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Response of Foliar Sprays of Micronutrient Formulations Grades on *Kharif* Onion

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ABSTRACT: A field experiment was conducted on Response of foliar sprays of micronutrient formulations grades on *Kharif* onion at Micronutrient Research Project, Department of Soil Science, Mahatma Phule Krishi Vidyapeeth Rahuri, Dist. Ahmednagar) on silty clay textural soil (*Typic ustorthent*) for three consecutive years of 2016 to 2019 during *Kharif* season. The soil was deficient in available iron, zinc and boron however, sufficient in manganese and copper. The treatments comprised of only GRDF (100:50:50 kgha^{-1} N: P_2O_5: K_2O + 20 tha^{-1} FYM and GRDF with two foliar sprays of water spray, Government notified micro grade II and Phule micro grade II (A and B @ 0.2 and 0.3 %) respectively. The pooled results revealed that the treatment GRDF + Two foliar sprays of Phule micro grade II 'B' @ 0.3 % resulted in significant increase in plant height (60.27 cm), number of leaves (9.01), total chlorophyll content in fresh leaves (2.00 mg g^{-1}), agronomic efficiency (1.88 kg kg^{-1}), bulb (23.10 t ha^{-1}) and stover yield (13.58 q ha^{-1}), total uptake of N (56.91 kg ha^{-1}), P (25.20 kg ha^{-1}), K (81.97 kg ha^{-1}), Fe (1509 g ha^{-1}), Zn (454 g ha^{-1}), Mn (389 g ha^{-1}), Cu (222.1 g ha^{-1}), B (259 g ha^{-1}) and also higher returns per rupees (B:C ratio of 2.20).

Keywords: Micronutrient foliar sprays, nutrient uptake, yield of *kharif* onion.

INTRODUCTION

In India total area under onion during 2022-2023 was 19.14 lakh hectares with production of 312.73 lakh MT and productivity of 16.33 MT ha^{-1}. Maharashtra is one of the leading states in onion production with an area of 9.25 lakh ha, producing 133.02 lakh MT fresh onions with a productivity of 14.38 MTha^{-1} (Anonymous, 2022). Onion being a shallow rooted crop is highly affected due to nutrient deficiencies. The major cause for micronutrient deficiencies is intensified agricultural practices, unbalanced fertilizer application including NPK, depletion of nutrients and no replenishment of micronutrients which are involved in all metabolic and cellular functions (Suman *et al.*, 2017). The deficiency of Zn arises mainly due to alkaline soil pH, calcareousness, low organic matter, exposed sub soil, Zn free fertilizers and flooding induced electrochemical changes, light textured soils, and soils containing low status of zinc. The function of iron in plants depends on the ready transitions between its two oxidation states in solution. Plants store iron as ferrit in, a protein that encapsulates ferric iron. Under aerobic soil conditions, iron is largely insoluble as a constituent of oxides and hydroxides. Ferric iron tends to be tied up in organic chelates. Hence, the concentration of free iron in the soil solution is exceedingly low in many soils.

Plants have mechanisms to mobilize iron and make it available for absorption by their roots. Manganese serves as an activator for enzymes in growth processes. It assists iron in chlorophyll formation. It is part of the system where water is split and oxygen gas is liberated. The splitting of water is an oxidation, namely $2H_2O \rightarrow O_2 + 4H^+ + 4\ e^-$. High manganese concentration may induce iron deficiency. Manganese uptake is primarily in the form of Mn^{++}. Copper can catalyse the formation of harmful free radicals, such as the hydroxyl and superoxide radicals. Thus, the main effect of phytotoxic amounts of Cu is the induction of oxidative stress, which can cause changes in metabolic pathways as a defence mechanism that results in differential responses of enzymes in plant parts. Boron is neither a constituent of enzymes nor it activates any of the enzymes. It is responsible for the cell wall formation and stabilization, lignification and xylem differentiation. It imparts drought tolerance to the crops, plays a role in pollen germination and pollen tube growth. It facilitates transport of K in guard cells as well as stomatal regulation. Molybdenum has a significant effect on pollen formation, so fruit and grain formation are affected in molybdenum-deficient plants. Because molybdenum requirements are so low, most plant species do not exhibit molybdenum-deficiency symptoms (Epstein and Bloom 2005). Looking to the role of essential micronutrients formulations of different grades tried for its efficiency in plant health of *Kharif* onion.

