables. In India, it covers an area around 0.68 million ha with production of 11.89 million tonnes of fruits with an average productivity of 17.5 tonnes per hectare.In Tamilnadu, the area under cultivation of brinjal is 7170 hectares with a production of about 7597 tonnes and productivity is 10.69 tonnes per hectare.The coastal agro system spreads around 8,129 km coastline of the country. Tamil Nadu occupies 6,80,622 ha of coastal area constituting 26.8 per cent of the total area of the coastal districts. The major limiting factor of crop production in this coastal region is salinity, acidity, waterlogging and sandy texture. Out of 10.78 M ha ofland under coastal agro ecosystem in India, about 7.31 M ha of land is saline (Arulmathiand Porkodi, 2020). Brinjal is one of the commonly grown vegetable crops in coastal areas of Tamil Nadu. Soil fertility is the most limiting factor for crop production in coastal sandy soil. Sandy soils have specific soil constraints *viz.,* light texture, poor exchange property, low nutrient and water retention capacity, low status of organic carbon and deficiency of both macro and micronutrients. Salinity affects the crop growth through altering physical properties of soil, increasing osmotic potential, reduced uptake ofboth nutrient and water and reduction in microbial activity. Brinjal is moderately salt tolerance but increase in salinity, absorption of nutrients like NPK, Ca and Mg, Zn and Fe by brinjal fruit; root and plant body is decreased.

Zinc is essential for formation of growth promoting and growth regulating compounds in brinjal plants.It is also involved in enzyme system and produce auxin in plant system. Deficiency of Zinc causes leaf discoloration, stunting reduced height, brown spots on upper leaves, distorted leaves, interveinalchlorosis which spread later to younger leaves (Bhuvaneswari*et al*., 2020). Iron (Fe) is also more important micronutrient in plant biochemical reactions which can directly or indirectly increase the performance of crops (Zarghamnejad*et al.,* 2015). Fe has a number of important functions within plants, including photosynthesis, respiration and chlorophyll synthesis. Further, many of metabolic pathways and enzymes are activated by iron. Deficiency of iron produces initially results in interveinalchlorosis near the base of older leaves followed by entire leaf including veins exhibit chlorotic symptoms with death of the entire plant at severe condition.

Micronutrient deficiency is one of the problems that limit the crop yield and nutritional quality that affect human health especially in coastal saline area. One way to alleviate nutrientdeficiency is through agronomic biofortification of staple foods. Biofortification is one of the techniques to improve the nutritional quality of food crops. In order to increase certain micronutrient contents in the edible part of crops, fertilizing soils or plant leaves with certain mineral micronutrient fertilizers or biofortification of organics with micronutrients to alleviate micronutrient deficiencies among humans. The impact of agronomic biofortification largely depends on the bioavailability of micronutrients throughout the entire pathway/ entire crop growth periods from soil to plant, from plant to food and uptake by the human body (Ali *et al*., 2021). So this study is conducted to evaluate the response of Zinc and Iron fortified organic manure with NPK levels on the nutrient content, uptake and productivity of brinjal in coastal saline soil.

MATERIALS AND METHODS

An experimental study was conducted in the farmer's field at Ponnanthittu coastal village, near Chidambaram, Cuddalore District, Tamil Nadu. The experimental site is geographically located at 11°24′N latitude, 79°44′E longitudes and altitude of +5.79 M above mean sea level (MSL).The climate is moderately warm with a hot humid summer. The experimental soil was sandy in texture and taxonomicallyclassified as *Typicusticpsaments*.The physico- chemical characteristics of experimental soil was saline sandy with pH- 8.37, EC- 1.58 dS m^{-1} andlow status of organic carbon (2.31 g kg^{-1}). The available nutrient status viz., alkaline $KMnO_4$-N(135.56 kg ha^{-1}), Olsen-P(9.45 kg ha^{-1})and NH_4OAC-K (157.30 kg ha^{-1})were low, low and medium, respectively. The available zinc (0.69 mg kg^{-1}) and iron content (3.87 mg kg^{-1}) of soil is below the critical level, respectively. The treatments included were four levels of NPK viz., A_1- Control (0% NPK), A_2-100% NPK, A_3-125% NPK and A_4-150% NPK were used as treatments in main plots as factor-A along with the three fortification levels of micronutrients*viz.*,B_1- 100% Zn Fortified Composted Coir pith (ZnFCCP), B_2-100% Fe Fortified Composted Coir pith (FeFCCP) and B_3 - 100% Zn + Fe Fortified Composted Coir pith (Zn+FeFCCP) @ 6.25 t ha^{-1} as factor-B. The experiment was laid out in a factorial randomized design (FRBD) with three replications. The test crop was brinjal var. Annamalai brinjal. N (100 kg N ha^{-1}), P (150 kg P_2O_5 ha^{-1}) and K (100 kg K_20 ha^{-1}) were applied through urea, super phosphate and muriate of potash respectively. Half of the N and entire P and K were applied as basal and remaining half N was applied in two splits at flowering and fruit formation stage. Micronutrients fortified organics as per the requirement of various treatments were applied. The growth parameters viz.,plant height, number of branches $plant^{-1}$, dry matter production were recorded at harvest, whereas yield components *viz.*, number of fruits $plant^{-1}$, fruit length and single fruit weight and yield was recorded at each harvest.The growth parameters are observed from the average of five tagged plants.Chemical analysis of plant samples were carried out by following standard methods such as Micro Kjeldahl'sDiacid extraction (Humphries, 1956) for nitrogen, Vanadomolybdate yellow colour method (Jackson, 1973) for phosphorus, Flame photometry (Toth and Prince, 1949)for potassium and Atomic Absorption Spectrophotometer method (Jackson, 1973) for Iron and Zinc. The total uptake of individualnutrients was computed by multiplying the respective nutrient content with DMP. The data obtained were statistically analyzed as suggested by Gomez and Gomez (1984). For significant results, the critical difference was worked at five per cent probability level.

