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Influence of FYM, Inorganic Fertilizers and Micronutrients on Soil Nutrient Status and Plant Nutrient Contents and their Uptake by African Marigold (*Tagetes erecta* Linn.)

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A B S T R A C T

A field experiment was carried out on Influence of FYM, Inorganic Fertilizers and Micronutrients on soil nutrient status and plant nutrient contents and their uptake by African marigold. The experiment was laid out in factorial randomized block design with three replications consisting three level of FYM (0, 20 and 30 t/ha), four levels of NPK (RDF @ 75, 100 and 125%) and four levels of micronutrients (Control, $ZnSO_4$ @ 0.50%, $FeSO_4$ @ 0.50% and $ZnSO_4$ 0.50% + $FeSO_4$ 0.50%) thus, making 48 treatment combinations. Application of FYM up to 30 t ha^{-1} significantly improved N, P, K, Zn and Fe content in plants, available in soil and uptake by plants. Among the different doses of NPK, application of NPK @ 125% RDF recorded significantly higher N, P and K content in plants, available in soil and uptake by plants over rest of treatments during 2011-12 and 2012-13, but uptake of Zn and Fe by plants recorded significantly higher with the treatment of NPK @ 100% RDF during both the years. However, application of $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% recorded maximum Zn and Fe content in plant and N, P, K, Zn and Fe uptake by plants during the year of 2011-12, 2012-13.

Introduction

African marigold (*Tagetes erecta* Linn.) has a prominent place in ornamental horticulture, is one of the commercially exploited flower crops belonging to the family Asteraceae. It is used in Hindu religious ceremonies. An account describes the marigold being used as garlands to decorate village gods during the harvest festival. It has also medicinal properties viz., (i) leaf extract is good remedy for ear-ache, (ii) flower extract is used as blood purifier and against bleeding piles, (iii) good remedy for eye diseases and ulcers, (iv) carotenoids are used to treat cancer and photosensivity diseases, (v) oil extract is used in perfumery industry and (vi) oil has an odour which acts as repellant to flies (Chopra, *et al.*, 1963). African marigold plants are hardy, easy to culture, wide adoptability to different soil and climatic conditions and easy to transportation. It is useful for decoration, landscaping, industries and medicinal sector and is also suitable for potted plants, bedding, edging, garland making, religious offerings and also for making different products. It has important role in preparation of garlands, bouquets and for floral decoration at the time of marriages and other ceremonies. It has also gained industrial importance due to its potential in value addition. African marigold is one of the important commercial flower crops of Rajasthan but yield levels are quite low, because in Rajasthan, NPK consumption ratio is 34.9: 15.9: 1 and use of Micronutrient is very low in all crops during 2011-12 (Anonymous, 2013).

Farmyard manure is considered as organic source of nutrient. They are also rich in micronutrients besides having plant growth promoting substances viz., hormones, enzymes and humus forming beneficial microbes. Organic sources, on application to the soil, improve the physical properties of soil such as aggregation, aeration, permeability and water holding capacity which promote growth and development of plants (Idan *et al.,* 2014). Chemical fertilizers and manures are very costly, thus efficient nutrient management not only help in increasing the present agricultural production level but also sustain the production and protect the environment from different types of hazards occurring due to mismanagement of costly fertilizers. Enrichment of the crop with micronutrients, especially iron and zinc is effective in regulating flowering in crops. This availability of micronutrient directly or indirectly affects the yield of flowers. Therefore, it seems essential to standardize the "Effect of FYM, Inorganic Fertilizers and Micronutrients on soil nutrient status & plant nutrient contents and their uptake by African marigold (*Tagetes erecta* Linn.)" under arid ecosystem of Western Rajasthan.

