www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2020; 9(10): 176-181

www.thepharmajournal.com
Received: 01-08-2020
Accepted: 04-09-2020

Solanki RM
Micro Irrigation Research Project, Department of Agronomy, Junagadh Agricultural University, Junagadh, Gujrat, India

Malam KV
Ph.D., Scholar, Department of Agronomy, Junagadh Agricultural University, Junagadh, Gujrat, India

Vasava MS
Micro Irrigation Research Project, Department of Agronomy, Junagadh Agricultural University, Junagadh, Gujrat, India

Chhodavadia SK
Instructional Farm, Department of Agronomy, Junagadh Agricultural University, Junagadh, Gujrat, India

Corresponding Author:
Malam KV
Ph.D., Scholar, Department of Agronomy, Junagadh Agricultural University, Junagadh, Gujrat, India

Influence of *rabi* onion (*Allium cepa* L.) to levels and application schedule of soluble fertilizers under drip irrigation

Solanki RM, Malam KV, Vasava MS and Chhodavadia SK

Abstract
An experiment during *rabi* season of 2016-17 to 2018-19. The experiment was laid out in a split plot design with four replication. The results revealed that significantly maximum bulb yield and stalk yield was recorded when fertilized the crop with 100% RDF (F_3) through fertigation during individual years and on pooled data basis, which was found statistically at par with F_2 (75% RDF) during individual years as well as in pooled results. Fertilizing the crop with 100% RDF through fertigation recorded significantly maximum plant height, equatorial diameter and polar diameter. On pooled data basis minimum doubles per plot was noted when crop was fertilized with 50% RDF (F_1). Fertigation at 10 days interval (T_3- 6 splits) produced significantly maximum bulb yield which was closely followed by fertigation at 8 days interval (8 splits) (T_2) and it was found statistically on same bar during 2016-17 and 2018-19. Similarly, significantly higher stalk yield, maximum no. of leaves plant^{-1} and maximum polar diameter were recorded when onion was fertilized through fertigation in six equal splits at 10 days interval (T_3) during 2016-17 and 2018-19, respectively.

Keywords: Influence, *rabi* onion, *Allium cepa* L, schedule, soluble fertilizers

Introduction
Onion (*Allium cepa* L.) is an important bulbous vegetable crop belonging to family Alliaceae is mainly grown for local consumption as well as for export purpose. It is also called as *viz.*, *Pyaz*, *Ullagaddi*, *Eerulli*, *Neerulli* in vernacular language. Since it is an indispensible component of culinary in the Indian kitchen. Therefore onion is popularly referred as "Queen of the Kitchen". In addition to these onion is used as salad and pickle.Onion is the most important crop grown almost all over the country. In India, it is grown in 1.21 million hectares with a production of 22.82 million tonnes and productivity of 18.71 tonnes per hectares. In Gujarat, it is grown in about 0.44 lakh hectares with a production of 1.11 million tonnes and productivity of 25.1 tonnes per hectares (NHRDF, 2018) [14]. Fertilizer application is one of the most important factors in onion production because it directly affects growth, development and yields (Kurtz *et al.*, 2013) [11].

Water and fertilizers are the main limiting factors affecting the agricultural production in arid and semi-arid regions. Application of fertilizers with irrigation water has several advantages. By fertigation, the time and rate of fertilizer applied can be regulated precisely. Fertigation is the most efficient method of fertilizer application, as it ensures application of the water and fertilizers directly to the plant roots leading to greater efficiency of application (Rajput and Patel, 2006) [16]. Fertigation can save fertilizers by 50% and may increase the crop yield by 20-30%. Dingre *et al.* (2012) [6] showed that drip fertigation resulted into 12 to 74% increase in the productivity of onion seed as compared to conventional method. It has been reported that efficiency of nitrogenous fertilizers is 95% under drip fertigation compared to 30-50% under soil application. Fertigation ensures saving in fertilizer (40-60%), due to better fertilizer use efficiency and reduction in leaching (Kumar and Singh, 2002) [9]. On the basis of performance evaluation of onion cultivation under trickle irrigation method in comparison to traditional method of irrigation at Etawah (Uttar Pradesh), (Gufran and Rajput, 2012) [7] reported that the yield of onion crop was higher under trickle method rather than traditional method with 70% of water saving, size and test weight of onion bulb, plant growth and B:C were also more in drip method of irrigation.

