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Nutrient status of soil, yield and nutrient content of onion (*Allium cepa* L.) as influenced by foliar application of various fertilizers

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Abstract
A field experiment was carried out on medium black calcareous soil during *rabi* season of 2018-19 and 2019-20 at Junagadh Agricultural University, Junagadh, Gujarat to evaluate the effect of foliar application of various fertilizers on growth, yield and nutrients uptake by onion (*Allium cepa* L.). The results revealed that the application of RDF + 1% foliar spray of WSF and Banana pseudostem sap at 45 and 60 DAT gave significantly higher value of available N, P_2O_5, K_2O and S in soil after harvest of onion. While, effect of different fertilizers on micronutrients content in soil was found non-significant. Significantly higher value of plant height, bulb polar diameter, bulb equatorial diameter, average bulb weight and bulb yield were recorded with RDF + 1% foliar spray of WSF and Banana pseudostem sap at 45 and 60 DAT. The magnitude of increased in bulb yield in pooled results were 13.01and 12.14% owing to application of RDF + 1% foliar spray of WSF and Banana pseudostem sap at 45 and 60 DAT and RDF + 1% foliar spray of WSF and Grade IV at 45 and 60 DAT, respectively over control. The application of RDF + 1% foliar spray of WSF and Banana pseudostem sap at 45 and 60 DAT gave significantly higher N and P content in bulb and leaves and S content in bulb and application of RDF + 1% foliar spray of WSF and multi-micronutrient formulation Grade IV at 45 and 60 DAT gave significantly higher K and Cu content in bulb and leaves, respectively and Fe content in bulb. While, significantly higher Mn and Zn content in bulb and leaves, S and Fe content in leaves were observed with application of 75% RDF + 1% foliar spray of WSF and Grade IV at 45 and 60 DAT.

Keywords: Onion, available nutrients, yield, nutrients content, WSF, Multi Micronutrients mixture, Banana sap

1. Introduction
Onion is one of the important commercial bulbous vegetable crop grown throughout the world. It is the only vegetable in which India figures prominently in the world for its production and export. However, the average productivity of onion is still very low. India is the second largest producer of onion in the world and occupies 12.63 thousand ha area with a production of 23.48 million MT (Anon. 2018) [1]. The growth and yield of onion is governed by the interaction of environment with the genetic makeup of the variety, various inputs, such as water, fertilizer, pesticides etc. One of the goals of nutrient management is to supply nutrients in a timely manner to maximize crop yield and quality. Recently, using macro and micro nutrients through foliar fertilization is preferable to avoid not only nutrient fixation in the soil, but also leaching during irrigation. It is also recognized that supplementary foliar fertilization during crop growth can improve the mineral status of plants and increase the crop yield and quality (Kolota and Osinska, 2001) [4]. Now in India, there are many foliar fertilizers containing the most macro and micro elements usually used to correct any deficiency in soil. Many investigators reported that, spraying the plants with foliar fertilizer have an important role in plant growth, yield and quality. An understanding of this improved fundamental aspect of foliar additions of nutrients in onion would help to more precisely predict which foliar fertilization for maximum benefit and enhance the success and reliability of this practice.

2. Materials and Method
A field experiment was conducted for two consecutive years in *rabi* season (2018-19 and 2019-20) at Vegetable Research Station, Junagadh Agricultural University, Junagadh (Gujarat) to evaluate the effect of foliar application of various fertilizers on growth, yield and nutrients uptake by onion (*Allium cepa* L.). The experiment was conducted in Randomized Block Design with three replications. There were twelve treatments *viz.*, T_1: Control (Fertilizer as per