Materials and Methods

The field experiment was conducted at Niche Area of Excellence Farm, SKRAU, Bikaner during 2011-12 and 2012-13 in factorial randomized block design with three replications. The randomization of the treatments was done with the help of random number table. Crop was raised during *rabi* season and plot size was 3.6 x 2.5 m = 9.00 square meters maintaining 50 x 50 cm spacing. The treatments comprised of three level of FYM (0, 20 and 30 t/ha), four levels of NPK (RDF @ 75, 100 and 125%) and four levels of micronutrients (Control, $ZnSO_4$ @ 0.50% , $FeSO_4$ @ 0.50% and $ZnSO_4$ 0.50% + $FeSO_4$ 0.50%) thus, making 48 treatment combinations. The recommended dose and fertilizers were used for Nitrogen (200 kg ha^{-1} and urea), Phosphorus (100 kg ha^{-1} and single super phospthate-SSP) and Potassium (100 kg ha^{-}1 and murate of potash-MOP). Application of FYM was done at 30 days before transplanting of seedlings. Full dose of SSP, MOP and half dose of urea was applied just before transplanting and remaining half dose of urea was applied through drip irrigation. Two foliar sprays of micronutrients were given at 30 days after transplanting and 45 days after transplanting as per treatment. The plant sample collected after harvest of crop each plot, then dried and ground.

The soil samples were drawn randomly from 0-15 cm depth from different plots of the experimental field just after harvesting of crop. Methods given by following scientists were used for estimation nutrient contents in plant and available nutrients in soil are presented in table 1. Total uptake of nutrients (N, P, K, Fe and Zn) by the African marigold crop was estimated by the formula given below. Then parameters were subjected to statistical analysis (Panse and Sukhatme, 1995).

Total Uptake (kg ha^{-1}) =

$$\frac{\text{Nutrient content in plant (\%) X Dry matter content (g/plant)}}{100}$$

Results and Discussion

The results regarding to nutrient content in plant, uptake of nutrient by plants and nutrient content in soil were recorded of two year crops are presented at the end in Tables 2, 3 and 4, respectively.

FYM (Farmyard manure)

The result indicated that the nutrient content in plants, availability in soil and uptakes with application of farmyard manure increased significantly upto 30 t FYM ha^{-1} (F_2). The application of farmyard manure recorded significantly higher nitrogen (2.30%, 2.35% and 2.32%), phosphorus (0.32%, 0.34% and 0.33%), potassium (1.57%, 1.66% and 1.61%), zinc (0.234ppm, 0.244ppm and 0.239ppm), and ferrous (2.28ppm, 2.27ppm and 2.28ppm) content with 30 t FYM ha^{-1} (F_2) during 2011-12, 2012-13 and average also, respectively. Whereas, nitrogen (272.14, 293.05 and 282.59 kg ha^{-1}), phosphorus (38.36, 42.58 and 40.47 kg ha^{-1}), potassium (185.29, 206.67 and 195.98 kg ha^{-1}), zinc (27.60, 30.28 and 28.94 mg ka^{-1}), and ferrous (268.92, 283.29 and 276.11 mg ka^{-1}) uptake by plants were also recorded significantly higher with 30 t FYM ha^{-1} (F_2) during 2011-12, 2012-13 and in mean calculation, respectively.

However, the application of FYM @ 30 t FYM ha^{-1} (F_2) recorded maximum organic carbon (0.087%, 0.088% and 0.088%) and available nitrogen (86.71, 90.20 and 88.45 kg ha^{-1}), phosphorus (24.64, 27.69 and 26.17 kg ha^{-1}), potassium (225.59, 224.98 and 225.29 kg ha^{-1}), zinc (0.439, 0.470 and 0.455 ppm) and ferrous (3.31, 3.50 and 3.41 ppm) in soil after harvest recorded during both the year and mean. The lower nutrient content in plant and availability in soil and uptake by plants were found in the treatment of FYM @ 0 t ha^{-1} (F_1). This increase in nutrient content in plants and soil because FYM is a organic source of nutrient, which when applied to the soil, improve the physical properties of soil such as aggregation, aeration, permeability and water holding capacity (Idan *et al.*, 2014). The high phytase and nucleosidase activity provided at the rhizosphere by addition of organic manure resulted in better utilization of the nutrients by crop, thus increasing its concentration and its uptake by plants. The results are in agreement with the findings of Hangarge *et al.*, (2002). Increase in availability of micronutrients coupled with higher dry matter accumulation with the addition of FYM might be the reason for higher micronutrient uptake by grain (Kafle and Sharma, 2015).