MATERIALS AND METHODS

The present investigation was carried out at Micronutrient Research Project Research Farm of the

Department of Soil Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra for three consecutive years of 2016 to 2019, *Kharif* onion (*Allium cepa* L.) var. Basvant 780 was grown on Entisol. The experimental site climatically belonged to the semi-arid zone (Scarcity Zone) with an average annual rainfall of 519 mm, minimum and maximum temperatures ranging between 13.7^{0}C to 23.6^{0}C and 30.1°C to 36.0°C, respectively with relative humidity during *kharif* ranging from 32 to 69% in morning and 20 to 39% during evening, respectively.

Treatment wise representative soil samples were collected from the depth of 0-22.5 cm for monitoring initial soil properties and fertility status of experimental plot one month prior to transplanting of onion seedlings.

The experiment was laid out in a randomized block design with three replications each comprised of eight treatments *viz.,* T_1: GRDF (100:50:50 kgha^{-1} N : P_2O_5: K_2O + 20 tha^{-1} FYM), T_2: T_1 + two foliar spray of water, T_3: T_1 + two foliar spray of Govt. notified micro grade II (0.2%), T_4: T_1 + two foliar spray of Govt. micro grade II (0.3%), T_5: T_1 + two foliar spray of Phule micro grade II 'A'(0.2%), T_6: T_1 + two foliar spray of Phule micro grade II 'A'(0.3%),T_7: T_1 + two foliar spray of Phule micro grade II 'B'(0.2%) and T_8: T_1 + two foliar spray of Phule micro grade II'B' (0.3%). GRDF was applied in two splits as 1/2 dose of N and full dose of P_2O_5 and K_2O as a basal dose at the time of transplanting and remaining 1/2 dose of N 30 days after transplanting. Foliar application of micro grades spray solutions as per treatments were done at two critical growth stages *i.e.,* at 35 and 55 DAT.

Initial soil properties of experimental site are presented in Table 2 and 3 whereas, composition of Govt. notified micronutrient grade- II, Phule micrograde II 'A' and Phule micrograde II 'B' are presented in Table 1.

Table 1: Composition of various micronutrient grades and Micronutrient supplied in kg through 20 t of FYM ha^{-1}.

Element	Govt. notified Micro Grade II (Foliar)	Phule Micro Grade-II 'A' (Foliar)	Phule Micro Grade-II 'B' (Foliar)	Micronutrient supplied in kg through 20 t of FYM
Fe (%)	2.5	2.5	3.0	1.520
Zn (%)	3.0	4.0	5.0	1.820
B (%)	0.5	0.2	0.5	0.324
Mn (%)	1.0	0.2	0.5	3.840
Cu (%)	1.0	0.5	0.5	0.296
Mo (%)	0.1	00	00	0.042

RESULT AND DISCUSSION

A. Soil Properties

Three years pooled data of chemical properties and fertility status of soil as influenced by different treatments are presented in Table 5 and 6. Soil pH, electrical conductivity, organic carbon, calcium carbonate, available P and K, DTPA- Fe, Zn, Cu and B content of soil at harvest showed non-significant whereas, soil available nitrogen significantly increased (190 kg ha^{-1}) in treatment T_7 over treatment T_1, T_2 and T_4 and were at par with T_3, T_5, T_6 and T_8. DTPA-Mn significantly increased (12.24 mg kg^{-1}) in treatment of T_4 over rest other treatments except treatment T_5 (12.00 mg kg^{-1}) which might be due to higher concentration of Mn (1.0%) in govt. notified micro grade II and can be supported by the findings of Keram *et al*. (2014); Waikar *et al*. (2015); Suryawanshi *et al*. (2016).

B. Yield Contributing Characters and Total Nutrient Uptake

The pooled mean values of onion growth parameters *viz.*, plant height, number of leaves and total chlorophyll content in fresh leaves of onion and total nutrient uptake are presented in table 2 and 3. Significantly, the highest plant height (60.27 cm) was recorded in the treatment T_8 (GRDF + two foliar applications of Phule micro grade-II 'B' @ 0.3%) over treatments T_1, T_2, T_3 and T_5. However, the treatment T_8 was at par with treatment T_4, T_6 and T_7.

Number of leaves and leaf total chlorophyll content recorded significantly higher in treatment of T_8(9.01 and 2.00 mg g^{-1}, respectively) over all the treatment except treatment T_6 (8.22) and T_7 (8.36) for number of leaves and treatment T_6 (1.97 mg g^{-1}) for total leaf chlorophyll content. The results are in agreement with the reports of Durgude *et al.* (2013); Acharya *et al.* (2015); Nagare *et al.* (2017).

