Int.J.Curr.Microbiol.App.Sci (2019) *8*(2): 409-418

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 8 Number 02 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.802.046

Effect of Irrigation and Nitrogen Levels on Growth, Yield and Quality Parameters of Onion (*Allium cepa* L.) in Himachal Pradesh, India

Samir Bhatti*, J.C. Sharma and Ridham Kakar

Department of Soil Science and Water Management, Dr YS Parmar University of Horticulture and Forestry, Nauni-Solan (HP) 173230, India

**Corresponding author*

A B S T R A C T

Keywords

Onion, Irrigation and Nitrogen levels, Biological yield, Bulb yield, Number of leaves, Leaf length, Equatorial diameter and Polar diameter

Article Info

Accepted:
04 January 2019
Available Online:
10 February 2019

Field experiments were conducted during 2015-16 and 2016-17 to study the effect of irrigation and N levels on growth and yield of onion *(Allium cepa* L.) in Himachal Pradesh. Twelve treatment combinations comprising four irrigation level i.e. 4 cm irrigation at IW/CPE ratio 1.2 (I_1), 1.0 (I_2), 0.8 (I_3), 0.6 (I_4) and three N levels i.e. 75 (N_1), 100 (N_2) and 125 per cent (N_3) of recommended dose of N, were replicated thrice in a Randomized Block Design. Growth parameters viz. Bulb yield, number of leaves, leaf length, equatorial diameter, polar diameter and TSS were at par under I_1 and I_2 levels and superior over I_3 and I_4. Among N levels, 125% of the recommended dose (N_3) was found to be optimum as it recorded significantly higher growth and yield of onion crop over N_2 and N_1 levels. The combinations of irrigation and N levels viz. I_1N_3 and I_2N_3 gave significantly higher bulb yield (467.0 q ha^{-1} and 435.5 q ha^{-1}). The study has led to a conclusion that for maximizing growth and yield of onion in Himachal Pradesh, 4 cm irrigation at 1.0 IW/CPE ratio and 125 per cent of recommended dose of N (I_2N_3) could be the best.

Introduction

Onion is an important crop of Himachal Pradesh, but the productivity of the crop is quite low owing to lack of assured availability of irrigation water, sub optimal and imbalanced use of fertilizer nutrients, improper management of soil and water resources and inadequate crop management practices, weed control and plant protection measures, etc. Among various factors involved, nutrient and moisture supply are important inputs for realizing higher onion yield. Irrigation scheduling is a critical management input to ensure optimum soil moisture regime for proper growth and development as well as for optimum yield and economic benefits. Well managed irrigation can lead to increased yields, greater farmer profit, and significant water savings, reduced environmental impacts and improved sustainability of irrigated agriculture (Evett *et* *al.,* 2011; Gill *et al.,* 2011). It has been documented that effect of irrigation and nitrogen is negligible if proper irrigation schedule is not followed. Irrigation scheduling and nitrogen levels in accordance with crop sensitivity to irrigation and nutrients during the growing cycle can hide the effects of other growth and yield affecting factors, such as rainfall amount and distribution pattern. Present study, therefore, was undertaken to determine optimum irrigation schedule and nitrogen level to achieve higher productivity of onion in Himachal Pradesh.

Materials and Methods

Field experiments were conducted during two crop years (2015-2016) at the experimental farm of Department of Soil Science and WM, Dr YS Parmar University of Horticulture and Forestry, Solan (HP). The soil (Typic Eutrochrept) was gravelly loam in texture. Salient physical and chemical properties of the experimental soil of 0-15 cm depth were pH 6.91, organic carbon (%) 0.93, available N, P and K 245.30, 33.16 and 260.20 kg ha^{-1}, respectively. Moisture retention at FC and PWP were 24.05 and 7.5 per cent in 0-15 cm depth, respectively. The experiment was laid out with 12 treatments replicated thrice in randomized block design. Recommended dose (100%) of FYM, N, $P_2 O_5$ and K_2O is 25 t ha^{-1}, 125, 75 and 60 kg ha^{-1}, respectively, and were applied as per the treatments of the experiment in the form of Urea, single super-phosphate and murate of potash. Entire dose of FYM, P and K fertilizers was applied at the time of field preparation. The N fertilizer was applied in two split doses, first dose at the time of transplanting and second dose one month after transplanting and third dose two months after transplanting.