RESULT AND DISCUSSION

Growth parameters of brinjal (Table 1)

Application of different levels of NPK along with micronutrients fortified composted coirpitheither through zinc or iron alone and or both significantly increased the growth characters like plant height, number of branches plant^{-1} and dry matter production of brinjal. The result showed that there is an increase growth characters with increasing levels of NPK from 0 to 150 per cent. Among the various levels of NPK evaluated, application of 150% NPK (A_4) recorded the highest plant height (100.05 cm), number of branches plant^{-1} (34.80), Dry matter production (20.55 t ha^{-1})of brinjal, respectively. This was found to be on par with application of 125% NPK (A_3). The lowest growth characters were noticed in control (without NPK). As experimental soil was low in all the available nutrients, the increase in NPK level than recommended dose has provided nutrients which are optimum for the plant growth which resulted in highest growth characters at 150% than other NPK levels. This is accordance with Hariyadi*et al.*, (2020).

Among the various fortified composted coirpith through zinc and iron tried, application of fortified composted coirpith through zinc and iron @ 6.25 t ha^{-1} (B_3) was superior over iron fortified (B_2) alone and zinc fortified (B_1) alone which recorded the higher mean plant height(93.70 cm), number of branches plant^{-1}(33.53) anddry matter production (18.98 t ha^{-1})of brinjal. This was followed by application of fortified composted coir pith through Zn @ 6.25 t ha^{-1} (B_1). The lowest mean growth parameters were recorded with application of fortified composted coir pith through Fe @ 6.25 t ha^{-1} (B_2) at all growth stages.Improved growth characters due to fortified organic manures might be due to the increased micronutrient content than normal content in manure which increased the availability of micronutrient to plant. Application of organic manure has increased the water holding capacity, microbial activity, reduced soluble salts in soil-water, lowered osmotic potential of the soil water and lower leaf water potential required to sustain transpiration. This is findings with Ramamoorthy*et al.*, (2018).

Interaction effect between various levels of NPK and CCP fortified with zinc alone or iron alone or combination of both on the plant height of brinjal was significant. The treatment

(A_4B_3), which received 150% NPK and Zn + Fe FCCP @ 6.25 t ha^{-1}recorded a highest plant height of 103.74 cm, number of branches plant^{-1} of 35.67, dry matter production of 21.56 t ha^{-1} at the harvest stage, respectively. However, it was found to be on par with 125% NPK and Zn + Fe FCCP @ 6.25 t ha^{-1} (A_3B_3). The treatment A_4B_2 and A_3B_2were next in order.The control (A_1B_2) registered the lowest growth parameters of brinjal at all the stages of crop growth. Increased growth characters of brinjal might be due to combination of organics with 150% NPK which improved the physical conditions of the soil which provided better aeration and water to plant root, facilitation of cations exchange with sustained availability of nutrients throughout the crop growth and increased uptake by the plants resulting in better growth. This is similar with findings of Manimegala and Gunasekaran (2020).

Yield parameters and yield of brinjal (Table 2)

Yield components such as fruit length, single fruit weight and number of fruits plant^{-1}and yield of brinjal were significantly increased due to different levels of NPK and different combinations of fortified organic fertilizers application.