Table.1 Method was used for analysis of nutrients given by following scientists

S.No.	Nutrients	Analysis in plant	Analysis in soil
1	Organic carbon	-	Walkley and Black (1934)
2	Nitrogen	Peach and Tracey (1956)	Subbiah and Asija (1956)
3	Phosphorus	Black (1965)	Olsen *et al.*, (1954)
4	Potassium	Williams and Twine (1960)	Jackson (1973)
5	Zinc	De Varies and Tiller (1980)	Lindsay and Norvell (1978)
6	Ferrous	De Varies and Tiller (1980)	Lindsay and Norvell (1978)

Table.2 Effect of FYM, NPK and micronutrients on nitrogen, phosphorus, potassium, zinc and ferrous Content in plants dry matter content of plants

Treatments	Nitrogen (%)			Phosphorus (%)			Potassium (%)			Zn (ppm)			Fe (ppm)			Dry matter content (g/plant)		
	2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean
FYM																		
F_0	1.97	1.98	1.97	0.28	0.29	0.29	1.23	1.24	1.23	0.185	0.208	0.196	1.891	1.99	1.94	77.5	81.68	79.59
F_1	2.18	2.2	2.19	0.31	0.32	0.31	1.48	1.55	1.52	0.211	0.239	0.225	2.18	2.16	2.17	87.64	93.03	90.34
F_2	2.3	2.35	2.32	0.32	0.34	0.33	1.57	1.66	1.61	0.234	0.244	0.239	2.28	2.27	2.28	89.86	95.29	92.58
SEm±	0.03	0.03	0.02	0	0	0	0.02	0.02	0.01	0.003	0.003	0.003	0.03	0.03	0.02	1.06	1.12	0.91
CD (P=0.05)	0.07	0.07	0.06	0.01	0.01	0.01	0.05	0.05	0.04	0.007	0.008	0.007	0.07	0.07	0.06	2.97	3.14	2.55
RDF																		
R_0	1.92	1.84	1.88	0.25	0.27	0.31	1.3	1.34	1.32	0.205	0.22	0.213	2.08	2.1	2.09	74	79.65	76.83
R_1	2.1	2.11	2.11	0.3	0.31	0.31	1.4	1.44	1.42	0.209	0.227	0.218	2.12	2.14	2.13	83.6	89.27	86.44
R_2	2.24	2.31	2.27	0.32	0.33	0.31	1.47	1.54	1.5	0.211	0.233	0.222	2.13	2.16	2.14	90.36	94.66	92.51
R_3	2.35	2.43	2.39	0.34	0.35	0.32	1.54	1.61	1.58	0.215	0.24	0.228	2.14	2.16	2.15	92.04	96.43	94.24
SEm±	0.03	0.03	0.02	0	0	0	0.02	0.02	0.02	0.003	0.003	0.003	0.03	0.03	0.02	1.22	1.29	1.05
CD (P=0.05)	0.09	0.09	0.07	0.01	0.01	0.01	0.06	0.06	0.05	NS	NS	NS	NS	NS	NS	3.43	3.63	2.95
Micronutrients																		
M_0	2.15	2.16	2.15	0.3	0.32	0.26	1.41	1.47	1.44	0.207	0.226	0.217	2.08	1.92	2	75.84	81.55	78.7
M_1	2.15	2.18	2.17	0.31	0.32	0.31	1.43	1.48	1.45	0.209	0.23	0.22	2.12	2.14	2.13	85.95	91.14	88.55
M_2	2.15	2.17	2.16	0.3	0.32	0.33	1.43	1.47	1.45	0.211	0.231	0.221	2.13	2.19	2.16	84.68	90.18	87.43
M_3	2.15	2.19	2.17	0.31	0.32	0.35	1.44	1.51	1.48	0.213	0.233	0.223	2.14	2.31	2.23	93.53	97.14	95.34
SEm±	0.03	0.03	0.02	0	0	0	0.02	0.02	0.02	0.003	0.003	0.003	0.03	0.03	0.02	1.22	1.29	1.05
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.005	0.005	0.004	0.05	0.05	0.04	3.43	3.63	2.95
CV	8.48	8.48	9.34	8.5	8.48	9.74	8.52	8.51	9.7	8.469	8.534	11.202	8.53	8.58	9.42	8.62	8.61	10.23

