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Yield and quality of cumin as influenced by FYM enriched micronutrients

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Abstract

An experiment was conducted in three *rabi* seasons from 2010-11 to 2012-13 at Center for Research on Seed Spices, S. D. Agricultural University, Jagudan to find out the effect of Fe and Zn enriched with farm yard manure on growth and yield, quality and uptake of nutrients for cumin. The growth and yield attributes viz., plant height, number of branches per plant, number of umbellates per umbel, number of seeds per umbellate and test weight were significantly affected due to different treatments. Enrichment of Fe or Zn or both with FYM (T_8, T_7 and T_6) increased not only seed yield but net income and BCR also. Combine application of Fe and Zn found better than alone application of Fe or Zn. Moreover, enrichment of Fe and Zn with FYM not only reduced the 50 per cent requirement of micronutrient but increased the yield considerably also. An application of RDF along with 1.0 t FYM enriched with 1.5 kg Fe and 0.75 kg Zn ha^{-1} (T_8) registered significantly higher uptake of Fe and Zn by seed and straw. The different treatments did not significantly change the organic carbon content in soil after harvest of crop in all the three years of study. DTPA-extractable Fe and Zn content in soil was noted maximum due to application of RDF + 1.0 t FYM enriched with 1.5 kg Fe and 0.75 kg Zn ha^{-1}.

Key words : Cumin, enriched micronutrients, seed spices, yield.

Introduction

Due to wide adaptability of seed spices under arid and semi arid regions, raising of global demand and more profitability as compared to other *rabi* crops, seed spices namely cumin, dill seed, fennel, etc.have become a high valued crops of Gujarat and Rajasthan. Cumin (*Cuminum cyminum* L.) is an important seed spice and cash crop of ari and semi-arid regions of India. This short duration crop is highly remunerative as it requires less inputs i.e. fertilizers, irrigation, labour, etc. and fetch higher market price than other *rabi* crops.Though it is highly risky crop of these regions.In intensive agriculture, uses of high analyze inorganic fertilizers, little or scarce use of FYM and considerable reduction in recycling of crop residues resulted in deficiencies of micro-nutrients in soil. Consequently, the deficiencies of micro-nutrients in soil have become major constraint for maintaining soil productivity. Wide spread of these micro-nutrients deficiencies particularly Fe and Zn has been observed in light textured soil of North Gujarat. Therefore, fertilization of soil with these micro-nutrients will play the vital role through not only improving yield and quality of cumin, but also sustain the soil productivity.

Materials and methods

To find out the effect of FYM enriched Fe and Zn on yield and quality of cumin crop, an investigation was carried out at Center for Research on Seed Spices, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, during *rabi* 2010-11 to 2012-13. Soil texture of experimental field was loamy sand with lower in both organic carbon (0.12 %) and nitrogen (135 kg ha^{-1}) as well as medium range of available phosphorus (34 Kg P_2O_5 ha^{-1}) and

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potassium (265 kg K_2O ha^{-1}). Eight treatments viz., T_1: RDF (30 kg N + 15 kg P_2O_5 ha^{-1}), T_2: T_1 + 1.0 t FYM ha^{-1}, T_3 : T_1 + 3.0 kg Fe ha^{-1}, T_4: T_1 + 1.5 kg Zn ha^{-1}, T_5: T_1 + 3.0 kg Fe ha^{-1} + 1.5 kg Zn ha^{-1}, T_6: T_1 + 1.0 t FYM enriched with 1.5 kg Fe ha^{-1}, T_7 : T_1 + 1.0 t FYM enriched with 0.75 kg Zn ha^{-1}, T_8: T_1 + 1.0 t FYM enriched with 1.5 kg Fe ha^{-1} + 0.75 kg Zn ha^{-1} were laid out in Randomized Block Design with three replications. The cumin seeds were sown manually at about 2-3 cm depth in furrow at 30 cm distance. The entire quantity of phosphorus and half of nitrogen in the form of DAP and Urea were manually applied as basal dose in the furrows.