Soil moisture contents in 0-7.5 and 7.5-15 cm depths were determined before and 24 hours after each irrigation to know the moisture regimes under different irrigation levels and the data has been presented for both the years of study. Plant growth parameters viz. Bulb yield, number of leaves, leaf length, equatorial diameter, polar diameter and TSS were determined at the time of harvesting of the crop. The bulb yield per hectare was calculated on the basis of per plot yield. The numbers of fully opened, grown and green leaves were recorded and average numbers of leaves per plant were worked out from five randomly selected plants. The length of leaves of five plants was recorded in centimeter (cm) from bulb neck to tip of leaf when held vertically and the average length of leaf was worked out. The equatorial and polar diameter was measured with the help of Vernier caliper and was expressed in centimetre (cm). Total soluble solids content of fresh bulbs were recorded with the help of hand refractometer and expressed as °Brix. The data of each parameter for two crop seasons (2015-16 and 2016-17) have been presented.

Results and Discussion

Soil moisture contents before and after irrigation

Maximum soil moisture contents was noticed under I_1 (4 cm irrigation at 1.2 IW/CPE ratio) irrigation level which ranged from 22.46-27.24 and 22.78-28.45 per cent with mean values of 25.94 and 26.27 per cent, which was slightly higher than the field capacity during both the years (Table 1). Minimum soil moisture contents were recorded in I_4 (4 cm irrigation at IW/CPE ratio 0.6) irrigation level which ranged from 17.79-21.88 and 18.79-22.97 per cent with mean values of 19.72 and 20.88 per cent, which was 18.0 and 13.5 per cent lower than the field capacity during the year 2016 and 2017, respectively. In 7.5-15 cm depth after irrigation mean values varied from 17.60-22.80 and 18.10-23.60 per cent during the year 2016 and 2017, respectively. Maximum soil moisture contents were noticed under I_1 irrigation level which ranged from 18.14-24.32 and 19.74-25.12 per cent with mean values of 22.80 and 23.60 per cent, which were near to field capacity during both the years of study. Minimum soil moisture contents were recorded in I_4 (4 cm irrigation at IW/CPE ratio 0.6) irrigation level which ranged from 15.78-19.12 and 16.48-19.72 per cent with mean values of 17.60 and 18.10 per cent, which were 26.8 and 24.7 per cent lower than the field capacity during the year 2016 and 2017, respectively. Higher soil moisture contents under I_1 and I_2 irrigation level were due to frequent irrigations, whereas, comparatively lower moisture contents under I_3 and I_4 treatment were due to longer interval between successive irrigations. Higher moisture contents due to higher frequency of irrigations did not show any visual stress on various physiological processes, resulting in better uptake of nutrients and finally increased plant growth; yields attributes and yield (Kuchenbuch *et al.*, 2006; Patel *et al.*, 2008; Kumari, 2013).

Bulb yield

Irrigation levels exerted significant impact on bulb yield of onion (Table 2). Significantly higher (407.8 q ha^{-1} and 410.7 q ha^{-1}) and lower (327.0 q ha^{-1} and 307.8 q ha^{-1}) bulb yield was recorded under I_1 and I_4, respectively as compared to other irrigation levels, during both the years of study. Among N levels, maximum bulb yield (406.5 q ha^{-1} and 408.8 kg ha^{-1}) and minimum (336.8 q ha^{-1} and 329.0 q ha^{-1}) was recorded under N_3 and N_1 levels, during both the years of study. In case of interaction (I×N) significantly higher bulb yield (462.7 q ha^{-1} and 471.3 q ha^{-1}) was recorded under I_1N_3 and lower (306.0 q ha^{-1} and 290.7 q ha^{-1}) under I_4N_1 which was found to be at par with I_4N_2 (316.7 q ha^{-1} and 305.3 q ha^{-1}) treatment combination during both the years. Pooled analysis showed that the effect of irrigation and N levels was significant and the trend was almost similar during both the years of study. Maximum (409.2 q ha^{-1}) and minimum bulb yield (317.4 q ha^{-1}) was recorded under I_1 and I_4, respectively over other irrigation levels, whereas maximum bulb yield (407.7 q ha^{-1}) and minimum bulb yield (334.3 q ha^{-1}) was recorded under N_3 and $N_{1,}$ respectively as compared to other N levels. In case of interaction of irrigation and N levels (I×N) maximum bulb yield (467.0 q ha^{-1}) was recorded under 1.2 IW/CPE ratio and supplied with 125 per cent N (I_1N_3) and minimum (303.7 q ha^{-1}) under 0.6 IW/CPE ratio with 75 per cent N (I_4N_1).