Among the different levels of NPK, application of NPK @ 150 %(A_4) recorded the highest mean fruit length(29.21 cm), single fruit weight (48.83 g) and number of fruits plant^{-1} (29.16), fruit yield (50.51 t ha^{-1})and stover yield (41.99 t ha^{-1}).However, it was found to be equally efficacious with application of NPK @ 125%. The lowest was registered with control.Among the three different combination of fortified organics tried, application of Zn+Fe FCCP @ 6.25 t ha^{-1} (B_3) was significantly superior to other combination in increasing fruit length(27.63 cm), single fruit weight (45.81 g) and number of fruits plant^{-1} (27.55 g),fruit yield (48.13 t ha^{-1}) and stover yield (40.08 t ha^{-1}). This was followed by the application Zn FCCP @ 6.25 t ha^{-1} (B_1) and least were withFeFCCP (B_2).

The interaction effect between NPK levels and fortification of Zn + Fe both or either Zn or Fe alone through CCP on yield characters of brinjal was significant. The treatment A_4B_3, which received 150% NPK along with Zn + Fe FCCP @ 6.25 t ha^{-1} recorded the highest fruit length(30.31 cm), single fruit weight (50.87 g) and number of fruits plant^{-1} (30.26), fruit yield (52.11 t ha^{-1})and stover yield 43.27 t ha^{-1} compared to other treatment combinations. However, it was found to be on par with 125% NPK along with Zn + Fe FCCP @ 6.25 t ha^{-1} (A_3B_3). The lowest yield character of brinjal was registered in sole fortified treatment (A_1B_2).Increased yieldscould be due to the application of fortified CCP with increased NPK fertilizers which attributed to the supply of nutrients through mineralization and improvement in physico-chemical properties of the soil might be reason for increased yield. This is in findings with Abou El-Magd*et al.*(2008) and Kader and Linberg (2010).

Quality parameters of brinjal (Table 3&4)

The quality parameters of brinjal *viz.*, Ascorbic acid content, crude protein content, titrable acidity, total soluble solid, zinc content and iron content was statistically enhanced by application of different levels of NPK and Zn + Fe FCCP.

Among the different levels of NPK evaluated, application of 150% NPK (A_4) recorded the highest mean ascorbic acid content, crude protein content, titrable acidity, total soluble solid, zinc content and iron content in the brinjal. It recorded 15.79 mg 100 g^{-1} fruit, 3.76%, 1.73%, 14.86%, 22.30% and 5.22%, respectively and this was comparable with the treatment A_3, the application of 125% NPK recorded a ascorbic acid content, crude protein content, titrable acidity, total soluble solid, zinc content and iron content of 15.62 mg 100 g^{-1} fruit, 3.71%, 1.70%, 14.63%, 22.05% and 5.16%, respectively at the above said critical stages of brinjal. This was followed by the treatments A_2 and A_1 (control). Among the various combination of fortified organic fertilizer tried, application of Zn+Fe FCCP @ 6.25 t ha^{-1} (B_3) recorded the highest ascorbic acid content, crude protein content, titrable acidity, total soluble solid, zinc content and iron content of 14.66 mg 100 g^{-1} fruit, 3.35%, 1.50%, 13.74%, 20.81% and 4.80%, respectively. However, this was followed by the application of sole fortified organics through zinc and iron (B_2) and (B_1).

The interaction effect between different levels of NPK and FCCP on the quality parameters of brinjal was significant. Application of 150% NPK along with Zn+Fe FCCP @ 6.25 t ha^{-1} (A_4B_3) registered the highest ascorbic acid content, crude protein content, titrable acidity, total soluble solid, zinc content and iron content of 16.59 mg 100 g^{-1} fruit, 3.95%, 1.85%, 15.63%, 23.25% and 5.51%, respectively. This was equally efficient with treatment (A_3B_3) which received125% NPK along with Zn+Fe FCCP @ 6.25 t ha^{-1} and recorded the ascorbic acid content, crude protein content, titrable acidity, total soluble solid, zinc content and iron content of 16.49 mg 100 g^{-1} fruit, 3.92%, %, 1.84%, 15.45%, 23.08% and 5.47% of brinjal, respectively. This was followed by the treatments A_4B_1 and A_4B_2. The lowest quality parameter of brinjal was recorded in Fe alone fortified treatment.