RDF soil application), T_2: RDF + 1% foliar spray of WSF at 45 and 60 DAT, T_3: 75% RDF + 1% foliar spray of WSF at 45 and 60 DAT, T_4: RDF + 1% foliar spray of multi-micronutrient Grade IV at 45 and 60 DAT, T_5: 75% RDF + 1% foliar spray of multi-micronutrient Grade IV at 45 and 60 DAT, T_6: RDF + 1% foliar spray of Banana pseudostem sap at 45 and 60 DAT, T_7: 75% RDF + 1% foliar spray of Banana pseudostem sap at 45 and 60 DAT, T_8: RDF + 1% foliar spray of WSF and Grade IV at 45 and 60 DAT, T_9: 75% RDF + 1% foliar spray of WSF and Grade IV at 45 and 60 DAT, T_{10}: RDF + 1% foliar spray of WSF and Banana pseudostem sap at 45 and 60 DAT, T_{11}: 75% RDF + 1% foliar spray of WSF and Banana pseudostem sap at 45 and 60 DAT and T_{12}: Fertilizer application as per yield target 30 t/ha (95-69-53-20 N-P_2O_5-K_2O-S kg/ha).The Water Soluble Fertilizers (WSF) has been given in form of 19-19-19 (N-P-K) as foliar application, while, recommendation dose of fertilizer (RDF) for onion is 75:60:50:20 N-P_2O_5-K_2O-S kg/ha which was applied as per recommended schedule. Nutrients content in multi micronutrient mixture grade- IV content was Fe- 4%, Mn- 1%, Zn- 6%, Cu- 0.5% and B- 0.5%.

Initial soil available nitrogen (N), phosphorous (P_2O_5) and potassium (K_2O) content in soil of the experimental site were 252, 48 and 315 kg/ha, while, sulphur (S) 18.54 mg/kg and micronutrients like Fe, Mn, Zn and Cu were 8.13, 12.87, 0.771 and 1.72 mg/kg, respectively.

The seeds of onion cv. Gujarat Junagadh White Onion 3 were sown in nursery first to raise the seedlings and then 30-35 days old seedlings were used for transplanting under field conditions. All the standard recommended cultural practices and plant protection measures were followed throughout the experimental periods.

The crop was harvested during second week of April during both the years and bulb yield, growth and yields attributes were recorded. The oven dried bulb and dry leaves samples were finely ground in Wiley mill and nutrients content were determined with standard procedures. Data were statistically analyzed using standard statistical method appropriate for experimental design adopted.

3. Results and Discussion

3.1 Nutrients status in soil at harvest of crop

The data in Table-1 revealed that the application of RDF + 1% foliar spray of WSF and Banana pseudostem sap at 45 and 60 DAT (T_{10}) gave significantly higher value of available N (263 kg/ha), P_2O_5 (43.4 kg/ha) K_2O (314 kg/ha) and S (17.5 ppm) in soil after harvest of onion. While, effect of different fertilizers on micronutrients content in soil were found non significant.

Plant roots excrete organic acids and chelating organic compounds in rhizosphere. These compounds form multiple complex compounds with Ca, Mg and/or Fe and thereby increased phosphorus availability in soil (Tinker, 1980) [11]. Increased availabilities of N, P, and K may also result from changes in soil nutrient turnover rates due to altered ecosystem properties. Soil nutrient turnover rate consist of decomposition, mineralization, weathering, chemical complexation, adsorption or nutrient uptake by crops and soil organisms (Mengel, 1982; Wallbridge and Vitousek, 1987 and Marrs, 1993) [6, 13, 5].

3.2 Growth, yield attributes and yield

The two year pooled data present in Table– 2 revealed that the significantly higher onion yield (33.79 t/ha), growth and yield parameters *viz*., plant height (55.52 cm), bulb polar diameter (6.41cm), bulb equatorial diameter (5.38 cm), average bulb weight (62.2 g) were recorded with treatment T_{10} (RDF + 1% foliar spray of WSF and Banana pseudostem sap at 45 and 60 DAT) and this treatment was statistically par with treatment T_4, T_6, T_8, T_9 and T_{11} in pooled results with respect to bulb yield, treatments T_{11}, T_8, T_4, T_{12}, T_6 and T_5 in case of plant height, T_8, T_{11}, T_4, T_9 and T_{12} in case of bulb polar diameter, T_{11} and T_8 in case of bulb equatorial diameter and T_{11}, T_8, T_9, T_6, T_{12}, and T_4 in case of average bulb weight. However, the number of leaves per plant and neck thickness did not affect significantly due to different treatments.

The probable reasons for higher plant height, no. of leaves per plant, neck thickness, bulb diameter, average bulb weight and bulb yield under application of RDF + water soluble fertilizer (19:19:19 N:P:K) + Banana pseudostem sap might be due to adequate availability of easily soluble nutrients. This attribute to an optimum level of synthesis of cytokinins at higher levels of N and P would have resulted in a favourable sink to supply more nutrients during critical growth stages. Increase in availability of N from foliar spray fastens the photosynthetic activity. Increase in bulb growth was attributed to the better utilization of photosynthates and increased allocation of photosynthates towards the economically useful parts. These findings are in conformity with the results of Narayanamma, *et al.* (2006) [7] in brinjal, Chakraborty and Chaudhuri (2008) [2] and Vekaria *et al.* (2018) [12] in garlic.