Table.3 Effect of FYM, NPK and micronutrients on uptake by plants of nitrogen, phosphorus, potassium, zinc and ferrous

Treatments	Nitrogen (kg/ha)			Phosphorus (kg/ha)			Potassium (kg/ha)			Zn (mg/kg)			Fe (mg/kg)		
	2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean
FYM															
F_0	191.41	198.74	195.08	27.71	29.25	28.48	119.57	124.23	121.9	17.92	20.77	19.35	183.13	199.89	191.51
F_1	253.36	268.99	261.17	35.81	39.3	37.56	172.46	189.2	180.83	24.44	29.08	26.76	252.55	264.3	258.42
F_2	272.14	293.05	282.59	38.36	42.58	40.47	185.29	206.67	195.98	27.6	30.28	28.94	268.92	283.29	276.11
SEm±	3	3.2	2.62	0.43	0.47	0.41	2.01	2.2	1.91	0.29	0.34	0.34	2.97	3.18	2.59
CD (P=0.05)	8.43	9	7.31	1.2	1.31	1.14	5.66	6.19	5.35	0.82	0.95	0.95	8.34	8.93	7.22
RDF															
R_0	189.81	190.87	190.34	24.93	28.21	26.57	129.27	139.96	134.61	20.35	22.8	21.57	206.28	218.62	212.45
R_1	230.83	240.2	235.52	33.27	35.57	34.42	154.23	164.6	159.42	23.07	25.83	24.45	233.76	244.32	239.04
R_2	259.38	282.11	270.75	37.62	40.76	39.19	171.33	188.35	179.84	24.53	28.46	26.49	247.42	264.42	255.92
R_3	275.87	301.19	288.53	40.03	43.63	41.83	181.6	200.57	191.08	25.34	29.75	27.55	252.01	269.28	260.65
SEm±	3.47	3.7	3.02	0.5	0.54	0.47	2.33	2.55	2.21	0.34	0.39	0.39	3.43	3.67	2.99
CD (P=0.05)	9.74	10.39	8.44	1.39	1.52	1.32	6.53	7.15	6.17	0.95	1.1	1.1	9.63	10.31	8.34
Micronutrients															
M_0	204	212.67	208.34	28.74	30.98	29.86	134.3	144.79	139.54	19.64	22.15	20.89	197.1	187.6	192.35
M_1	244.27	254.89	249.58	34.69	37.02	35.85	162.44	173.46	167.95	23.7	26.77	25.23	240.1	248.3	244.2
M_2	237.91	257.06	247.48	33.69	37.75	35.72	158.95	174.56	166.75	23.31	27.24	25.28	235.05	257.45	246.25
M_3	269.7	289.75	279.72	38.74	42.42	40.58	180.74	200.66	190.7	26.63	30.68	28.66	267.22	303.29	285.25
SEm±	3.47	3.7	3.02	0.5	0.54	0.47	2.33	2.55	2.21	0.34	0.39	0.39	3.43	3.67	2.99
CD (P=0.05)	9.74	10.39	8.44	1.39	1.52	1.32	6.53	7.15	6.17	0.95	1.1	1.1	9.63	10.31	8.34
CV	8.71	8.75	10.4	8.75	8.75	11.28	8.77	8.81	11.28	8.7	8.78	13.31	8.76	8.84	10.47

Table.4 Effect of FYM, NPK and micronutrients on organic carbon in soil and available nitrogen, phosphorus, Potassium, zinc and ferrous in soil after harvesting