The improvement in quality of brinjal with the application of 125% recommended NPK along with Zn + Fe fortified CCP @ 6.25 t ha^{-1} was well evidenced. Application of inorganic nutrients both macro and micronutrients along with fortified organics namely composted coirpith through soil might have increased the nutrient availability which resulted in better accumulation of N content and hence the protein content in fruit (Olaniyi*et al.*, 2010). Further, micronutrients like zinc and iron helps in synthesis of metabolites and rapid translocation of photosynthetic products and minerals from other parts of plants to developing fruits. Similar results were earlier made byOladipo and Ishola, (2020). Further, the combined application of Zn and Fe fortified composted coirpith along with 125% recommended dose of NPK fertilizers recorded the highest ascorbic acid content, crude protein content, titrable acidity, total soluble solid, zinc and iron content in brinjal fruit. Increased ascorbic acid, titrable acidity and protein content could mainly be due to cumulative effect of these treatments on these parameters. Further, higher nutrient availability due to NPK + fortified organics addition resulted in greater accumulation of nutrients the fruits with high crude protein content, ascorbic acid and titrable acidity content. Similar results of NPK and fortified organic manures application with the earlier findings of Ram *et al*, (2016) and NehaAgarwal*et al*, (2020).

Macro nutrients uptake (Table 5)

Application of different levels of NPK along with micronutrients fortified organics positively increased the uptake of nitrogen,phosphorus and potassium by both fruit and stover of brinjal.

Among the different levels of NPK studied, application of 150% NPK (A_4) registered the highest nitrogen(57.85and 31.64kg ha^{-1}), phosphorus (14.43 and 9.73 kg ha^{-1}) and potassium (55.67 and 30.23 kg ha^{-1}) uptake by fruit and stover, respectively. However, this was equally efficient with 125% NPK (A_3) application. This was followed by the treatments A_2(100% NPK) and A_1 (Control/ no NPK).Among the various combination of fortified organic manure evaluated application of Zn + Fe FCCP @ 6.25 t ha^{-1} (B_3) recorded the highest N(52.75 and 29.22 kg ha^{-1}), P (13.25 and 8.81 kg ha^{-1}) and K (51.33 and 28.08 kg ha^{-1}) uptake by fruit and stover of brinjal, respectively.This was followed by application of Zn FCCP @ 6.25 t ha^{-1} (B_1), which recordednitrogen (49.19 and 27.29 kg ha^{-1}), phosphorus (12.51 and 8.22 kg ha^{-1}) and potassium uptake (48.66 and 26.65 kg ha^{-1}) by fruit and stover in brinjal, respectively. Lowest NPK uptake was recorded with application of Fe sole fortification with CCP (B_2).

A significant interaction effect due to different levels of NPK and different combination of fortified organic manures on the major nutrients (NPK) uptake by brinjal was significantly noticed. Application of 150% NPK along with Zn+Fe FCCP @ 6.25 t ha^{-1} (A_4B_3), registered highest nitrogen (61.23 and 33.97 kg ha^{-1}), P (15.11 and 10.29 kg ha^{-1}) and K (58.17 and 31.69 kg ha^{-1}) uptake by fruit and stover of brinjal, respectively. However, this was comparable with 125% NPK along with Zn+Fe FCCP @ 6.25 t ha^{-1} (A_3B_3), which recorded a comparable nitrogen, phosphorus and potassium uptakeby brinjal fruit (60.42, 14.88 and 57.24 kg ha^{-1}) and stover (33.68, 10.16 and 31.41kg ha^{-1}), respectively. This was followed by the treatment pairs like A_4B_1 and A_4B_2. The control (A_1B_2) registered the lowest NPK uptake by brinjal.

The increased NPK uptake by brinjal with application of increased dose of NPK along with Zn and Fe fortified composted coirpithmay be due improvement of the soil environment which encouraged proliferation of roots resulting in more absorption of water and nutrients from larger rhizosphere. Moreover, Zn and Fefortifiedcomposted coirpith, during decomposition release nutrients which became available to the plants and thus increased NPK concentration. Further, combined application of plant nutrients results in more uptakes of them as compared to sole use of fortified organics or inorganic NPK alone and control. This may be due to the fact that the balanced and combined use of various plant nutrient sources results in proper absorption, translocation and assimilation of those nutrients, ultimately increasing the dry matter accumulation and nutrient contents of plant and thus showing more uptake of NPK nutrients. Similar findings were reported by Uikey*et al*, (2018) and Rehan*et al*, (2020).

Increase in yields of brinjal could be due to decomposition of organic matter release the nutrients required for the growth of plant. Further, it also releases organic acids which reduce the pH which increase the availability of native nutrients which improve the nutrient absorption and increase in nutrient content in plant. Zinc and iron fortified with organics and increased NPK result in increased nitrogenease activity which increases the nutrient uptake with increase in nutrient content in plant (Anburani and Manivannan, 2002 and Malik and Maqbool, 2020).