Before 45 days, approximately 1000 kg FYM was thoroughly mixed with $ZnSO_4.7H_2O$ or $FeSO_4.7H_2O$ as per the enrichment treatments *viz*., 0.75 and 1.5 kg Zn and 1.5 and 3.0 kg Fe per hectare. This mixture was filled in the polythene lined pits of 1.5 x 1.5 x 1.5 m^3 in size. The moisture percentage of FYM after mixing with $ZnSO_4.7H_2O$ or $FeSO_4.7H_2O$ and cow dung slurry @ 1 per cent was kept at about 75. The pit was covered with polythene sheet and allowed for decomposition. The mixture was turned over periodically (weekly) and moisture level was maintained. The enrichment process was completed after 5 to 6 weeks. This process helps to convert inorganic Fe and Zn into organically bound and naturally chelated form of Fe and Zn. The estimation of organic carbon was determined by Walkely and Black's rapid titration method (Jackson, 1978). Seed and straw samples collected at harvest from each treatment were dried at 70 ^{o}C and powdered in a grinder having stainless steel blade and digested in di-acid mixture (HNO_3 and $HClO_4$ in ratio of 3:1). The extract was used for the determination of Fe and Zn by atomic absorption spectrophotometer (ELICO SL-194). The uptake of Fe and Zn was calculated by multiplying dry weight of seed and straw with their respective content. The post-harvest soil samples were collected, processed and analyzed for DTPA-Fe and Zn with 0.005 *M* DTPA (Lindsay and Norvell, 1978) and contents were determined on atomic absorption spectrophotometer. The volatile oil content (%) of seed was estimated as per steam distillation method (A.O.A.C., 1970).

Results and discussion

Growth and yield attributes

The data related to growth and yield attributes (Table 1) *viz*., plant height, number of branches per plant, number of umbellates per umbel, number of seeds per umbellate and test weight were significantly affected due to different treatments. Though, imposed treatments could not make any significant effect on number of umbels per plant and volatile oil content of seed on pooled data basis.

The tallest plants were recorded with treatment T_5 and was at par with the treatments T_6, T_3, and T_2, but significantly superior over rest of the treatments. In case of number of branches per plant, treatment T_3 was significantly superior over rest of the treatments except T_4, T_6, T_8, T_1 and T_2. Significantly more number of umbellates per umbel was recorded with T_4 and was at par with the treatments T_1 and T_3. Similarly, treatment T_4 produced significantly higher number of umbellates per umbel over rest of the treatments except T_1 and T_3. Whereas, differences between treatments T_4 and T_6 were at par but recorded significantly higher number of seeds per umbellate. Further, test weight was the maximum with treatment T_8 and was at par with T_2,T_7 and T_6 but significantly superior over rest of the treatments.

Seed yield

Different FYM enriched Fe and Zn significantly influenced the seed yield of cumin during individual years as well as on pooled basis also (Table 2). Differences in yield due to application of RDF along with FYM enriched Fe or Zn or both Fe and Zn (T_6, T_7 and T_8) were non-significant during course of investigation as well as in pooled result too, but remarkably higher than treatments T_1, T_2, T_3, T_4 and T_5 except in the years 2011-12 and 2012-13. During 2010-11 and 2012-13, treatments T_6, T_7, T_8 and T_5 recorded statistically near to equal and were produced significantly higher over the treatments T_1 and T_2. The maximum seed yield of cumin was

Table 1: Growth and yield attributes as influenced by different FYM enriched Fe and Zn treatments (Pooled data of three years)