Information on combined use of fertilizers with drip irrigation is limited in a closely spaced crop like onion in our country.

Keeping all these points in view, a research experiment was frame out on "Influence of *rabi* onion (*Allium cepa* L.) to levels and application schedules of soluble fertilizers under drip irrigation" was proposed and conducted from *rabi*-2016-17 to 2018-19 at Micro Irrigation Research Project, Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh.

Material and Methods

The field experiment was carried out during *rabi* season of 2016-17 to 2018-19 at Micro Irrigation Research Project, Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat). The area is situated in southern part of Gujarat, which falls under South Saurashtra agro-climatic zone. It lies between the parallels of 20º51' N latitudes and 70º31' E longitudes with an average elevation of 83 meters above mean sea level.

The field experiment was carried out to study the influence of *rabi* onion (*Allium cepa* L.) to levels and application schedules of soluble fertilizers under drip irrigation. The soil of experimental field was medium black in texture, medium in available phosphorus, potassium and O.C. with alkaline in reaction (pH of 8.74). The net plot area of 4.0 m × 2.1 m. The 45 days old seedlings of onion (cv. Pilipatti) were dibbled at 15 cm × 10 cm spacing. Nine treatment combinations consisted of three fertigation levels *viz.*, F_1: 50% RDF, F_2: 75% RDF, F_3: 100% RDF (75-60-50 Kg/ha of N:P:K) and three levels of fertigation schedule *viz.*, T_1: Fertigation at 6 days interval (10 splits), T_2: Fertigation at 8 days interval (8 splits) and T_3: Fertigation at 10 days interval (6 splits) were tested under split plot design with four replications. The crop was raised as per recommended package of practices made for the region. During the experimental period, no infestation of serious pests and diseases were observed. In the control plot soil application of 100% RDF and irrigation as per recommendations through surface irrigation at 0.8 IW/CPE ratio with 50 mm depth were applied. The source of fertilizers, liquid fertilizer 19-19-19% NPK and N and P in the form of Urea and Phosphoric acid, respectively were used. A basal dose of well decomposed farm yard manure @ 5 t ha^{-1} was incorporated in the soil before one month of sowing. Drip irrigation at 1.0 IW/CPE. Fertigation start after two common flood irrigations for proper establishment of crop. In control plot half dose of N and full dose of P and K applied as basal and remaining half dose of N was applied at 30 DAT.

Results and Discussion

Effect of level of fertilizer

Bulb and stalk yields

The data furnished in Table-1 showed that different levels of fertilizer had significant effect on bulb and stalk yields. Significantly maximum bulb yield of 30000, 29818, 31687 and 30502 kg ha^{-1} was recorded when the crop fertilized with 100% RDF (F_3) through fertigation during 2016-17, 2017-18, 2018-19 and on pooled data basis, respectively which was found statistically at par with F_2 (75% RDF) during individual years as well as in pooled results. Stalk yield of onion was also significantly influenced by various levels of fertilizer. Significantly maximum stalk yield of 2750, 2291, 2229 and 2423 kg ha^{-1}during 2016-17, 2017-18, 2018-19 and in pooled results, respectively was recorded when crop was fertilized with 100% RDF (F_3) and it was remained on same bar with F_2 (75% RDF) during 2016-17 and 2018-19.

The increase in bulb and stalk yields might be due to nitrogen application improve the vegetative growth and increase in net assimilation rate and accelerating the photosythates in storage organs of bulbs, resulting in an increased diameter and weight of the bulb (Sharma, 1992) [17]. Rahim *et al.* (1992) [15] and Al-Moshileh (2001) [2] have also reported a significant effect of nitrogen and phosphorus on growth and yield of onion. Nasreen *et al.* (2007) [13] reported that the addition of nitrogen fertilizers exerted significant influence on the single bulb weight and yield of onion. Ali *et al.* (2007) [1] reported that bulb diameter of onion crop is positively affected by potassium, the bulb diameter increases with increases potash levels.