Micronutrients uptake (Figure 1)

The micronutrientsuptake of brinjal *viz.,* zinc and iron were statisticallysignificantby application of different levels of NPK and different combination of fortified organic manures.

Among the different levels of NPK studied the highest Zn(272.59 and 202.26 g ha-1) and Fe (564.85 and 392.26 g ha^{-1}) by brinjal fruit and stover, respectively. However, this was equally efficient with 125% recommended dose of NPK (A_3). This was followed by the treatment A_2 (100% NPK). The lowest zinc and iron uptake was found under control (without NPK). Among the various combination of fortified organic manure evaluated, application of Zn + Fe FCCP @ 6.25 t ha^{-1} (B_3) recorded the highest zinc uptake (251.46 and 186.38 g ha^{-1}) and iron uptake (523.54 and 362.88 g ha^{-1}) by fruit and stover in brinjal, respectively.This was followed by application of zinc fortified composted coirpith (ZnFCCP) @ 6.25 t ha^{-1} (B_1) and the lowest Zn and Fe uptake was recorded withapplication of iron fortified composted coirpith (FeFCCP) @ 6.25 t ha^{-1}(B_2).

Interaction effect due to graded levels of NPK and different combination of fortified organic manures on the zinc and iron uptake by brinjal was significant. Application of 150% NPK along with Zn+Fe fortified composted coirpith (Zn+FeFCCP) @ 6.25 t ha^{-1} (A_4B_3) registered the highestuptake of zinc (285.63 and 212.56 g ha^{-1}) and iron (594.23 and 412.56 g ha^{-1}), in fruit and stover, respectively. However, it was found to be on par with application of 125% NPK along with Zn+Fe fortified composted coirpith (Zn+FeFCCP) @ 6.25 t ha^{-1} (A_3B_3). This was followed by (A_4B_2) which received 150% NPK along with Fe FCCP @ 6.25 t ha^{-1} . The lowest zinc and iron uptake of brinjal fruit and stover was noticed in control.

The addition of fortified organics with increased application of NPK increased through soil enhanced the uptake of nutrients by brinjal. Addition of organics improves the physical properties by increasing water and nutrient holding capacity. Additions of organics increase the microbial population and provide the required nutrients at optimum quantity throughout the growthand increase the nutrient uptake in plant through mineralization. Decomposition of organics releases an acid which regulate the soil condition, nutrient uptake and crop growth. Similar results were earlier made by El-Missery (2003). Fortification with zinc increases the nutrient content of organics and increases the nutrient content in soil and with increase uptake of nutrient. These results are in parity with results reported by Bhatt *et al.*, (2020). The control (A_1B_2) registered the lowest nutrient uptake at all stages.

CONCLUSION

From the results of the present investigation, it is concluded that application of increasing level of NPK fertilizer along with Zn and Fe fortified compost has improved the growth, yield, quality and uptake of brinjal. From the various combination tried combined application of 150% NPK fertilizer and 100% zinc and iron fortified coir pith compost resulted better than other treatment combination. So, this treatment combination may be recommended to the coastal brinjal growers for getting better profit and fight against the micronutrient malnutrition.

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Table 1. Effect of biofortification of Zinc and Iron through fortified organics along with NPK levels on the growth characters of brinjal

A / B	Plant height (cm)					Number of branches plant^{-1}					Dry matter production (t ha^{-1})				
	A_1	A_2	A_3	A_4	**Mean**	A_1	A_2	A_3	A_4	**Mean**	A_1	A_2	A_3	A_4	**Mean**
B_1	72.88	85.93	99.08	100.19	**89.52**	29	32	35	35	**33**	13.75	17.16	20.24	20.57	**17.93**
B_2	67.98	81.91	95.01	96.21	**85.28**	28	31	35	34	**32**	12.74	16.05	19.24	19.52	**16.89**
B_3	77.32	90.92	102.83	103.74	**93.70**	30	33	36	36	**34**	14.89	18.11	21.36	21.56	**18.98**
Mean	**72.73**	**86.25**	**98.97**	**100.05**		**29**	**32**	**35**	**35**		**13.79**	**17.11**	**20.28**	**20.55**	
		SE_D		CD (p=0.05)			SE_D		CD (p=0.05)			SE_D		CD (p=0.05)	
A		0.83		1.71			0.19		0.39			0.22		0.46	
B		0.95		1.97			0.22		0.45			0.26		0.53	
A x B		1.65		3.41			0.37		0.77			0.44		0.92	