The pooled mean values of total uptake of N (56.91kg ha^{-1}), P (25.20 kg ha^{-1}) and K (81.97 kg ha^{-1}) by *kharif* onion were significantly higher in treatment T_8(GRDF + two foliar application of Phule micro grade-II 'B' @ 0.3%) over all the treatments except the treatments T_6 and T_7which were found statistically similar with treatment T_8 for total N and P uptake and treatment T_7 found statistically similar with treatment $T_8$for total K uptake.

The total Fe and Zn uptake by onion was significantly the higher (1509 and 454 g ha^{-1}, respectively) in treatment of T_8 over rest of other treatments whereas, total Mn and Cuuptake by onion was found significantly highest (389 and 222.1g ha^{-1}, respectively) in treatment T_8 over all the treatments except treatment T_7. Total B uptake by onion was found significantly highest (259 g ha^{-1}) in treatment of T_8 which was statistically at par and followed by treatments T_7 and T_5. These results are in conformity with the findings of Durgude *et al.* (2013); Nagare *et al.* (2017).

C. Yield

The pooled mean data are results as reported in Table 2 which revealed that, the bulb yield of onion was significantly influenced by the treatments applied recorded the highest (23.10 t ha^{-1}) in treatment of T_8which was at par with treatment T_7 (22.59 t ha^{-1}) and superior over rest all the treatment. In respect of stover yield, it was significantly recorded higher significantly (13.58 q ha^{-1}) in treatment of T_8 however, it was at par with treatment T_6 and T_7. The similar results were also observed by Khalate *et al.* (2002); Durgude *et al.* (2013); Acharya *et al.* (2015). The increase in bulb yield might be due to increase in metabolic activities in plant as influenced by foliar spray of grade B@0.37.

D. Agronomic efficiency

It is expressed as the additional amount of economic yield per unit nutrient applied in kg kg^{-1} and are presented in Table 5 which revealed that the highest agronomic efficiency (1.88 kg kg^{-1}) was recorded in treatment of T_8 followed by treatment T_7 (1.59 kg kg^{-1}).

E. Economics

Cost of cultivation, gross and net monetary returns and B:C ratio as influenced by application of different foliar micronutrient grades on onion are presented in table 7. The lowest cost of cultivation was recorded in treatment T_1 (Rs. 81105/-) while the highest in treatment T_8 (Rs. 84679/-). The highest net returns (Rs. 101479/-) was recorded in treatment T_8 followed by treatment T_7 (Rs. 97441/-). The B:C ratio was recorded highest (2.20) in treatment T_8 followed by treatment T_7 (2.15). Similar findings are also recorded by Acharya *et al.* (2015); Goyal and Verma (2017).

Overall view of experiment

T_1: GRDF (100:50:50 kg ha^{-1} N: P_2O_5: K_2O + 20 t ha^{-1} FYM)

T_7: GRDF + Two foliar spray of Phule micro grade-II 'B' (0.2%)

T_8: GRDF + Two foliar spray application of Phule micro grade-II 'B' (0.3%)

Table 2: Growth parameter and yield as influence by different foliar micronutrient grades on onion. (Pooled mean).

Tr. No.	Treatments	Plant height (cm)	No. of leaves	Total chlorophyll at 45 DAT (mg g^{-1})	Bulb yield (t ha^{-1})	Stover yield (q ha^{-1})
T_1	GRDF (100:50:50 kg ha^{-1} N: P_2O_5: K_2O + 20 t ha^{-1} FYM)	55.90	7.12	1.52	19.81	11.76
T_2	GRDF + Two foliar spray of water	56.90	7.44	1.57	20.26	11.92
T_3	GRDF + Two foliar spray of Govt. micro grade II (0.2%)	57.17	7.49	1.68	21.62	12.60
T_4	GRDF + Two foliar spray of Govt. micro grade II (0.3%)	58.70	8.11	1.77	21.93	12.81
T_5	GRDF + Two foliar spray of Phule micro grade-II 'A' (0.2%)	57.70	7.53	1.82	21.14	12.77
T_6	GRDF + Two foliar spray of Phule micro grade-II 'A' (0.3%)	58.93	8.22	1.97	21.52	13.15
T_7	GRDF + Two foliar spray of Phule micro grade-II 'B' (0.2%)	59.33	8.36	1.88	22.59	13.20
T_8	GRDF + Two foliar spray of Phule micro grade-II 'B' (0.3%)	60.27	9.01	2.00	23.10	13.58
	SE(m)±	**0.743**	**0.278**	**0.035**	**0.298**	**0.246**
	CD at 5 %	**2.275**	**0.852**	**0.106**	**0.913**	**0.755**

Table 3: Total nutrient uptake as influence by different foliar micronutrient grades on onion (Pooled mean).