Table 1: Influence of levels and application schedule of soluble fertilizers through fertigation on onion yield

Treatments	Bulb Yield (kg/ha)				Stalk yield (kg/ha)			
	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled
Level of fertilizer								
F_1-50% RDF	21337	25457	27126	24640	2016	1739	1927	1894
F_2-75% RDF	28717	29247	30178	29381	2469	1913	2119	2167
F_3-100% RDF	30000	29818	31687	30502	2750	2291	2229	2423
S.Em. ±	1134.8	1034.7	1018.8	614.3	141.4	93.5	65.9	60.6
CD at 5%	3927.3	3580.6	3525.5	1825.2	489.3	323.5	228.2	180.1
CV%	14.7	12.7	11.3	13.1	20.3	16.3	10.9	16.8
Time of application								
T_1- Fertigation at 6 days interval (10 splits)	25411	24931	26406	25583	2242	1643	1735	1874
T_2-Fertigation at 8 days interval (8 splits)	26193	28088	30453	28245	2318	1965	2140	2141
T_3-Fertigation at 10 days interval (6 splits)	28450	31503	32133	30695	2675	2335	2400	2470
S.Em.±	824.6	566.0	762.6	419.3	92.2	79.1	51.7	44.0
CD at 5%	2450.2	1681.9	2265.9	1188.8	274.4	235.2	153.5	124.8
CV%	10.7	7.0	8.9	8.9	13.3	13.8	8.6	12.2
F x T interaction								
S.Em. ±	1428.3	980.4	1320.9	1257.8	159.8	137.1	89.5	132.1
CD at 5%	NS	NS	NS	NS	NS	NS	NS	374.5

Growth and yield attributes

Results furnished in Table 2 to 4 revealed that growth attributes *viz.*, plant height (cm), equatorial diameter (mm), polar diameter (mm) and no. of doubles $plot^{-1}$ were significantly influenced by different levels of fertilizer. Fertilizing the crop with 100% RDF through fertigation (F_3) recorded significantly maximum plant height of 51.7 and 50.3 cm during 2016-17 and in pooled results, respectively (Table-

2). Results presented in Table-3 indicated that significantly maximum equatorial diameter of 37.44 mm was recorded when crop was fertilized with 100% RDF through fertigation in pooled results. Application of 100% RDF through fertigation recorded significantly maximum polar diameter of 52.86 mm and 52.28 mm during 2018-19 and in pooled, respectively and it was statistically at par with F_2 (75% RDF) in case of polar diameter. On pooled data basis minimum doubles per plot (Table-4) was noted when crop was fertilized with 50% RDF (F_1).

The increase in plant height, stem diameter and bulb diameter with the addition of NPK may be attributed to more availability of nutrients, especially N, which enhances the number of leaves by its simulative effect on cell division and cell enlargement that in turn may increase number of leaves and leaf dimensions. This finding is correlated with the findings of Tiwari *et al.,* 2002 [20]. Number of leaves and neck thickness were also higher in drip irrigation method that indicated that in drip irrigation system plant receive favourable conditions for enlargement of root system thereby plant growth and vigour is high. The results are in line with the results of Bhonde *et al*. (2003) [4]; Kumar *et al.* (2007) [10] and Bangali *et al*. (2012) [3] for plant growth. Nasreen *et al.*, (2007) [13] reported that the addition of nitrogen fertilizers exerted significant influence on the number of leaves/plant, plant height and bulb diameter of onion.

Effect of time of fertilizer application

Bulb and stalk yields

Bulb and stalk yields of onion were significantly influenced by time of fertilizer application during individual years as well as in pooled results (Table-1). Fertigation at 10 days interval (T_3- 6 splits) produced significantly maximum bulb yield of 28450, 31503, 32133 and 30695 kg ha^{-1} during 2016-17, 2017-18, 2018-19 and in pooled results, respectively which was closely followed by (T_2) fertigation at 8 days interval (8 splits) and it was found statistically on same bar during 2016-17 and 2018-19. Similarly, significantly higher stalk yield of 2675, 2335, 2400 and 2470 kg ha^{-1} was recorded when onion was fertilized through fertigation in six equal splits at 10 days interval (T_3).