Number of leaves

Data in Table 3 showed significant effect for N levels while, non-significant for irrigation levels and interaction effect (I×N) and the trend was almost similar during both the years (except in second year for irrigation level). During the year 2016-17, under irrigation levels, maximum number of leaves were recorded with I_1 (12.3) and minimum (11.7) under I_4 level, which were statistically at par with I_3 and I_2 (11.8 and 11.9). Under N levels, significantly higher number of leaves (10.3 and 12.5) were recorded with N_3 and lower (8.7 and 11.0) with N_1 level, during both the years of study. Pooled analysis of the data showed that the effect of N was significant and higher number of leaves (11.4) was found under N_3 and lower (9.9) was under N_1 level. The effect of irrigation and interaction (I×N) was non-significant.

Leaf length

Irrigation and N levels exerted significant effect on leaf length and the trend was almost similar during both the years (Table 4). Under irrigation levels maximum (39.29 and 42.62 cm) and minimum (29.93 and 32.60 cm) leaf length was recorded under I_1 and I_4, respectively as compared to other irrigation levels, during both the years of study. Among N levels, significantly higher (37.32 and 39.43 cm) and lower (33.67 and 35.88 cm) leaf length was recorded under N_3 and N_1 levels during both the years of study. In case of interaction (I×N), maximum leaf length (41.33 and 45.27 cm) was recorded under I_1N_3 during both the years, which was statistically at par with I_2N_3 (40.33 cm) during the year 2015-16, whereas minimum (29.00 and 31.87 cm) under I_4N_1 during both the years, which was found to be at par with I_4N_2 (30.20 cm) in 2015-16 and I_4N_2 (32.67 cm) and I_4N_3 (33.27 cm) in 2016-17. Pooled analysis showed that the effect of irrigation and N levels was significant. Under irrigation levels, significantly higher (40.96 cm) leaf length was recorded with I_1 and lower (31.27 cm) with I_4 level. Among N levels, differences were significant and maximum leaf length (37.21 cm) was recorded with 125 per cent N level (N_3) and minimum (30.43 cm) with 75 per cent N level (N_1). The interaction effect (I×N) was significant and maximum leaf length (43.30 cm) was recorded with I_1N_3 and minimum (30.43 cm) under I_4N_1 treatment combination which was at par with I_4N_2 (31.43 cm).

Equatorial diameter

Effect of irrigation and N levels during both the years was significant (Table 5). Under irrigation levels significantly higher (4.28 and 4.64 cm) and lower (3.74 and 3.77 cm) equatorial diameter was recorded under I_1 and I_4, respectively over other irrigation levels, during both the years of study. Among N levels, maximum (4.17 and 4.53 cm) and minimum (3.80 and 3.93 cm) equatorial diameter was recorded under N_3 and N_1 levels during both the years of study. In case of interaction (I×N) maximum (4.52 and 4.98 cm) equatorial diameter was recorded under I_1N_3 during both the years, which was statistically at par with I_2N_3 (4.89 cm) during the year 2016-17, whereas minimum (3.57 and 3.63 cm) under I_4N_1 during both the years, which was found to be at par with I_4N_2 (3.81 cm), I_4N_3 (3.86 cm) and I_3N_1 (3.74 cm) in 2016-17. Pooled analysis showed that the effect of irrigation and N levels was significant. Under irrigation levels, significantly higher (4.46cm) and lower (3.75 cm) equatorial diameter was recorded with I_1 and I_4 levels, respectively. Among N levels, differences were significant and maximum equatorial diameter (4.35 cm) was recorded with 125 per cent N level (N_3) over N_2 (4.14 cm) and minimum (3.86 cm) with 75 per cent N level (N_1). The interaction effect (I×N) was significant and maximum equatorial diameter (4.75 cm) was recorded with I_1N_3 and minimum (3.86 cm) under I_4N_1 treatment combination.