Treatments	Organic Carbon in soil (%)			Available N (kg/ha) in soil			Available P (kg/ha) in soil			Available K (kg/ha) in soil			Available Zn (ppm) in soil			Available Fe (ppm) in soil		
	2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean
FYM																		
F_0	0.071	0.075	0.073	76.04	78.54	77.29	21.29	24.15	22.72	203.45	206.71	205.08	0.359	0.41	0.385	2.65	2.9	2.77
F_1	0.081	0.083	0.082	83.25	86.27	84.76	23.07	26.14	24.61	215.96	216.31	216.14	0.409	0.44	0.425	3.07	3.28	3.17
F_2	0.087	0.088	0.088	86.71	90.2	88.45	24.64	27.69	26.17	225.59	224.98	225.29	0.439	0.47	0.455	3.31	3.5	3.41
SEm±	0.001	0.001	0.001	1.01	1.04	0.82	0.28	0.32	0.31	2.63	2.64	2.05	0.005	0.005	0.005	0.04	0.04	0.03
CD (P=0.05)	0.003	0.003	0.002	2.82	2.92	2.29	0.79	0.89	0.87	7.39	7.42	5.72	0.014	0.015	0.013	0.1	0.11	0.09
RDF																		
R_0	0.079	0.081	0.08	74.38	77.26	75.82	20.44	23.75	22.09	193.93	196.9	195.41	0.393	0.43	0.411	2.97	3.2	3.08
R_1	0.08	0.082	0.081	80	82.98	81.49	22.71	25.57	24.14	211.78	211.18	211.48	0.403	0.435	0.419	3.01	3.2	3.11
R_2	0.08	0.082	0.081	85	87.76	86.38	23.9	26.76	25.33	222.37	223.02	222.7	0.403	0.445	0.424	3.03	3.23	3.13
R_3	0.081	0.083	0.082	88.62	92	90.31	24.95	27.9	26.43	231.93	232.9	232.41	0.412	0.45	0.431	3.04	3.28	3.16
SEm±	0.001	0.001	0.001	1.16	1.2	0.95	0.32	0.37	0.36	3.04	3.05	2.37	0.006	0.006	0.006	0.04	0.05	0.04
CD (P=0.05)	NS	NS	NS	3.26	3.38	2.65	0.91	1.03	1.01	8.54	8.57	6.61	NS	NS	NS	NS	NS	NS
Micronutrients																		
M_0	0.079	0.081	0.08	80.83	83.79	82.31	22.67	25.61	24.14	211.93	212.91	212.42	0.395	0.43	0.413	2.96	3.19	3.08
M_1	0.08	0.082	0.081	81.61	84.6	83.11	22.89	25.88	24.39	213.98	214.97	214.48	0.405	0.442	0.424	3.03	3.24	3.14
M_2	0.08	0.082	0.081	82.39	85.4	83.9	23.11	26.12	24.62	216.02	217.03	216.53	0.4	0.438	0.419	3.02	3.2	3.11
M_3	0.081	0.083	0.082	83.17	86.21	84.69	23.33	26.37	24.85	218.08	219.09	218.59	0.41	0.45	0.43	3.04	3.27	3.16
SEm±	0.001	0.001	0.001	1.16	1.2	0.95	0.32	0.37	0.36	3.04	3.05	2.37	0.006	0.006	0.006	0.04	0.05	0.04
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV	8.499	8.497	9.48	8.49	8.49	9.64	8.47	8.48	12.49	8.48	8.48	9.32	8.499	8.49	11.123	8.51	8.5	10.43

NPK

Among the different recommended dose (RDF) of NPK (nitrogen, phosphorus and potassium), application of NPK recorded significantly nitrogen, phosphorus and potassium content in plant and availability in soil up to 125% RDF (R_3) during both the year. The maximum contents in plants of nitrogen (2.35%, 2.43% and 2.39%), phosphorus (0.34%, 0.35% and 0.32%) and potassium (1.54%, 1.61% and 1.58%) and as well as availability in soil of nitrogen (88.62, 92.00 and 90.31 kg ha^{-1}), phosphorus (24.95, 27.90 and 26.43 kg ha^{-1}) and potassium (231.93, 232.90 and 232.41 kg ha^{-1}) were observed in the treatment of 125% RDF (R_3).

The application of FYM increased significantly nitrogen, phosphorus and potassium uptake by plants up to 125% RDF (R_3) and zinc and ferrous up to 100% RDF (R_2) during both the years. The mean percent increases in nitrogen (6.57, 14.96 and 23.74,), phosphorus (6.76, 13.86 and 29.48), potassium (6.26, 12.81 and 18.42), zinc (3.98, 8.34 and 13.38) and ferrous (4.57, 8.65 and 12.64) uptake by plants with application of inorganic fertilizers @ 125% RDF (R_3) over 100% RDF (R_2), 100% RDF (R_2) over 75% RDF (R_1) and 75% (R_1) RDF over control (R_0), respectively.