Split application of fertilizers were found to consistently reduce the amount of N leaching, even though year to year differences of N leaching reductions (Nakamura *et al.,* 2004) [12]. Similarly, frequent application of fertilizer improves the quality and quantity of crop yield compared to conventional practices. Earlier studies had also demonstrated an improved nutrient movement of soil P and K in root zone with drip fertigation. Hebbar *et al.* (2004) [8] observed higher tomato yield through fertigation than banded and furrow irrigation or banded and then trickle irrigated.

Growth and yield attributes

The data furnished in Table-2 to 4 indicated that time of fertilizer application failed to produce their significant effect on plant height during individual years as well as in pooled results. Significantly maximum number of leaves plant^{-1} of 7.93 and 9.23 was noted when onion was fertilized through fertigation in six and eight equal splits at 10 days interval (T_3) and 8 days interval (T_2) during 2016-17 and 2017-18, respectively and it was statistically at par with (T_2) fertigation at 8 days interval (8 splits) during 2016-17. Equatorial and polar diameter were significantly influenced by time of fertilizer application (Table-3). Significantly maximum equatorial diameter of 38.3 mm was recorded when onion was fertilized through fertigation in eight equal splits at 8 days interval (T_2) during 2018-19 and it was statistically at par with fertigation in six equal splits at 10 days (T_3). Maximum polar diameter of 51.3 and 53.2 mm were recorded when onion was fertilized through fertigation in six equal splits at 10 days interval (T_3) during 2016-17 and 2018-19, respectively. Least number of doubles per plot was found when onion was fertilized through fertigation in ten equal splits at 6 days interval (T_1).

The method of fertilizer application is very important in obtaining optimal use of fertilizer. It is recommended that fertilizer should be applied regularly and timely in small amounts. This will increase the amount of fertilizer used by the plant and reduce the amount lost by leaching (Shock *et al.*, 2003) [18]. The results are in line with the results of Singandhupe *et al.* (2007) [19]; Contreras *et al.* (2006) [5] and Dingre *et al.* (2012) [6].

Table 2: Influence of levels and application schedule of soluble fertilizers through fertigation on growth of onion

Treatments	Plant height (cm)				No. of leaves/plant			
	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled
Level of fertilizer								
F_1-50% RDF	45.6	43.4	51.3	46.8	7.55	8.65	7.98	8.66
F_2-75% RDF	47.8	45.6	51.1	48.1	7.47	8.70	8.05	8.07
F_3-100% RDF	51.7	44.9	54.4	50.3	7.48	9.33	8.43	8.51
S.Em. ±	0.54	1.02	1.30	0.58	0.29	0.26	0.24	0.15
CD at 5%	1.87	NS	NS	1.72	NS	NS	NS	NS
CV%	3.9	8.0	8.6	7.2	13.1	10.0	10.1	11.0
Time of application								
T_1- Fertigation at 6 days interval (10 splits)	47.9	43.1	52.4	47.8	7.03	8.18	8.30	7.84
T_2-Fertigation at 8 days interval (8 splits)	49.6	44.9	52.5	49.0	7.83	9.26	8.27	8.45
T_3-Fertigation at 10 days interval (6 splits)	47.7	45.8	51.9	48.5	7.93	9.23	7.90	8.35
S.Em.±	0.69	0.97	0.80	0.48	0.24	0.20	0.22	0.24
CD at 5%	NS	NS	NS	NS	0.71	0.60	NS	NS
CV%	4.9	7.5	5.3	5.9	10.9	7.9	9.4	9.3
F x T interaction								
S.Em. ±	1.19	1.67	1.39	1.43	0.41	0.35	0.38	0.60
CD at 5%	NS	NS	NS	NS	NS	1.04	NS	NS