3.3 Nutrients content in onion

The nutrients content in onion bulb and leaves varied significantly due to different doses of fertilizers (Table 3 and 4). The data clearly indicated that the application of RDF + 1% foliar spray of WSF and Banana pseudostem sap at 45 and 60 DAT (T_{10}) gave significantly higher N (1.90 and 2.04%) and P (0.331 and 0.340%) content in bulb and leaves and S (0.296%) content in bulb. But where RDF + 1% foliar spray of WSF and multi-micronutrient formulation Grade 4 at 45 and 60 DAT (T_8) was employed, it had significantly increase K (1.30 and 1.42%) and Cu (46.4 and 52.2 ppm) content in bulb and leaves, respectively and Fe content (593 ppm) in bulb. While, significantly higher Mn (95.9 and 36.0 ppm) and Zn (58.8 and 41.1 ppm) content in bulb and leaves, S (0.546%) and Fe (1049 ppm) content in leaves were observed with application of 75% RDF + 1% foliar spray of WSF and Grade IV at 45 and 60 DAT (T_9). The improvement in the nutrients content could be attributed to an enhancement in absorption and assimilation of the micronutrients which provided balanced nutrition to the crops for higher growth and thereby nutrients uptake which ultimately resulted into higher yield of the crops. The increased nutrients content and ultimately uptake by crops due to use of multi-micronutrients fertilizers have also been reported by several workers Ghritlahare *et al*., (2015) [3], Patel *et al.* (2008) [8], Polara *et al.* (2017) [9], Vekaria *et al.* (2018) [12] and Sakarvadia *et al.* (2020) [10].

4. Conclusion

The results of the study revealed that soil sustainability in terms of availability of major plant nutrients and onion yield under medium black calcareous soil can be achieved with application of 75% RDF (56-45-37.5-15 kg/ha N-P_2O_5-K_2O-S) + 1% foliar spray of water soluble fertilizer (19-19-19% N-P-K) and 1% Banana pseudostem sap both at 45 and 60 day after transplanting with higher nutrient content in onion bulb and leaves.

Table 1: Effect of various fertilizers on available nutrients in soil at harvest of onion (Pooled)

Treatment	N	P_2O_5	K_2O	S	Fe	Mn	Zn	Cu
	(kg/ha)			(ppm)				
T_1	256	41.3	307	16.8	7.56	12.0	0.769	1.82
T_2	259	42.1	310	17.3	7.70	13.1	0.792	1.87
T_3	226	28.4	263	14.5	8.15	12.1	0.767	1.88
T_4	257	42.8	307	17.1	7.39	13.0	0.759	1.84
T_5	227	29.7	265	14.3	7.79	12.8	0.779	1.85
T_6	259	41.9	310	17.3	7.74	12.3	0.750	1.89
T_7	225	29.9	266	13.9	7.45	11.9	0.774	1.88
T_8	260	42.4	308	17.0	7.67	13.0	0.777	1.83
T_9	227	31.0	267	14.1	7.84	13.6	0.738	1.86
T_{10}	263	43.4	314	17.5	7.97	13.5	0.797	1.95
T_{11}	226	30.0	272	14.4	7.87	13.6	0.769	1.93
T_{12}	262	43.2	312	12.7	7.50	13.2	0.754	1.88
S.Em.±	8	1.7	10	0.7	0.35	0.5	0.032	0.08
C. D. at 5%	23	5.0	29	1.9	NS	NS	NS	NS
C. V.%	8.1	11.5	8.5	10.3	11.0	9.6	10.2	10.3
Y x T								
S.Em. ±	11	2.5	14	0.92	0.49	0.71	0.045	0.11
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of application of various fertilizers on growth, yield attributes and yield of onion (Pooled)