Factor – A (NPK Levels); A_1– control; A_2 – 100% NPK; A_3 – 125% NPK and A_4 – 150% NPK
Factor – B (Fortified CCP); B_1– 100% Zn fortified composted coir pith (ZnFCCP) @ 6.25 t ha^{-1}; B_2 – 100 % FeFCCP @ 6.25 t ha^{-1}and B_3–100% Zn + Fe FCCP @ 6.25 t ha^{-1}

Table 2. Effect of biofortification of Zinc and iron through fortified organics along with NPK levels on the yield parameters and yield of brinjal

A / B	Fruit length (cm)					Single fruit weight (g)					Number of fruits plant^{-1}					Fruit yield (t ha^{-1})					Stover yield (t ha^{-1})				
	A_1	A_2	A_3	A_4	**Mean**	A_1	A_2	A_3	A_4	**Mean**	A_1	A_2	A_3	A_4	**Mean**	A_1	A_2	A_3	A_4	**Mean**	A_1	A_2	A_3	A_4	**Mean**
B_1	22.09	25.62	28.85	29.22	**26.45**	35.36	41.98	48.31	48.88	**43.63**	22	26	29	29	**26**	40.57	45.04	49.91	50.56	**46.52**	33.69	37.88	41.81	42.02	**38.85**
B_2	21.08	24.57	27.85	28.09	**25.40**	33.41	39.73	46.11	46.75	**41.50**	21	24	28	28	**25**	39.09	43.55	48.28	48.87	**44.95**	32.21	36.59	40.41	40.69	**37.48**
B_3	23.35	26.73	30.12	30.31	**27.63**	37.51	44.09	50.76	50.87	**45.81**	23	27	30	30	**26**	42.04	46.73	51.64	52.11	**48.13**	35.08	39.07	42.91	43.27	**40.08**
Mean	**22.17**	**25.64**	**28.94**	**29.21**		**35.43**	**41.93**	**48.39**	**48.83**		**22**	**26**	**29**	**29**		**40.57**	**45.11**	**49.94**	**50.51**		**33.66**	**37.85**	**41.71**	**41.99**	
		SE_D		CD (p=0.05)			SE_D		CD (p=0.05)			SE_D		CD (p=0.05)			SE_D		CD (p=0.05)			SE_D		CD (p=0.05)	
A		0.24		0.50			0.45		0.93			0.24		0.49			0.34		0.70			0.27		0.57	
B		0.28		0.57			0.52		1.08			0.27		0.57			0.39		0.80			0.32		0.65	
A x B		0.48		0.99			0.90		1.86			0.47		0.98			0.67		1.39			0.55		1.13	

Factor – A (NPK Levels); A_1– control; A_2 – 100% NPK; A_3 – 125% NPK and A_4 – 150% NPK
Factor – B (Fortified CCP); B_1– 100% Zn fortified composted coir pith (ZnFCCP) @ 6.25 t ha^{-1}; B_2 – 100 % FeFCCP @ 6.25 t ha^{-1}and B_3–100% Zn + Fe FCCP @ 6.25 t ha^{-1}

Table 3. Effect of biofortification of Zinc and Iron through fortified organics along with NPK levels on the quality parameters of brinjal fruit

A / B	Ascorbic acid content (mg 100 g^{-1} fruit)					Crude protein content (%)					Titrable acidity (%)				
	A_1	**A_2**	**A_3**	**A_4**	**Mean**	**A_1**	**A_2**	**A_3**	**A_4**	**Mean**	**A_1**	**A_2**	**A_3**	**A_4**	**Mean**
B_1	10.66	13.25	15.65	15.82	**13.85**	2.09	2.88	3.71	3.77	**3.11**	0.84	1.24	1.70	1.74	**1.38**
B_2	9.78	12.56	14.73	14.97	**13.01**	1.87	2.63	3.51	3.55	**2.89**	0.67	1.12	1.56	1.59	**1.24**
B_3	11.59	13.96	16.49	16.59	**14.66**	2.34	3.17	3.92	3.95	**3.35**	0.94	1.37	1.84	1.85	**1.50**
Mean	**10.68**	**13.26**	**15.62**	**15.79**		**2.10**	**2.89**	**3.71**	**3.76**		**0.82**	**1.24**	**1.70**	**1.73**	
		SED		CD (p=0.05)		SED			CD (p=0.05)		SED			CD (p=0.05)	
A		0.15		0.31		0.04			0.08		0.02			0.05	
B		0.17		0.35		0.04			0.09		0.03			0.05	
A x B		0.29		0.61		0.07			0.15		0.04			0.09	