Tr. No.	Treatments	Total uptake of macro and micronutrients gha^{-1}							
		N	P	K	Fe	Mn	Zn	Cu	B
T_1	GRDF (100:50:50 kg ha^{-1} N: P_2O_5: K_2O + 20 t ha^{-1} FYM)	46.63	17.89	59.34	1265	316	322	170.3	215
T_2	GRDF + Two foliar spray of water	46.82	19.33	58.56	1281	331	341	177.6	218
T_3	GRDF + Two foliar spray of Govt. micro grade II (0.2%)	50.38	21.26	68.98	1349	365	367	195.9	223
T_4	GRDF + Two foliar spray of Govt. micro grade II (0.3%)	51.79	22.24	73.52	1382	350	389	201.5	240
T_5	GRDF + Two foliar spray of Phule micro grade-II 'A' (0.2%)	52.23	22.24	72.95	1373	356	403	206.1	253
T_6	GRDF + Two foliar spray of Phule micro grade-II 'A'(0.3%)	54.67	24.09	73.91	1410	346	419	209.7	245
T_7	GRDF + Two foliar spray of Phule micro grade-II 'B'(0.2%)	55.73	24.76	78.98	1386	385	437	216.2	257
T_8	GRDF + Two foliar application of Phulemicro grade-I'B' (0.3%)	56.91	25.20	81.97	1509	389	454	222.1	259
	SE(m)±	**1.123**	**0.672**	**1.908**	**23.94**	**4.77**	**5.46**	**3.29**	**2.97**
	CD at 5 %	**3.44**	**2.058**	**5.843**	**73.32**	**14.62**	**16.74**	**10.09**	**9.10**

Table 4: Soil properties as influenced by different foliar micronutrient grades on onion. (Pooled mean).

Tr. No.	Treatments	Soil Properties			
		pH (1:2.5)	EC (dSm^{-1})	Org.C (%)	$CaCO_3$ (%)
T_1	GRDF (100:50:50 kgha^{-1}N : P_2O_5 : K_2O + 20 tha^{-1} FYM)	8.16	0.19	0.53	8.02
T_2	GRDF + Two foliar spray of water	8.15	0.18	0.54	8.01
T_3	GRDF + Two foliar spray of Govt. micro grade II (0.2%)	8.16	0.19	0.54	7.96
T_4	GRDF + Two foliar spray of Govt. micro grade II (0.3%)	8.16	0.18	0.56	7.92
T_5	GRDF + Two foliar spray of Phule micro grade-II 'A' (0.2%)	8.16	0.19	0.55	7.96
T_6	GRDF + Two foliar spray of Phule micro grade-II 'A' (0.3%)	8.16	0.19	0.54	7.95
T_7	GRDF + Two foliar spray of Phule micro grade-II 'B' (0.2%)	8.15	0.18	0.55	7.92
T_8	GRDF + Two foliar spray of Phule micro grade-II 'B' (0.3%)	8.15	0.19	0.53	7.89
	SE(m)±	**0.021**	**0.001**	**0.009**	**0.022**
	CD at 5 %	**NS**	**NS**	**NS**	**NS**
	Initial	**8.2**	**0.18**	**0.54**	**8.0**

Table 5: Soil properties as influenced by different foliar micronutrient grades on onion. (Pooled mean).

Tr. No.	Treatments	Available Nutrients (kg ha^{-1}))			
		Av.N	Av.P	Av. K	Agronomic efficiency (kg kg^{-1})
T_1	GRDF (100:50:50 kgha^{-1}N : P_2O_5 : K_2O + 20 tha^{-1} FYM)	174	12.72	584	-
T_2	GRDF + Two foliar spray of water	172	13.57	568	0.26
T_3	GRDF + Two foliar spray of Govt. micro grade II (0.2%)	182	12.72	586	1.03
T_4	GRDF + Two foliar spray of Govt. micro grade II (0.3%)	180	14.02	591	1.21
T_5	GRDF + Two foliar spray of Phule micro grade-II 'A' (0.2%)	188	12.46	609	0.76
T_6	GRDF + Two foliar spray of Phule micro grade-II 'A' (0.3%)	186	13.22	614	0.98
T_7	GRDF + Two foliar spray of Phule micro grade-II 'B' (0.2%)	190	12.69	602	1.59
T_8	GRDF + Two foliar application of Phule micro grade-II 'B' (0.3%)	186	12.49	590	1.88
	SE(m)±	**3.143**	**0.437**	**13.805**	**-**
	CD at 5 %	**9.627**	**NS**	**NS**	**-**
	Initial	**188**	**15.8**	**458**	

