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Effect of zinc and FYM on productivity and nutrient availability in maize (*Zea mays*)–linseed (*Linum usitatissimum*) cropping sequence

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ABSTRACT

A field experiment consisting of eight treatments was conducted for 3 consecutive years from 2003-04 to 2005-06 in randomized block design with three replications at Palampur to study the effect of zinc with and without farmyard manure (FYM) on production, economics and nutrient status of soil in maize (*Zea mays* L.) - linseed (*Linum usitatissimum* L.) crop sequence. The soil of the experimental field was medium in zinc content. The results revealed that application of Zn through $ZnSO_4$ @ 25 kg/ha to both the crops + FYM 5 t/ha to maize recorded significantly higher growth parameters and yield attributes of linseed crop, resulting in significantly more linseed and linseed equivalent yield (61.3 and 52.9%, respectively). Application of $ZnSO_4$ @ 25 kg/ha + FYM 5 t/ha to maize crop was also proved to be equally effective on maize and recording significantly higher tillers/plant, branches/plant and capsules/plant of linseed crop. On system basis, significantly higher net returns obtained with the application of $ZnSO_4$ @ 25 kg/ha to both the crops + FYM 5 t/ha to maize. Application of $ZnSO_4$ @ 25 kg/ha to both the crops + FYM 5 t/ha to maize and application of $ZnSO_4$ @ 25 kg/ha + FYM 5 t/ha to maize behaved statistically alike in improving the overall fertility status of the soil with respect to N,P,K,S and DTPA extractable-Zn content over rest of treatments.

Key words: Economics, Farmyard manure, Linseed, Maize, Nutrient status, Productivity, Zinc

Linseed in India is cultivated on a lager area and occupies second (17.15%) in area after Canada in the world, but stands at fourth place (7.74%) in production, with poor productivity of 385 kg/ha. Linseed is an important oilseed crop and is cultivated primarily for oil meant for edible as well as industrial purposes. About 80% of oil is used for paints, varnishes, a wide range of coating oils, linoleum, pad and printing inks, leather finishing, more strength and durability which blends very well with wool, cotton, silk etc. Nutritionally, linseed is the best herbal source of Omega-3 and Omega-6 fatty acids which have immense medicinal effect on human body. In Himachal Pradesh, it is generally grown as *utera* crop after rice and stand next to rapeseed-mustard in oilseed group. However, very seldom is grown in prepared seed bed with limited/ unbalanced use of inputs especially chemical fertilizers, micro-nutrients and organic sources of manure. The imbalanced use of high analysis fertilizers in combination with negligible use of organic manures, using high yielding crop varieties under intensive cropping system have accelerated micronutrient deficiency in soils. Among micronutrients, zinc deficiency is world's most wide spread disorder in crops. Like major plant nutrients, zinc deficiency is severe problem in soils of the Himachal Pradesh (Kanwar and Tripathi, 1988), which is a key factor for poor yield. The FYM improves the soil properties and finally crop yield (Bhatia and Shukla, 1982). Keeping in view the above facts, the present investigation was undertaken to find out the effect of zinc and FYM in maize-linseed crop sequence.

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MATERIALS AND METHODS

A field experiment was conducted for 3 consecutive years at Palampur from 2003-05 to 2005-06. The experiment consisting of 8 treatments was laid out in randomized block design with three replications. Three schedules of Zn application were tested in the absence and presence of FYM in maize-linseed crop sequence and compared with recommended dose of fertilizer application as well as absolute control. Zinc (Zn) through zinc sulphate ($ZnSO_4$) @ 25 kg/ha was applied as per treatments at the sowing of maize or linseed crop. The FYM @ 5 t/ha was also incorporated at the time of layout of the experiment as per treatment (Table 1). The soil of the experimental site was silty clay loam in texture, medium in available N (292 kg/ha), phosphorus (14.3 kg/ha) and potassium (221 kg/ha). The available S and DTPA-extractable Zn content was 14.4 kg/ha and 0.68 mg/ kg of soil (medium), respectively.

The reaction of the soil was acidic in nature (5.7). The 'Girija' maize (composite variety of maize) and 'Him Alsi-1' linseed were sown with all the recommended package of practices with recommended fertilizer doses except for treatments. The maize crop received the recommended dose of 120:26.4:33.3kg N:P:K/ha, and for linseed it was 50:17.6:16.7 kg N:P:K/ha. The maize crop was sown on 12 June 2004, 15 June 2005 and 10 June 2006 at 60 cm apart rows with plant to plant spacing of 20 cm and linseed crop was sown on 16 October 2004, 26 October 2005 and 10 October 2006 at 22 cm apart rows. The farm yard manure used in the experiment contains 0.52% N, 0.21% P and 0.48% K. The total rainfall received during 2003-04, 2004-05 and 2005-06 was 234.1, 455.6 and 868.7 mm, respectively. The growth parameters and all the yield attributes were recorded for both the crops. The standard analytical methods used for determination of availability of nutrients are alkaline permanganate method for N, Olsen's method for P extraction with neutral normal ammonium acetate and determination by flame photometer for K, Turbidity method for S and DTPA-extraction for Zn.