Table 3: Influence of levels and application schedule of soluble fertilizers through fertigation on equatorial and polar diameter of onion bulb

Treatments	Equatorial diameter (cm)				Polar diameter (cm)			
	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled
Level of fertilizer								
F_1-50% RDF	35.89	36.46	36.45	36.27	49.04	50.34	50.18	49.85
F_2-75% RDF	35.05	36.62	38.12	36.60	50.07	52.43	51.92	51.47
F_3-100% RDF	36.71	37.70	37.90	37.44	51.44	52.55	52.86	52.28
S.Em. ±	0.41	0.47	0.41	0.25	0.64	0.64	0.49	0.34
CD at 5%	NS	NS	NS	0.74	NS	NS	1.71	1.02
CV%	4.0	4.4	3.8	4.1	4.5	4.3	3.3	4.0
Time of application								
T_1- Fertigation at 6 days interval (10 splits)	35.8	36.9	37.0	36.5	48.5	51.6	50.2	50.1
T_2-Fertigation at 8 days interval (8 splits)	35.9	37.3	38.3	37.2	50.8	51.5	51.6	51.3
T_3-Fertigation at 10 days interval (6 splits)	36.0	36.6	37.2	36.6	51.3	52.2	53.2	52.2
S.Em.±	0.33	0.38	0.35	0.20	0.58	0.37	0.48	0.45
CD at 5%	NS	NS	1.05	NS	1.72	NS	1.43	NS
CV%								
F x T interaction								
S.Em. ±	0.57	0.65	0.61	1.07	1.00	0.63	0.84	0.84
CD at 5%	1.70	NS	NS	NS	NS	NS	NS	NS

Table 4: Influence of levels and application schedule of soluble fertilizers through fertigation on onion yield

Treatments	No. of double/plot			
	2016-17	2017-18	2018-19	Pooled
Level of fertilizer				
F_1-50% RDF	4.67	4.88	4.57	4.70
F_2-75% RDF	5.65	5.66	4.83	5.38
F_3-100% RDF	5.54	5.65	5.08	5.42
S.Em. ±	0.34	0.28	0.38	0.19
CD at 5%	NS	NS	NS	0.58
CV%	22.4	18.2	27.2	22.6
Time of application				
T_1- Fertigation at 6 days interval (10 splits)	5.54	5.44	4.23	5.07
T_2-Fertigation at 8 days interval (8 splits)	5.22	5.28	5.00	5.17
T_3-Fertigation at 10 days interval (6 splits)	5.10	5.47	5.25	5.27
S.Em.±	0.31	0.26	0.30	0.17
CD at 5%	NS	NS	NS	NS
CV%	20.0	16.4	21.9	19.4
F x T interaction				
S.Em. ±	0.53	0.44	0.53	0.91
CD at 5%	1.57	1.31	1.57	NS

Interaction effect

Interaction effect between fertilizer levels and time of fertilizer application was found significant for stalk yield on pooled data basis, No. of leaves plant^{-1} during 2016-17, equatorial diameter during 2016-17 and No. of doubles plot^{-1} during each individual years (Table-5 to 6). Significantly maximum stalk yield of 2901 kg ha^{-1} was recorded when onion was fertilized with 100% RDF with 6 equal splits at 10 days interval (F_3T_3). Maximum No. of leaves plant^{-1} during 2016-17 was noted when 100% RDF was applied in eight equal splits at 8 days interval (F_3T_2) and it was remained at par with F_3T_3, F_1T_2, F_1T_3 and F_3T_1. In case of equatorial diameter during 2016-17 it was maximum under F_3T_1 (i.e. 100% RDF applied in 10 equal splits at 6 days interval) and it was observed at par with F_3T_2 and F_1T_3. Number of doubles per plot was found significant during each individual years and minimum doubles were observed when crop was fertiilized with 50% RDF in 8 equal splits during 2016-17 and 2017-18 whereas, during 2018-19 minimum doubles were noted when crop was fertilized with 100% RDF in 10 equal splits at 6 days interval which was at par with F_1F_3 and F_2F_3 during each year.