Table 6: Soil available micronutrients as influenced by different foliar micronutrient grades on onion. (Pooled mean).

Tr. No.	Treatments	DTPA- Micronutrients (mg kg^{-1})				Av. B (mg kg^{-1})
		Fe	Mn	Zn	Cu	
T_1	GRDF (100:50:50 kgha^{-1} N: P_2O_5: K_2O + 20 tha^{-1} FYM)	4.01	11.60	0.43	2.07	0.34
T_2	GRDF + Two foliar spray of water	3.86	11.77	0.41	2.33	0.31
T_3	GRDF + Two foliar spray of Govt. micro grade II (0.2%)	4.16	11.31	0.42	2.35	0.30
T_4	GRDF + Two foliar spray of Govt. micro grade II (0.3%)	4.16	11.24	0.42	2.37	0.36
T_5	GRDF + Two foliar spray of Phule micro grade-II 'A' (0.2%)	3.96	11.60	0.41	2.31	0.32
T_6	GRDF + Two foliar spray of Phule micro grade-II 'A' (0.3%)	4.06	11.44	0.42	2.36	0.34
T_7	GRDF + Two foliar spray of Phule micro grade-II 'B' (0.2%)	4.00	11.56	0.42	2.27	0.34
T_8	GRDF + Two foliar spray of Phule micro grade-II 'B' (0.3%)	4.10	11.49	0.41	2.34	0.36
	SE(m)±	**0.096**	**0.015**	**0.012**	**0.068**	**0.010**
	CD at 5 %	**NS**	**NS**	**NS**	**NS**	**NS**
	Initial	**4.1**	**12.40**	**0.48**	**2.30**	**0.38**

Table 7: Economics of onion as influenced by different foliar micronutrient grades.

Tr. No.	Treatments	Cost of cultivation	Gross monetary returns	Net monetary returns	B:C ratio
		Rs ha^{-1}			
T_1	GRDF (100:50:50 kg ha^{-1} N: P_2O_5: K_2O + 20 t ha^{-1} FYM)	81105	159656	78551	1.97
T_2	GRDF + Two foliar spray of water	84439	163272	78833	1.93
T_3	GRDF + Two foliar spray of Govt. micro grade II (0.2%)	84587	174220	89633	2.06
T_4	GRDF + Two foliar spray of Govt. micro grade II (0.3%)	84661	176721	92060	2.09
T_5	GRDF + Two foliar spray of Phule micro grade-II 'A' (0.2%)	84567	170397	85830	2.01
T_6	GRDF + Two foliar spray of Phule micro grade-II 'A' (0.3%)	84631	173475	88844	2.05
T_7	GRDF + Two foliar spray of Phule micro grade-II 'B' (0.2%)	84599	182040	97441	2.15
T_8	GRDF + Two foliar spray of Phule micro grade-II 'B' (0.3%)	84679	186158	101479	2.20

Note: Rs. 13.04/kg N, Rs. 48.75/kg P_2O_5, Rs. 19.43/kg K_2O, Rs. 1200/t FYM, bulb Rs.8000/t, stover Rs. 100/q, spraying charges@ Rs 50/15 lit pump (Rs. 1667/ha), Grade II Rs. 74/L, Phule A Rs. 64/L, Phule B Rs. 80/L

CONCLUSIONS

Foliar application of Phule micro grade-II 'B' (Fe 3%, Zn 5%, Mn 0.5%, B 0.5%, Cu 0.5%) @ 0.3% at35 and 55 days after transplanting of onion seedlings along with general recommended dose of fertilizers (100:50:50 kg ha^{-1} N:P_2O_5:K_2O + 20 t ha^{-1} FYM) found beneficial for increase in bulb yield, nutrient uptake, agronomic efficiency and higher monetary returns on shallow silty clay soils of Western Maharashtra.

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