This might be due to the fact that both nitrogen and phosphorus improve the K nutrition and enhance the uptake of K by the plant. One peak rate of uptake was observed in nitrogen, phosphorus and potash at peak flowering stage followed by a decline at final harvest stage (Konnerup and Brix, 2010). In the responsive zone, increasing nitrogen supply enhances both shoot and root growth. The roots become finer (higher branching) and the surface area increases (Marschner, 1995). With an increase in root surface area as well as volume at a higher level of nitrogen (200 kg ha^{-1}) might have increased due to greater foliage area. By increasing the photosynthetic activities and cell formation process, nitrogen application at 200 kg N ha^{-1} increased the dry matter content of plant as determined by the dry weight of plant, thereby resulting in greater uptake of nutrients. Application of phosphorus at higher level might have increased the absorption of NPK due to increased root density. Further, by exacerbating the photosynthetic activities of plants, phosphorus at higher level resulted in greater plant dry weight. The increase in P and K uptake was due to the fact that nitrogen promotes phosphorus and potassium uptake by increasing top and root growth, altering plant metabolism and increasing P and K solubility and availability. Thus, the increase in absorption of N, P and K with greater dry matter accumulation with higher level of phosphorus ultimately resulted in greater N and P uptake in chrysanthemum (Joshi *et al.*, 2012). The Zn and Fe content in plant and availability in soil was found non-significant because micronutrient was applied as foliar spray, whereas Zn and Fe uptake by plant was differ significantly because uptake is correlated with dry matter accumulation. This result is also in conformity with Naik (2015) in African marigold and Polara *et al.,* (2014).

Micronutrients

The application of micronutrient as foliar spray significantly increased the zinc and ferrous content in plant and nitrogen, phosphorus, potassium, zinc and ferrous uptake by plants. But N, P and K content in plants and N, P, K, Zn and Fe availability in soil were found non-significant with foliar spray of micronutrient. However, application of singly $ZnSO_4$ @ 0.5% and $FeSO_4$ @ 0.5% was observed non-significant difference each other.

The zinc (0.213, 0.233 and 0.223 ppm) and ferrous (2.14, 2.31 and 2.23 ppm) content in plant and nitrogen (275.87, 301.19 and 288.53

kg ha^{-1}), phosphorus (40.03, 43.63 and 41.83 kg ha^{-1}), potassium (181.60, 200.57 and 191.08 kg ha^{-1}), Zinc (25.34, 29.75 and 27.55 mg ka^{-1}) and Ferrous (252.01, 269.28 and 260.65 mg ka^{-1}) uptake by plants were recorded maximum with foliar application of $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% during the year of 2011-12, 2012-13 and in mean, respectively. The application of $ZnSO_4$ and $FeSO_4$ increased dry matter of plants which help in increasing the uptake of nutrients. Zinc is essential micronutrient for proteins production in plants; also zinc is main composition of ribosome and is essential for their development. Amino acids accumulated in plant tissues and protein synthesis decline by zinc deficit. One of the sites of protein synthesis is pollen tube that amount of zinc in their tip is 150 micrograms per gram of dry matter (Pandey *et al.*, 2006). Zinc deficiency is lead to iron (Fe) deficiency, due to reduced transfer of Fe from root to shoot in zinc deficiency conditions (Rengel and Romheld, 2000). Similar result was reported by Alloway (2008) and Mousavi *et al.*, (2012). Application of FYM up to 30 t ha^{-1} was superior in respect of N, P, K, Zn and Fe content in plants, available in soil and uptake by plants. The N, P and K content in plants, available in soil and uptake by plants was recorded maximum with application of NPK @ 125% RDF over rest of treatments during 2011-12 and 2012-13, therefore uptake of Zn and Fe by plants were also recorded highest with the treatment of NPK @ 125% RDF during both the years. However, application of $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% recorded maximum Zn and Fe content in plant and N, P, K, Zn and Fe uptake by plants during the year of 2011-12, 2012-13.

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