Polar diameter

Irrigation and N levels exerted significant effect on polar diameter and the trend was almost similar in both the years (Table 6). Under irrigation levels, significantly higher (4.39 and 4.65 cm) and lower (3.80 and 3.82 cm) polar diameter was recorded under I_1 and I_4, respectively over irrigation levels, during both the years of study. Among N levels, significantly higher (4.23 and 4.56 cm) polar diameter was recorded under N_3 and minimum (3.89 and 3.95 cm) was recorded under N_1, during both the years of study. The effect of interaction (I×N) was significant and the trend was almost similar for both the years. Maximum polar diameter (4.61 and 4.98 cm) was recorded under 1.2 IW/CPE ratio with 125 per cent N (I_1N_3), and minimum (3.63 and 3.63 cm) under 0.6IW/CPE with 75 per cent N (I_4N_1) during both the years of study. Pooled analysis for this trait showed that the effect of irrigation and N levels was significant (Table 6). Under irrigation levels, significantly higher (4.52 cm) polar diameter was recorded with I_1 and minimum (3.81 cm) with I_4 level. Under N levels, differences were significant and maximum polar diameter (4.40 cm) was recorded with N_3 and minimum (3.92 cm) with N_1 level. The interaction effect (I×N) was significant and maximum polar diameter (4.79 cm) was recorded with 1.2 IW/CPE ratio and supplied with 125 per cent N (I_1N_3) and minimum (3.63 cm) under 0.6 IW/CPE ratio with 75 per cent N (I_4N_1).

The highest number of leaves, leaf length, bulb size and yield at irrigation levels I_1 and I_2 might be due to optimum soil moisture regimes (Table 1) throughout the growing period which might have facilitated greater nutrient uptake and proper soil physical environment to help the plants to put forth better vegetative growth, leading to higher bulb growth and yield. The present results are in accordance with the earlier findings of Lorenz and Maynard (1980), Adentuji (1990) and Lingaiah *et al.,* (2005) and Bungard *et al.,* (1999) in onion. They reported that the water is an essential component of photosynthesis and plays a key role in transpiration, stomatal opening and growth and expansion of leaves. In the present findings also, better performance of all the components as a result of optimum soil moisture provided by appropriate quantity of water at desired interval might have resulted in steady active plant growth and maximum possible yield. Rathore and Singh (2009) also emphasized the importance of irrigation at appropriate time as plant tissue contains more than 95 per cent of water which should be maintained for keeping the plant photosynthetically active resulting in proper growth and development and ultimately yield. Higher yield and biological yield attributes (bulb size and number of leaves) of onion in N_3 might be due to complete solubility, mobilization and availability of N at regular interval in required quantity due to split application. Similar results were also reported by Sharma *et al.,* (2009) in onion, Gulsum *et al.,* (2010) in lettuce, Goudra and Rokhade (2001) in cabbage, Alam *et al.,* (2010) in carrot, Singh *et al.,* (2010) in potato and Tolga *et al.,* (2010) in broccoli. Favourable effects of N on yield of tomato and eggplant have also been reported by Hegde and Srinivas (1989), Pal *et al.,* (2002) and Rahman *et al.,* (2007). The reasons suggested for such a response was that optimum N application increased growth parameters, which in return synthesized more plant metabolites thereby increased crop yield.