Factor – A (NPK Levels); A_1– control; A_2 – 100% NPK; A_3 – 125% NPK and A_4 – 150% NPK
Factor – B (Fortified CCP); B_1– 100% Zn fortified composted coir pith (ZnFCCP) @ 6.25 t ha^{-1}; B_2 – 100 % FeFCCP @ 6.25 t $ha^{-1}$and B_3–100% Zn + Fe FCCP @ 6.25 t ha^{-1}

Table 4. Effect of biofortification of Zinc and Iron through fortified organics along with NPK levels on the quality parameters of brinjal fruit

A / B	Total soluble solid (%)					Zinc content (%)					Iron content (%)				
	A_1	**A_2**	**A_3**	**A_4**	**Mean**	**A_1**	**A_2**	**A_3**	**A_4**	**Mean**	**A_1**	**A_2**	**A_3**	**A_4**	**Mean**
B_1	10.06	12.32	14.67	14.88	**12.98**	15.89	18.86	21.95	22.26	**19.74**	3.35	4.27	5.14	5.22	**4.50**
B_2	9.37	11.57	13.78	14.06	**12.20**	14.84	17.79	21.12	21.38	**18.78**	2.99	3.93	4.86	4.92	**4.18**
B_3	10.87	13.01	15.45	15.63	**13.74**	16.81	20.11	23.08	23.25	**20.81**	3.68	4.55	5.47	5.51	**4.80**
Mean	**10.10**	**12.30**	**14.63**	**14.86**		**15.85**	**18.92**	**22.05**	**22.30**		**3.34**	**4.25**	**5.16**	**5.22**	
		SED			CD (p=0.05)		SED			CD (p=0.05)		SED			CD (p=0.05)
A		0.15			0.31		0.21			0.43		0.05			0.11
B		0.17			0.36		0.24			0.49		0.06			0.12
A x B		0.30			0.62		0.41			0.85		0.10			0.21

Factor – A (NPK Levels); A_1– control; A_2 – 100% NPK; A_3 – 125% NPK and A_4 – 150% NPK
Factor – B (Fortified CCP); B_1– 100% Zn fortified composted coir pith (ZnFCCP) @ 6.25 t ha^{-1}; B_2 – 100 % FeFCCP @ 6.25 t $ha^{-1}$and B_3–100% Zn + Fe FCCP @ 6.25 t ha^{-1}

Table 5. Effect of biofortification of Zinc and iron through fortified organics along with NPK levels on the macro nutrient uptake (kg ha^{-1}) of brinjal

A / B	N- Fruit					N- Stover				
	A_1	**A_2**	**A_3**	**A_4**	**Mean**	**A_1**	**A_2**	**A_3**	**A_4**	**Mean**
B_1	35.02	46.89	56.97	57.88	**49.19**	20.03	25.8	31.48	31.86	**27.29**
B_2	30.73	43.41	53.49	54.44	**45.52**	17.88	24.31	28.83	29.08	**25.03**
B_3	39.13	50.23	60.42	61.23	**52.75**	22.09	27.15	33.68	33.97	**29.22**
Mean	**34.96**	**46.84**	**56.96**	**57.85**		**20.00**	**25.75**	**31.33**	**31.64**	