	Treatments	Plant height (cm)	No. of branches plant^{-1}	No. of umbels plant^{-1}	No. of umbellates umbel^{-1}	No. of seeds umbellate^{-1}	Test weight (g)	Volatile oil (%)
T_1	RDF (30 kg N + 15 kg P_2O_5 ha^{-1})	27.59	4.71	16.30	5.24	6.20	3.47	4.67
T_2	T_1 + 1.0 t FYM ha^{-1}	27.79	4.70	17.26	4.88	6.37	3.83	4.38
T_3	T_1 + 3.0 kg Fe ha^{-1}	28.24	5.31	15.83	5.12	6.66	3.64	4.45
T_4	T_1 + 1.5 kg Zn ha^{-1}	26.82	5.21	14.68	5.32	6.74	3.67	4.49
T_5	T_1 + 3.0 kg Fe ha^{-1} + 1.5 kg Zn ha^{-1}	28.72	4.37	16.41	4.88	6.21	3.71	4.51
T_6	T_1 + 1.0 t FYM enriched with 1.5 kg Fe ha^{-1}	28.40	5.13	16.36	5.04	6.74	3.78	4.55
T_7	T_1 + 1.0 t FYM enriched with 0.75 kg Zn ha^{-1}	26.35	4.38	15.19	5.02	5.04	3.81	4.48
T_8	T_1 + 1.0 t FYM enriched with 1.5 kg Fe ha^{-1} + 0.75 kg Zn ha^{-1}	27.49	5.07	16.57	4.96	6.38	4.01	4.87
	S Em ±	0.37	0.25	0.98	0.08	0.21	0.10	0.10
	CD (P= 0.05)	1.06	0.71	NS	0.22	0.59	0.29	NS
	CV %	3.51	13.40	15.89	3.98	8.65	5.80	6.09
	Y x T	NS	NS	NS	NS	NS	NS	NS

recorded with treatments T_8 and was at par with treatments T_7 and T_6, but significantly higher seed yield over rest of the treatments except in 2011-12 and 2012-13. On the contrary, the minimum seed yield was recorded when crop received only RDF (T_1) and was at par with treatments T_2, T_3 and T_4 but significantly inferior over rest of the treatments. Combine application of both the micronutrients (Fe and Zn) found better than alone application of Fe or Zn. Moreover, enrichment of Fe and Zn with FYM not only reduced the 50% requirement of micro-nutrients but also increased the yield considerably. Similar results were also observed by Sharma (1998) in fennel, Meena and Chaudhary (1998) in cumin and Jakhar *et al* (2013) in fenugreek crop.

Chemical study

Uptake of Fe by seed and straw

Uptake of Fe by seed and straw was affected significantly due to different treatments of Fe and Zn enriched FYM during all the years of study as well as in pooled analysis (Table 3 & 4). An application of RDF along with 1.0 t FYM enriched with 1.5 kg Fe and 0.75 kg Zn ha^{-1} (T_8) registered significantly higher uptake of Fe by seed and straw over rest of the treatments except treatments T_6 and T_7. The minimum uptake of Fe by seed and straw were recorded under RDF (T_1).

Uptake of Zn by seed and straw

The individuals as well as pooled data revealed that the uptake of Zn by seed and straw influenced significantly due to different treatments. During three years of experimentation and in pooled data (Table 5 & 6) an application of RDF along with 1.0 t FYM enriched with 1.5 kg Fe and 0.75 kg Zn ha^{-1} recorded significantly higher uptake of Zn by seed and straw over rest of the treatments but remained at par with treatment T_6 in case of Zn uptake by seed and T_7 in case of Zn uptake by straw. The lowest Zn uptake by seed and straw were recorded under RDF treatment (T_1).

Table 2. Seed yield (Kg ha^{-1}) of cumin as influenced by different FYM enriched Fe and Zn treatments (Pooled data of three years)

Treatments		Cumin seed yield (Kg ha^{-1})			
		2010-11	2011-12	2012-13	Pooled
T_1	RDF (30 kg N + 15 kg P_2O_5 ha^{-1})	496	423	404	441
T_2	T_1 + 1.0 t FYM ha^{-1}	510	441	424	458
T_3	T_1 + 3.0 kg Fe ha^{-1}	525	471	452	483
T_4	T_1 + 1.5 kg Zn ha^{-1}	519	436	422	459
T_5	T_1 + 3.0 kg Fe ha^{-1} + 1.5 kg Zn ha^{-1}	552	490	470	504
T_6	T_1 + 1.0 t FYM enriched with 1.5 kg Fe ha^{-1}	595	522	506	541
T_7	T_1 + 1.0 t FYM enriched with 0.75 kg Zn ha^{-1}	609	548	523	560
T_8	T_1 + 1.0 t FYM enriched with 1.5 kg Fe ha^{-1} + 0.75 kg Zn ha^{-1}	620	562	549	577
S Em ±		23	25	32	15
CD (P = 0.05)		67	73	93	44
CV %		8.24	10.20	13.52	7.98
Y x T		-	-	-	NS