RESULTS AND DISCUSSION

Growth and yield attributes of linseed

All the treatments have significant influence on the growth parameters of the linseed crop over absolute control (Table 1). Application of $ZnSO_4$ 25 kg/ha to both crops + FYM 5 t/ha to maize recorded significantly higher plant height, number of tillers and branches per plant over rest of treatments. However, application of $ZnSO_4$ 25 kg/ha + FYM 5 t/ha to maize was at par with it in recording significantly higher tillers/plant and branches/plant .The plants were also recorded significantly taller owing to this treatment. The plots receiving application of $ZnSO_4$ 25 kg/ha to linseed + FYM 5 t/ha to maize has significantly similar impact in recording more number of tillers/plant and plant height. The forms and availability of various major and micronutrient content are influenced by the use of FYM with Zn fertilizer coupled with the release of organic acids and other microbial products. Zn content in plant is known to involve in the metabolic activities, controlling auxin levels and nucleic acids in plants thereby contributing towards increase in growth and development of plant (Das, 2000).

Application of $ZnSO_4$ 25 kg/ha to both crops + FYM 5 t/ha to maize recorded significantly higher number of capsules/plant, seeds/capsules and 1000 seed weight over all the treatments but was on par with the application of $ZnSO_4$ 25 kg/ha to linseed + FYM 5 t/ha to maize in recording significantly more number of capsules/plant and seeds/capsules, the application of $ZnSO_4$ 25 kg/ha + FYM 5 t/ha to maize was also statistically similar to $ZnSO_4$ 25 kg/ha to both crops + FYM 5 t/ha to maize for recording significantly higher number of capsules/plant (Table 1).

Maize and linseed yield

On pooled basis and during 2004-05 and 2005-06, application of $ZnSO_4$ @ 25 kg/ha + FYM @ 5 t/ha to maize gave significantly higher yield attributes and grain yield of maize and was on par with $ZnSO_4$ 25 @ kg/ha to both crops + FYM 5 t/ha to maize. However, maize yield recorded during 2005-06 due to application of Zn to both the crops or Zn to maize only was also on par with highest yielder. During 2006-07 application of $ZnSO_4$ @ 25 kg/ha to linseed + FYM 5 t/ha to maize also behaved statistically similar to these treatments (Table 2). On pooled basis, the

Table 1. Effect of zinc and farmyard manure on growth of linseed and yield attributes of linseed and maize at harvest (Pooled data of 3 years)

Treatment	Maize		Linseed					
	Yield attributes		Growth parameters			Yield attributes		
	Grains /cob	1000-grain wt. (g)	Plant height (cm)	Tillers/ plant (No.)	Branches/ plant (No.)	Capsules/ plant (No.)	Seeds/ capsule (No.)	1000-seed weight(g)
Zn to maize only	425.3	227.0	65.9	2.9	6.0	39.1	6.93	6.76
Zn to linseed only	386.7	215.3	63.6	3.0	6.4	36.8	7.83	7.57
Zn to both crops	411.7	218.2	70.3	2.8	6.2	34.1	7.62	7.18
Zn to maize + FYM to maize	445.3	232.3	72.3	3.0	7.2	41.7	7.93	7.61
Zn to linseed + FYM to maize	403.0	222.9	72.4	3.2	6.3	43.5	8.02	7.64
Zn to both crops + FYM to maize	448.7	233.0	76.6	3.6	8.2	48.9	8.49	8.44
Recommended NPK to both crops	420.0	216.1	66.3	3.0	5.0	34.8	7.31	7.10
Control (No NPK, Zn, FYM)	298.3	207.9	60.0	1.9	4.1	22.8	5.77	6.24
SEm±	1.68	1.32	1.38	0.22	0.59	3.02	0.17	0.11
CD (P=0.05)	4.86	3.89	4.20	0.70	1.80	9.20	0.53	0.34

Note: Zn through zinc sulphate @25 kg/ha, and FYM @ 5 t/ha.