Treatments	Plant height (cm)	No of leaves per plant	Neck thickness (cm)	Bulb polar diameter (cm)	Bulb equatorial diameter (cm)	Average bulb weight (g)	Bulb yield (t/ha)
T_1	48.39	10.68	1.07	5.05	4.64	50.3	27.85
T_2	51.65	11.41	1.06	5.86	5.00	56.2	29.56
T_3	51.15	11.20	1.05	5.57	4.89	55.1	28.22
T_4	53.80	11.64	1.13	6.04	5.05	58.1	31.18
T_5	52.30	11.51	1.06	5.71	4.98	56.2	29.54
T_6	53.20	11.77	1.12	5.89	5.06	59.2	31.05
T_7	51.94	11.20	1.11	5.25	4.90	55.2	28.05
T_8	54.61	11.86	1.18	6.37	5.25	61.9	33.49
T_9	53.79	11.63	1.11	6.00	5.08	60.5	32.73
T_{10}	55.52	12.00	1.20	6.41	5.38	62.2	33.79
T_{11}	54.62	11.70	1.14	6.07	5.25	61.9	33.53
T_{12}	53.33	11.58	1.16	5.99	5.06	58.8	29.90
S.Em.±	1.10	0.46	0.04	0.18	0.09	1.7	1.01
C.D. at 5%	3.15	NS	NS	0.50	0.25	4.8	2.88
C.V.%	5.12	9.68	8.5	7.5	4.31	7.1	8.05
Y x T							
S.Em. ±	1.56	0.64	0.05	0.25	0.13	2.37	1.43
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS

Table 3: Effect of various fertilizers on nutrientt content in onion bulb

Treatments	Nutrients content in onion bulb							
	N	P	K	S	Fe	Mn	Zn	Cu
	(%)				(ppm)			
T_1	1.65	0.284	1.07	0.265	493	72.3	46.0	37.2
T_2	1.85	0.320	1.26	0.268	511	81.9	50.9	40.4
T_3	1.81	0.299	1.21	0.274	517	84.7	50.9	40.6
T_4	1.72	0.288	1.10	0.275	561	90.4	55.7	44.5
T_5	1.69	0.275	1.03	0.283	577	94.0	57.0	45.4
T_6	1.78	0.295	1.12	0.263	520	80.0	47.9	38.5
T_7	1.71	0.294	1.08	0.277	525	78.6	46.9	37.8
T_8	1.87	0.326	1.30	0.281	593	93.4	57.8	46.4
T_9	1.82	0.308	1.23	0.289	590	95.9	58.8	45.0
T_{10}	1.90	0.331	1.29	0.296	555	84.7	52.0	40.0
T_{11}	1.85	0.316	1.24	0.280	541	83.2	50.3	39.3
T_{12}	1.82	0.309	1.21	0.252	522	80.6	50.1	39.7
S.Em.±	0.04	0.008	0.04	0.007	14	3.1	1.6	1.0
C. D. at 5%	0.10	0.023	0.10	0.020	39	8.7	4.6	2.9
C. V.%	5.0	6.4	7.5	6.1	6.2	8.8	7.5	6.1
Y x T								
S.Em. ±	0.05	0.01	0.05	0.01	19.42	4.34	2.26	1.45
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS

Table 4: Effect of various fertilizers on nutrientt content in onion leaves

Treatments	Nutrients content in onion leaves							
	N	P	K	S	Fe	Mn	Zn	Cu
	(%)				(ppm)			
T_1	1.76	0.283	1.18	0.485	884	28.3	32.5	43.1
T_2	1.98	0.325	1.39	0.489	901	30.9	34.5	45.4
T_3	1.90	0.297	1.30	0.490	908	31.2	35.0	46.2
T_4	1.83	0.290	1.23	0.528	1028	34.7	39.1	51.0
T_5	1.76	0.269	1.13	0.532	1038	35.4	39.9	50.5
T_6	1.86	0.293	1.24	0.494	915	30.5	33.4	44.1
T_7	1.81	0.284	1.19	0.509	932	30.2	32.8	43.4
T_8	2.00	0.331	1.42	0.533	1044	35.4	40.8	52.2
T_9	1.95	0.310	1.31	0.546	1049	36.0	41.1	51.5
T_{10}	2.04	0.340	1.41	0.502	938	30.5	35.5	44.9
T_{11}	1.97	0.320	1.31	0.498	942	31.3	35.1	44.9
T_{12}	1.95	0.305	1.36	0.483	929	31.1	35.7	46.0
S.Em.±	0.04	0.009	0.04	0.013	24.04	1.0	1.0	1.1
C. D. at 5%	0.13	0.025	0.10	0.037	69	2.9	2.9	3.2
C. V.%	5.68	7.18	6.95	6.19	6.14	7.76	6.77	5.77
Y x T								
S.Em. ±	0.06	0.01	0.05	0.02	34.00	1.44	1.42	1.56
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS

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