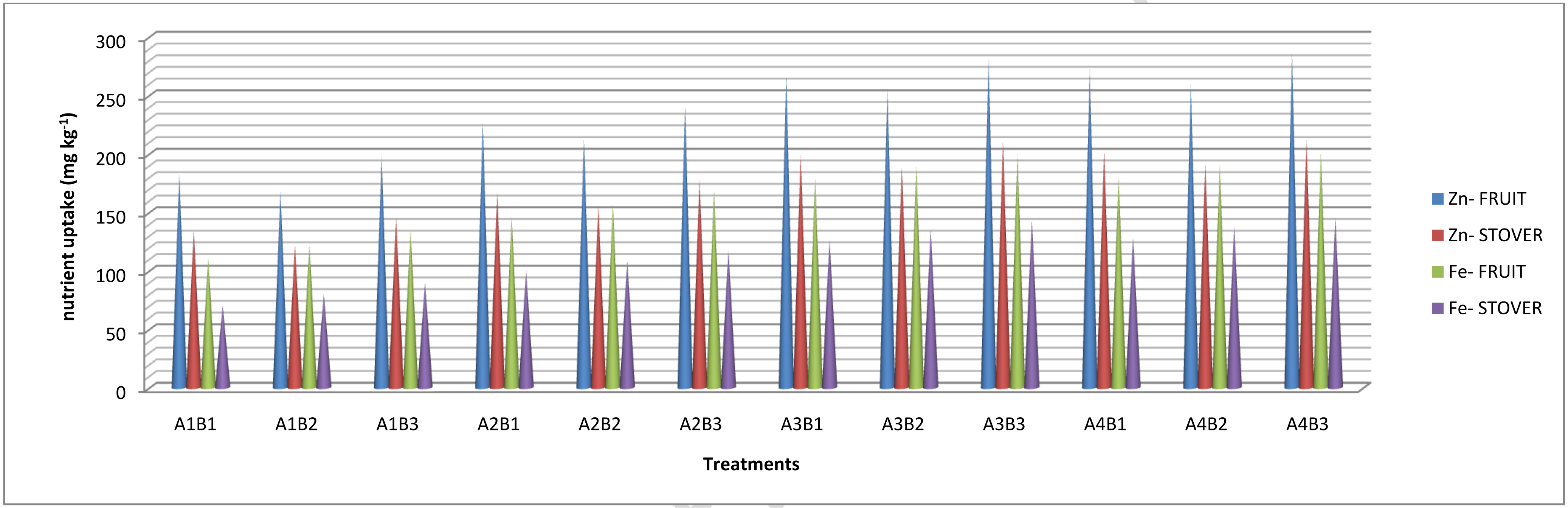
A / B	P- Fruit					P- Stover				
	A_1	**A_2**	**A_3**	**A_4**	**Mean**	**A_1**	**A_2**	**A_3**	**A_4**	**Mean**
B_1	9.28	12.01	14.31	14.43	**12.51**	5.71	7.8	9.63	9.74	**8.22**
B_2	8.31	11.16	13.57	13.76	**11.70**	4.96	7.18	9.06	9.15	**7.59**
B_3	10.21	12.78	14.88	15.11	**13.25**	6.42	8.38	10.16	10.29	**8.81**
Mean	**9.27**	**11.98**	**14.25**	**14.43**		**5.70**	**7.79**	**9.62**	**9.73**	

A / B	K- Fruit					K- Stover				
	A_1	**A_2**	**A_3**	**A_4**	**Mean**	**A_1**	**A_2**	**A_3**	**A_4**	**Mean**
B_1	37.55	46.56	54.8	55.72	**48.66**	20.62	25.56	30.09	30.34	**26.65**
B_2	34.47	43.67	52.28	53.13	**45.89**	18.83	24.11	28.53	28.66	**25.03**
B_3	40.56	49.33	57.24	58.17	**51.33**	22.28	26.94	31.41	31.69	**28.08**
Mean	**37.53**	**46.52**	**54.77**	**55.67**		**20.58**	**25.54**	**30.01**	**30.23**	

	N- Fruit SED	N- Fruit CD (p=0.05)	N- Stover SED	N- Stover CD (p=0.05)	P- Fruit SED	P- Fruit CD (p=0.05)	P- Stover SED	P- Stover CD (p=0.05)	K- Fruit SE_D	K- Fruit CD (p=0.05)	K- Stover SE_D	K- Stover CD (p=0.05)
A	0.70	1.45	0.30	0.61	0.15	0.31	0.12	0.25	0.56	1.15	0.29	0.61
B	0.81	1.67	0.34	0.71	0.17	0.36	0.14	0.28	0.64	1.32	0.34	0.70
A x B	1.40	2.89	0.59	1.22	0.30	0.62	0.24	0.49	1.11	2.29	0.58	1.21

Factor – A (NPK Levels); A_1– control; A_2 – 100% NPK; A_3 – 125% NPK and A_4 – 150% NPK
Factor – B (Fortified CCP); B_1– 100% Zn fortified composted coir pith (ZnFCCP) @ 6.25 t ha^{-1}; B_2 – 100 % FeFCCP @ 6.25 t ha^{-1}and B_3–100% Zn + Fe FCCP @ 6.25 t ha^{-1}

Figure 1: Effect of biofortification of Zinc and iron through fortified organics along with NPK levels on the micronutrients (mg kg^{-1}) of brinjal



Factor – A (NPK Levels); A_1– control; A_2 – 100% NPK; A_3 – 125% NPK and A_4 – 150% NPK

Factor – B (Fortified CCP); B_1– 100% Zn fortified composted coir pith (ZnFCCP) @ 6.25 t ha^{-1}; B_2 – 100 % FeFCCP @ 6.25 t ha^{-1}and B_3–100% Zn + Fe FCCP @ 6.25 t ha^{-1}