per cent increase in maize grain yield recorded with application of $ZnSO_4$ 25 kg/ha to both crops + FYM 5 t/ha to maize and application of $ZnSO_4$@25 kg/ha + FYM 5 t/ha to maize was 21.1 and 21.6, respectively over plots receiving recommended NPK to both crops and 90.7 and 91.6, respectively over absolute control plots. The cumulative beneficial effect of growth and yield attributing characters (Table 2) was finally reflected in grain yield of maize. These findings are similar to Khanday *et al.* (1993) in maize crop. With respect to linseed seed yield and linseed equivalent yield, it was found that on pooled basis during 2004-05 and 2005-06 significantly highest linseed yield and linseed equivalent yield were recorded with application of $ZnSO_4$@ 25 kg/ha to both crops + FYM 5 t/ha to maize. However, during 2005-06 application of $ZnSO_4$ 25 kg/ha either to maize or linseed in combination with FYM 5 t/ha to maize behaved statistically similar to it in recording significantly higher linseed and linseed equivalent yield (Tables 2 and 3). Nandanwar *et al.* (2000) reported the similar results and observed increase in seed yield of linseed due to zinc application at Nagpur. On pooled basis, the application of $ZnSO_4$@25 kg/ha to both crops + FYM 5 t/ha to maize recorded an increase of 65.3 and 158.3% linseed yield over recommended dose of NPK to both crops and absolute control plots, respectively. However, this per cent corresponding increase in linseed equivalent yield was 38.2 and 112.4%.

Economics

The economic indicators indicated that application of $ZnSO_4$ 25 kg/ha to both crops + FYM 5 t/ha to maize recorded significantly highest NMR followed by statistically similar treatments of application of $ZnSO_4$ 25 kg/ha to linseed with FYM 5 t/ha to maize in recording significantly higher NMR over rest of treatments. The benefit: cost ratio was not significantly influenced but recommended application of NPK to both crops recorded numerically the highest B: C ratio (1.15) due to reduced cost of cultivation (16,161/ha) incurred in the application of treatment. Application of $ZnSO_4$ 25 kg/ha to both crops + FYM 5 t/ha to maize followed it very well because of significantly higher linseed equivalent yield (Table 3).

Table 2. Effect of zinc and farmyard manure on maize and linseed yield (t/ha).

Treatment	Maize				Linseed			
	2003-04	2004-05	2005-06	Pooled	2003-04	2004-05	2005-06	Pooled
Zn to maize only	4.12	4.14	4.10	4.12	0.56	0.74	0.89	0.73
Zn to linseed only	3.77	3.73	3.67	3.72	0.58	0.70	1.12	0.80
Zn to both crops	4.10	4.17	3.99	4.09	0.63	0.99	1.05	0.89
Zn to maize + FYM to maize	4.30	4.43	4.95	4.56	0.74	1.02	1.14	0.97
Zn to linseed + FYM to maize	3.87	3.75	4.65	4.09	0.77	1.06	1.24	1.02
Zn to both crops + FYM to maize	4.28	4.36	4.98	4.54	1.12	1.26	1.34	1.24
Recommended NPK to both crops	3.75	3.44	4.06	3.75	0.63	0.68	0.95	0.75
Control (No NPK, Zn, FYM)	2.51	2.26	2.37	2.38	0.35	0.51	0.59	0.48
SEm±	0.04	0.12	0.14	0.14	0.03	0.05	0.07	0.05
CD (P=0.05)	0.11	0.37	0.43	0.42	0.10	0.14	0.21	0.14

Table 3. Effect of zinc and FYM on LEY, economics and available nutrient status after linseed harvest in maize-linseed crop sequence (Pooled basis)

Treatment	Linseed equivalent yield (t/ha)				Economics indicators			Available nutrients				
	2003-04	2004-05	2005-06	Pooled	Cost of cultivation (₹/ha)	NMR (₹/ha)	Net B:C ratio	N (kg/ha)	P (kg/ha)	K (kg/ha)	S (kg/ha)	DTPA extractable Zn (mg/kg)
Zn to maize only	1.69	2.03	2.12	1.95	19,479	16,443	0.84	326	14.9	209	14.2	0.65
Zn to linseed only	1.61	1.85	2.22	1.89	19,570	15,630	0.80	328	15.0	215	15.8	0.69
Zn to both crops	1.77	2.31	2.24	2.11	23,967	15,154	0.63	330	14.8	210	13.9	0.78
Zn to maize + FYM to maize	1.92	2.39	2.62	2.31	21,899	17,892	0.82	350	17.9	220	16.1	0.78
Zn to linseed + FYM to maize	1.83	2.22	2.63	2.23	21,319	20,672	0.97	348	18.0	215	16.5	0.80
Zn to both crops + FYM to maize	2.27	2.61	2.83	2.57	25,029	22,898	0.91	349	17.8	223	15.9	0.81
Recommended NPK to both crops	1.66	1.76	2.17	1.86	16,161	18,511	1.15	329	15.3	212	12.1	0.69
Control (No NPK, Zn, FYM)	1.04	1.29	1.29	1.21	12,213	10,237	0.84	305	11.8	205	9.5	0.58
SEm±	0.04	0.06	0.08	0.07	935	1,004	0.02	3	0.9	1.48	0.69	0.02
CD (P=0.05)	0.11	0.18	0.25	0.21	2,806	3,015	0.07	10	2.8	4.5	2.1	0.06