Table 5: Interaction effect of fertilizer levels and time of application on stalk yield and No. of leaves plant^{-1} and equatorial diameter:

F x T	Stalk yield (pooled) (kg/ha)			No. of leaves plant^{-1} (2016-17)			Equatorial diameter (2016-17) (mm)		
	F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	F_3
T_1	1591	1948	2044	7.13	8.68	8.75	35.03	34.58	37.79
T_2	1948	2143	2328	9.40	8.63	9.75	35.90	34.87	36.89
T_3	2143	1989	2901	9.42	8.80	9.48	36.75	35.69	35.47
S.Em. ±			132.1			0.35			0.57
CD at 5%			374.5			1.04			1.70

Table 6: Interaction effect of fertilizer levels and time of application on doubles plot^{-1}

F x T	2016-17			2017-18			2018-19		
	F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	F_3
T_1	6.67	4.79	6.17	5.33	6.27	4.71	4.20	5.25	3.25
T_2	4.00	6.63	5.04	4.25	5.56	6.02	4.50	4.50	6.00
T_3	4.33	5.54	5.42	5.04	5.15	6.21	5.00	4.75	6.00
S.Em. ±			0.53			0.44			0.53
CD at 5%			1.57			1.31			1.57

Available soil nutrient status after harvest

Results furnished in Table-7 on soil nutrient status after harvest of crop indicated that there is no consistence results were observed.

However, EC was increased over control, pH was decreased, O.C. was slightly reduced, available P_2O_5 was also decreased over control and available K_2O was slightly increase after three years of experimentation.

Table 7: Soil nutrient status before and after harvest of cop

Treatments	EC (ds m^{-1})	pH	OC (%)	Available (kg ha^{-1})	
				P_2O_5	K_2O
Level of fertilizer					
F_1-50% RDF	0.712	8.35	0.687	21.80	196.5
F_2-75% RDF	0.843	8.42	0.717	23.47	205.5
F_3-100% RDF	0.887	8.54	0.793	25.90	213.0
Time of application					
T_1- Fertigation at 6 days interval (10 splits)	0.800	8.47	0.780	27.05	211.0
T_2-Fertigation at 8 days interval (8 splits)	0.815	8.41	0.733	22.91	196.8
T_3-Fertigation at 10 days interval (6 splits)	0.827	8.43	0.680	25.13	201.8

Economics

Economics was worked out by using current market prices of produce and inputs used (Table-8). The mean data of three years indicated that maximum gross return of Rs. 122008 ha^{-1} was obtained when crop was fertilized with 100% RDF. Whereas, maximum net return of Rs. 59412 ha^{-1} with higher B: C ratio of 2.02 were noted when onion was fertilized with 75% RDF (F). In case of time of fertilizer application, numerically higher gross Rs. 122780 ha^{-1} and net realization (Rs. 64792 ha^{-1}) with higher B:C ratio of 2.11 were obtained when crop was fertilized with 6 equal splits at 10 days interval (T_3).

Table 8: Economics of different treatments in *rabi* onion (Average of three years)

Treatments	Bulb Yield (kg/ha)	Gross realization (Rs./ha)	Total cost of cultivation (Rs./ha)	Net realization (Rs./ha)	B:C ratio
Level of fertilizer					
F_1	24640	98560	52930	45630	1.86
F_2	29381	117524	58111	59413	2.02
F_3	30502	122008	63524	58484	1.92
S.Em.±	614.3				
CD at 5%	1825.2				
Time of application					
T_1	25583	102332	58388	43944	1.75
T_2	28245	112980	58188	54792	1.94
T_3	30695	122780	57988	64792	2.11
S.Em.±	419.3				
CD at 5%	1188.8				

Selling price: Onion Bulb Rs.4.0/kg, Stalk Rs.1.0/kg

Conclusion

On the basis of three years experimental results, it may be concluded that application of 100% recommended dose of chemical fertilizers (75-60-50 kg NPK ha^{-1}) in the form of water soluble fertilizer in six equal splits at 10 days interval through drip fertigation were found effective in improving the bulb yield and gross realization of onion (cv. Pilipatti) under south saurashtra Agro climatic zone of Gujarat.