The interaction effect of irrigation and N levels on yield and biological yield attributes of onion was found to be significant (Table 2-6). These increased with higher frequency of irrigation and increasing N levels. The response of yield to high amounts of water and N application could be attributed to the favorable effect on the availability of nutrients to the plant roots, which improves the growth of the crop. Significant increase in yield due to higher N application might also be due to increased photosynthesis as N is a major constituent of chlorophyll molecule which plays an important role in photosynthesis. Increased photosynthesis results in accumulation of carbohydrates in the bulb and ultimately enhanced the plant growth and hence the yield [Neerja *et al.,* (1999) in onion and Kemal (2014) in shallot]. These results further get support from the findings of Sanchez (2000) in lettuce, Goudra and Rokhade (2001) in cabbage, Rahman (2007) in tomato and Bozkurt *et al.,* (2011) in cauliflower. Better expression of growth and yield under higher quantum of irrigation and N were also reported by Singh *et al.,* (2010) in potato because of complimentary effect of nutrient availabilities to the plants.

Total soluble solids

Effect of irrigation and N levels on TSS was significant. Under irrigation levels significantly higher (12.27 and 12.36 ºB) TSS was observed in I_1 during both the years, which was found to be at par with I_2 (12.22 ºB) in the year 2015-16, and lower (11.56 and 10.13 ºB) TSS was observed under I_4 during both the years, which was found to be at par with I_3 (11.71 ºB) during the year 2015-16. In case of interaction (I×N) highest TSS (12.80 and 12.81 ºB) was recorded under I_1N_3, which was at par with I_2N_3 and I_1N_2 (12.67 and 12.65 ºB) during 2015-16 and I_2N_3 and I_1N_1 (12.67 ºB and12.33 ºB) during 2016-17 (Table 7).

Table.1 Effect of irrigation levels on soil moisture contents (0-7.5 cm and 7.5-15 cm depths) during the year 2016 and 2017

Treatments			Moisture contents (%,w/w)			
			0-7.5 cm depth		7.5-15 cm depth	
			Before irrigation	After irrigation	Before irrigation	After Irrigation
I_1	Range	2016	10.92-16.44	22.46-27.24	11.44-17.62	**18.14-24.32**
		2017	11.77-16.69	22.78-28.45	12.52-17.92	**19.74-25.12**
	Mean	2016	14.96	25.94	16.22	**22.80**
		2017	15.10	26.27	16.46	**23.60**
I_2	Range	2016	10.22-14.08	21.12-26.84	11.14-15.96	**18.14-23.94**
		2017	10.52-14.12	21.26-27.14	11.84-15.76	**18.66-24.24**
	Mean	2016	13.12	24.14	14.20	**21.86**
		2017	13.24	24.58	14.16	**22.26**
I_3	Range	2016	10.02-13.12	20.88-24.24	10.08-13.34	**17.16-21.16**
		2017	10.16-13.18	20.18-24.44	10.84-13.74	**17.46-21.96**
	Mean	2016	11.04	22.48	12.36	**18.86**
		2017	11.12	22.84	12.64	**19.18**
I_4	Range	2016	9.84-11.22	17.79-21.88	9.96-12.54	**15.78-19.12**
		2017	9.64-11.04	18.79-22.97	10.06-12.87	**16.48-19.72**
	Mean	2016	10.48	19.72	11.24	**17.60**
		2017	**10.34**	**20.88**	**11.46**	**18.10**

Table.2 Effect of irrigation and N levels on bulb yield (q ha^{-1})

Treatments	2015-16				2016-17				Pooled			
N / I	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
I_1	370.0	390.7	462.7	407.8	354.7	406.0	471.3	410.7	362.3	398.3	467.0	409.2
I_2	346.7	364.0	423.7	378.1	350.7	373.3	447.3	390.4	348.7	368.7	435.5	384.3
I_3	324.7	340.0	381.3	348.7	320.0	357.3	389.3	355.6	322.3	348.7	385.3	352.1
I_4	306.0	316.7	358.3	327.0	290.7	305.3	327.3	307.8	303.7	305.7	342.8	317.4
Mean	336.8	352.8	406.5	365.4	329.0	360.5	408.8	366.1	334.3	355.3	407.7	365.8
$CD_{(0.05)}$												
I		10.2				13.5				7.1		
N		8.9				11.7				6.2		
I×N		17.7				23.3				12.4		