Table 3. Fe uptake (g ha^{-1}) by cumin seed as influenced by different FYM enriched Fe and Zn treatments

Treatments		Fe uptake (g ha^{-1}) by seed			
		2010 - 11	2011 - 12	2012 - 13	Pooled
T_1	RDF (30 kg N + 15 kg P_2O_5 ha^{-1})	45.30	34.63	34.67	38.20
T_2	T_1 + 1.0 t FYM ha^{-1}	49.67	37.67	37.30	41.55
T_3	T_1 + 3.0 kg Fe ha^{-1}	57.70	44.41	43.64	48.58
T_4	T_1 + 1.5 kg Zn ha^{-1}	50.68	38.28	37.45	42.14
T_5	T_1 + 3.0 kg Fe ha^{-1} + 1.5 kg Zn ha^{-1}	61.54	48.42	45.31	51.76
T_6	T_1 + 1.0 t FYM En. with 1.5 kg Fe ha^{-1}	69.49	54.45	51.40	58.45
T_7	T_1 + 1.0 t FYM En. with 0.75 kg Zn ha^{-1}	66.17	54.36	52.09	57.54
T_8	T_1 + 1.0 t FYM En. with 1.5 kg Fe ha^{-1} + 0.75 kg Zn ha^{-1}	74.48	60.51	57.68	64.17
SEm ±		3.72	3.14	3.99	2.10
CD (P = 0.05)		10.93	9.25	11.72	5.87
CV (%)		12.52	13.50	17.73	14.44

Table 4. Fe uptake (g ha^{-1}) by cumin straw as influenced by different FYM enriched Fe and Zn treatments

Treatments		Fe uptake (g ha^{-1}) by straw			
		2010 - 11	2011 - 12	2012 - 13	Pooled
T_1	RDF (30 kg N + 15 kg P_2O_5 ha^{-1})	170.69	131.48	128.39	143.52
T_2	T_1 + 1.0 t FYM ha^{-1}	178.78	150.88	141.47	157.04
T_3	T_1 + 3.0 kg Fe ha^{-1}	201.84	167.34	159.37	176.18
T_4	T_1 + 1.5 kg Zn ha^{-1}	208.99	153.03	141.92	167.98
T_5	T_1 + 3.0 kg Fe ha^{-1} + 1.5 kg Zn ha^{-1}	216.03	180.66	166.66	187.79
T_6	T_1 + 1.0 t FYM En. with 1.5 kg Fe ha^{-1}	243.19	192.68	186.00	207.29
T_7	T_1 + 1.0 t FYM En. with 0.75 kg Zn ha^{-1}	245.64	197.93	189.13	210.90
T_8	T_1 + 1.0 t FYM En. with 1.5 kg Fe ha^{-1} + 0.75 kg Zn/ha	255.96	223.03	209.65	229.55
SEm ±		10.19	14.07	11.25	6.90
CD (P = 0.05)		29.97	41.38	33.08	19.31
CV (%)		9.47	16.11	13.61	12.91

Table 5. Zn uptake (g ha^{-1}) by cumin seed as influenced by different FYM enriched Fe and Zn treatments