References

1. Ali MK, Alam MF, Alam MN, Islam MS, Khandaker SMAT. Effect of nitrogen and potassium level on yield and quality seed production of onion. J. Appl. Sci. Res., 2007; 3(12):1889-1899.
2. Al-Moshileh AM. Effect of nitrogen, phosphorus and potassium fertilizer on onion productivity in central region of Saudi Arabia. Assi. J Hort. Sci. 2001; 32:291-305.
3. Bangali AN, Patil HB, Guled MB, Patil RV. Effect of scheduling of drip irrigation on growth, yield and water use efficiency of onion (*Allium cepa* L.). Karnataka J. Agri. Sci. 2012; 25:116-119.
4. Bhonde SR, Singh NB, Singh DK. Studies on the effect of drip irrigation in onion bulb crop. NHRDF Newsletter. 2003; 23:1-3.
5. Contreras-Govea FE, Albrecht KA. Forage production and nutritive value of oat in autumn and early summer. Crop Sci. 2006; 46(6):2382-2386.
6. Dingre SK, Pawar DD, Kadam KG. Productivity, water use and quality of onion (Allium cepa) seed production under different irrigation scheduling through drip. Indian J Agron. 2012; 57:186-190.
7. Gufran M, Rajput PK. Response and economics of intercultural hand tools on growth and yield of onion under drip system of irrigation. Int. J Agri. Eng. 2012; 5(1):77-79.
8. Hebbar SS, Ramachandrappa BK, Nanjappa HV, Prabhakar M. Studies on NPK drip fertigation in filed grown tomato (*Lycopersicon esculentum* Mill.). Europ. J Agron. 2004; 21:117-127.
9. Kumar A, Singh AK. Improving nutrient and water use efficiency through fertigation. J Water Mangnt. 2002; 10:42-48.
10. Kumar S, Imtiyaz M, Kumar A, Singh R. Response of onion to different levels of irrigation water. Agric. Water Mgnt. 2007; 89:161-166.
11. Kurtz C, Ernani PR, Pauletti V, Menezes Junior FOG, Vieira NJ. Produtividade e conservação de cebola afetada pela adubação nitrogenada no sistema de plantio direto. Hortic. Bras. 2013; 31:559-567.
12. Nakamura K, Harter T, Hirono Y, Horino H, Mitsuno T. Assessment of root zone nitrogen leaching as affected by irrigation and nutrient management practices. Vadose Zone J. 2004; 3:1353-1366.

13. Nasreen S, Haque MM, Hossain MA, Farid ATM. Nutrient uptake and yield of onion as influenced by nitrogen and sulphur fertilization. Bangla. J Agril. Res. 2007; 32(3):413-420.
14. NHRDF. National Horticultural Research and Development Foundation, 2018. www.nhrdf.com
15. Rahim MA, Bashar MA, Begun A, Hakim MA. Onion storage in Bangaladesh. Onion Newsletter for the Tropics. 1992; 4:55-56.
16. Rajput TBS, Patel N. Water and nitrate movement in drip-irrigated onion under fertigation and irrigation treatments. Agric Water Mangnt. 2006; 79:293-311.
17. Sharma RP. Effect of planting material, nitrogen and potash on bulb yield of rainy season onion (*Allium cepa* L.). Ind. J Agron. 1992; 37:868-869.
18. Shock CC, Feibert EB, Saunders LD, James SR. Umatilla Russet' and `Russet Legend' Potato Yield and Quality Response to Irrigation. Hort. Sci. 2003; 38:1117-1121.
19. Singandhupe RB, James BK, Edna A, Nanda P. Response of drip irrigation and mulching on growth and fruit yield of pointed gourd (*Trichosanthes dioica*). Ind. J Agri. Sci. 2007; 77:8-13.
20. Tiwari RS, Ankur A, Sengar SC. Effect of doses and methods of nitrogen application on growth, bulb yield and quality of "Pusa Red" onion (*Allium cepa*). Ind. J Agril. Sci. 2002; 72(1):23-25.