Soil nutrient status

The available N, P, K and S status of soil and DTPA extractable Zn content was significantly improved after the harvest of linseed crop with either the incorporation of Zn SO_4 25 kg/ha to maize, linseed or both crops alone or in combination with FYM 5 t/ha to maize over absolute control (Table 3). Application of $ZnSO_4$ 25 kg/ha to both crops + FYM 5 t/ha to maize being statistically at par with $ZnSO_4$ @ 25 kg/ha + FYM 5 t/ha to maize significantly improved the overall fertility status of the soil in respect of all the nutrients determined over rest of all treatments. However, application of $ZnSO_4$ @ 25 kg/ha to linseed + FYM 5 t/ha to maize also behaved statistically similar to this treatment in increasing N, P, S and Zn content of the soil. Application of $ZnSO_4$ @ 25 kg/ha to both crops + FYM 5 t/ha to maize increased available N, P, K and S by 57.0, 2.9, 2.0 and 1.5 kg/ha over initial soil fertility status, respectively, while with application of $ZnSO_4$ @ 25 kg/ha + FYM 5 t/ha to maize the increase in N, P and S content in the soil was 58.0, 3.6 and 1.7 kg/ha. These two treatments significantly improved DTPA extractable Zn content by 17.4 and 13.0%, respectively over recommended application of NPK to both crops and 39.7 and 34.5%, respectively over control. The release of organic acids and other microbial products through the conjunctive use of FYM with Zn fertilizer might have influenced the availability of Zn content. These results are similar to the findings of Husain *et al.* (2009) who reported improvement in all the soil nutrients with the application of micro-nutrients and farmyard manure in mustard-soybean crop sequence. Latha *et al.* (2001) also found the increased zinc availability at all the stages of maize crop with enrichment of manure with $ZnSO_4$.

It is concluded that application of 25 kg $ZnSO_4$ and 5 t FYM/ha to maize is enough in maize-linseed system for maximum net returns.

REFERENCES

Bhatia, K.S. and Shukla, K.K. 1982. Effect of continuous application of fertilizers and manure on some physical properties of eroded alluvial soil. *Journal of the Indian Society of Soil Science* **30**(1): 33–36.

Das, D.K. 2000. *Micronutrient: Their Behaviour in Soil and Plants*. Kalyani Publishers, Ludhiana.

Husain, K., Chandra, R., Srivastava, R.L., Dubey, S.S., Singh, K, and Saxena, M.C. 2009. Effect of zinc and farmyard manure on productivity and profitability of rice (*Oryza sativa*)-linseed (*Linum usitatissimum*) crop sequence. *Indian Journal of Agronomy* **54**(4): 395–400.

Kanwar, B.B. and Tripathi, B.R. 1988. Distribution between some soil properties and DTPA extractable micronutrient cations in some soils of Himachal Pradesh. *International Journal of Tropical Agriculture* **6**(1 and 2): 39–46.

Khanday, B.A., Thakur, R.C. and Khushu, M.K. 1993. Nitrogen, FYM and zinc interaction on maize (*Zea mays* L.). *Haryana Journal of Agronomy* **9**(1): 79–81.

Latha, M.R., Savithri, P., Indirani, R. and Kamaraj, S. 2001. Influence of zinc enriched organic manures on availability of micronutrients in soil. *Madras Agricultural Journal* **88**(1 and 3): 165–167.

Meena, M., Patel, K.P. and Rathod, D.D. 2008. Effect of Zn and Fe enriched FYM on yield and removal of nutrients under mustard-soybean (fodder) cropping sequence in semi-arid region of Gujarat. *Indian Journal of Dryland Agricultural Research and Development* **23**: 28–34.

Nandanwar, S.B., Chaphale, S.D., Badola, W.P. and Badola, R. 2000. Effect of sulphur and zinc on growth and yield of linseed. *Journal of Soils and Crops* **10**(2): 301–303.