Treatments		Zn uptake (g ha^{-1}) by seed			
		2010 - 11	2011 - 12	2012 - 13	Pooled
T_1	RDF (30 kg N + 15 kg P_2O_5 ha^{-1})	14.94	15.50	13.21	14.55
T_2	T_1 + 1.0 t FYM ha^{-1}	16.90	16.80	14.15	15.95
T_3	T_1 + 3.0 kg Fe ha^{-1}	19.51	18.36	16.18	18.02
T_4	T_1 + 1.5 kg Zn ha^{-1}	16.60	15.97	14.79	15.78
T_5	T_1 + 3.0 kg Fe ha^{-1} + 1.5 kg Zn ha^{-1}	20.83	20.08	17.39	19.44
T_6	T_1 + 1.0 t FYM En. with 1.5 kg Fe ha^{-1}	23.99	22.04	20.49	22.17
T_7	T_1 + 1.0 t FYM En. with 0.75 kg Zn ha^{-1}	24.97	22.14	20.81	22.64
T_8	T_1 + 1.0 t FYM En. with 1.5 kg Fe ha^{-1} + 0.75 kg Zn ha^{-1}	26.09	24.18	23.55	24.60
SEm ±		0.94	1.10	1.26	0.87
CD (P = 0.05)		2.76	3.23	3.70	2.45
CV (%)		9.14	11.35	14.40	11.60

Table 6. Zn uptake (g ha^{-1}) by cumin straw as influenced by different FYM enriched Fe and Zn treatments

Treatments		Zn uptake (g ha^{-1}) by straw			
		2010 - 11	2011 - 12	2012 - 13	Pooled
T_1	RDF (30 kg N + 15 kg P_2O_5 ha^{-1})	6.93	4.93	6.11	5.99
T_2	T_1 + 1.0 t FYM ha^{-1}	7.86	6.33	6.87	7.02
T_3	T_1 + 3.0 kg Fe ha^{-1}	8.37	7.67	7.81	7.95
T_4	T_1 + 1.5 kg Zn ha^{-1}	9.98	7.84	7.91	8.58
T_5	T_1 + 3.0 kg Fe ha^{-1} + 1.5 kg Zn ha^{-1}	10.09	8.13	7.75	8.66
T_6	T_1 + 1.0 t FYM En. with 1.5 kg Fe ha^{-1}	11.56	9.72	9.99	10.42
T_7	T_1 + 1.0 t FYM En. with 0.75 kg Zn ha^{-1}	12.55	12.62	11.98	12.38
T_8	T_1 + 1.0 t FYM En. with 1.5 kg Fe ha^{-1} + 0.75 kg Zn ha^{-1}	13.92	13.09	12.92	12.79
SEm ±		0.56	0.50	0.69	0.34
CD (P = 0.05)		1.64	1.48	2.02	0.95
CV (%)		10.98	11.72	15.43	12.76

Soil status study

Organic carbon

Different treatments of micro-nutrients enriched with FYM did not influence the organic carbon content of soil (Table 7). However, application of FYM @ 1.0 t ha^{-1} improves the organic carbon content of soil. Morover, status of organic carbon content improved year after year slightly.

DTPA-extractable Fe and Zn

The year wise data on DTPA-extractable Fe and Zn content in soil (Table 7) showed that the maximum build-up of DTPA-extractable Fe and Zn content in soil was noted due to application of RDF + 1.0 t FYM enriched with 1.5 kg Fe and 0.75 kg Zn ha^{-1} (T_8), however it was at par with the treatments T_6 and T_7. The minimum Fe content in soil was noted under the treatment of RDF (T_1). Improve status of soil under these treatments might be due to addition of enrich micronutrients with FYM converts inorganic form in to natural chelated form.

Economics

Enrichment of Fe or Zn or both with FYM (T_8, T_7 and T_6) increased not only seed yield but net income and BCR also (Table 8). The maximum net income of Rs. 39585 ha^{-1} and BCR of 2.21 were recorded under application of RDF with 1.0 t FYM enriched 1.5 kg Fe and 0.75 kg Zn ha^{-1} (T_8) which was closely followed by treatments T_7 with net return of Rs. 37570 ha^{-1} and BCR of 2.16.

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Table 7. Effect of different treatments on soil fertility status after harvest of crop (0 – 15 cm)

	Treatments	2010 – 11			2011 – 12			2012 - 13		
		O. C. (%)	DTPA-Fe (mg kg^{-1})	DTPA-Zn (mg kg^{-1})	O. C. (%)	DTPA-Fe (mg kg^{-1})	DTPA-Zn (mg kg^{-1})	O. C. (%)	DTPA-Fe (mg kg^{-1})	DTPA-Zn (mg kg^{-1})
T_1	RDF (30 kg N + 15 kg P_2O_5 ha^{-1})	0.12	4.67	0.42	0.20	5.04	0.45	0.21	4.64	0.47
T_2	T_1 + 1.0 t FYM ha^{-1}	0.14	4.88	0.44	0.22	5.15	0.47	0.23	4.75	0.48
T_3	T_1 + 3.0 kg Fe ha^{-1}	0.12	5.18	0.45	0.21	5.27	0.44	0.23	4.81	0.47
T_4	T_1 + 1.5 kg Zn ha^{-1}	0.14	4.90	0.48	0.22	5.10	0.46	0.24	4.75	0.49
T_5	T_1 + 3.0 kg Fe ha^{-1} + 1.5 kg Zn ha^{-1}	0.13	5.20	0.47	0.23	5.18	0.47	0.24	4.87	0.50
T_6	T_1 + 1.0 t FYM En. with 1.5 kg Fe ha^{-1}	0.16	5.37	0.49	0.25	5.45	0.47	0.25	5.10	0.54
T_7	T_1 + 1.0 t FYM En. with 0.75 kg Zn ha^{-1}	0.16	5.20	0.52	0.25	5.20	0.53	0.26	5.08	0.56
T_8	T_1 + 1.0 t FYM En. with 1.5 kg Fe ha^{-1} + 0.75 kg Zn ha^{-1}	0.16	5.48	0.54	0.26	5.47	0.54	0.27	5.15	0.60
SEm ±		0.016	0.06	0.02	0.017	0.08	0.02	0.013	0.09	0.03
CD (P = 0.05)		NS	0.18	0.05	NS	0.24	0.06	NS	0.27	0.09
CV (%)		5.10	4.96	5.10	6.15	5.99	5.20	7.75	6.90	6.10
Initial status		0.11	4.70	0.43	0.21	4.98	0.45	0.21	4.70	0.48

Table 8. Economics of the different treatment influenced by various FYM enriched Fe and Zn contents (Pooled data of three years)

	Treatments	Seed yield (Kg ha^{-1})	Gross realization (₹ ha^{-1})	Gross expénditure (₹ ha^{-1})	Net return (₹ ha^{-1})	BCR
T_1	RDF (30 kg N + 15 kg $P_2O_5ha^{-1}$)	441	55140	31704	23437	1.74
T_2	T_1 + 1.0 t FYM ha^{-1}	458	57310	32281	25029	1.78
T_3	T_1 + 3.0 kg Fe ha^{-1}	483	60340	31977	28363	1.89
T_4	T_1 + 1.5 kg Zn ha^{-1}	459	57378	32034	25344	1.79
T_5	T_1 + 3.0 kg Fe ha^{-1} + 1.5 kg Zn ha^{-1}	504	62966	32307	30660	1.95
T_6	T_1 + 1.0 t FYM En. with 1.5 kg Fe ha^{-1}	541	67613	32417	35196	2.09
T_7	T_1 + 1.0 t FYM En. with 0.75 kg Zn ha^{-1}	560	70016	32445	37570	2.16
T_8	T_1 + 1.0 t FYM En. with 1.5 kg Fe ha^{-1} + 0.75 kg Zn ha^{-1}	577	72168	32583	39585	2.21

Price : Cumin seed ₹ 125 kg^{-1}
Phosphorus ₹ Rs. 46.25 kg^{-1} (SSP)
Nitrogen : ₹ 13.26 kg^{-1} (Urea)
Zn : ₹ 40 kg^{-1} (Zn SO_4 7 H_2O)
Fe : ₹ 15 kg^{-1} (Fe SO_4 7 H_2O)

Note : DAP mentioned in methodology to provide phosphorous and nitrogen, so it may include in price of fertilizers.

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