I_1: (1.2 IW/CPE ratio), I_2: (1.0 IW/CPE ratio), I_3: (0.8 IW/CPE ratio), I_4: (0.6 IW/CPE ratio)
N_1: 75 % of recommended dose of N, N_2: Recommended dose of N, N_3: 125 % of recommended dose of N

Table.3 Effect of irrigation and N levels on number of leaves

Treatments	2015-16				2016-17				Pooled			
N / I	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
I_1	9.1	9.7	11.2	10.0	11.3	12.7	12.8	12.3	10.2	11.2	12.0	11.1
I_2	8.8	9.1	10.7	9.6	11.0	12.3	12.3	11.9	9.9	10.7	11.5	10.7
I_3	8.5	9.0	9.9	9.2	10.8	12.1	12.3	11.8	9.7	10.6	11.1	10.5
I_4	8.5	8.5	9.3	8.8	11.0	11.5	12.7	11.7	9.8	10.0	11.0	10.3
Mean	8.7	9.1	10.3	9.4	11.0	12.2	12.5	11.9	9.9	10.6	11.4	10.6
$CD_{(0.05)}$												
I		NS				0.4				NS		
N		0.9				0.4				0.6		
I×N		NS				NS				NS		

I_1: (1.2 IW/CPE ratio), I_2: (1.0 IW/CPE ratio), I_3: (0.8 IW/CPE ratio), I_4: (0.6 IW/CPE ratio)
N_1: 75 % of recommended dose of N, N_2: Recommended dose of N, N_3: 125 % of recommended dose of N

Table.4 Effect of irrigation and N levels on leaf length (cm)

Treatments	2015-16				2016-17				Pooled			
N / I	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
I_1	37.33	39.20	41.33	39.29	39.60	43.00	45.27	42.62	38.47	41.10	43.30	40.96
I_2	35.27	36.33	40.33	37.31	37.93	39.93	41.93	39.93	36.60	38.13	41.13	38.62
I_3	33.07	34.67	37.00	34.91	34.13	36.87	37.27	36.09	32.63	37.07	32.47	34.06
I_4	29.00	30.20	30.60	29.93	31.87	32.67	33.27	32.60	30.43	31.43	31.93	31.27
Mean	33.67	35.10	37.32	35.36	35.88	38.12	39.43	37.81	34.53	36.93	37.21	36.23
$CD_{(0.05)}$												
I		0.80				0.98				0.79		
N		0.69				0.85				0.69		
I×N		1.38				1.70				1.38		

I_1: (1.2 IW/CPE ratio), I_2: (1.0 IW/CPE ratio), I_3: (0.8 IW/CPE ratio), I_4: (0.6 IW/CPE ratio)
N_1: 75 % of recommended dose of N, N_2: Recommended dose of N, N_3: 125 % of recommended dose of N

Table.5 Effect of irrigation and N levels on bulb equatorial diameter (cm)

Treatments	2015-16				2016-17				Pooled			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
I_1	4.03	4.30	4.52	4.28	4.30	4.63	4.98	4.64	4.17	4.46	4.75	4.46
I_2	3.84	4.09	4.25	4.06	4.03	4.40	4.89	4.44	3.94	4.25	4.57	4.25
I_3	3.77	3.97	4.07	3.94	3.74	4.09	4.39	4.07	3.75	4.03	4.23	4.00
I_4	3.57	3.80	3.84	3.74	3.63	3.81	3.86	3.77	3.60	3.81	3.85	3.75
Mean	3.80	4.04	4.17	4.00	3.93	4.23	4.53	4.23	3.86	4.14	4.35	4.12
$CD_{(0.05)}$												
I		0.04				0.13				0.07		
N		0.04				0.11				0.06		
I×N		0.08				0.23				0.13		

I_1: (1.2 IW/CPE ratio), I_2: (1.0 IW/CPE ratio), I_3: (0.8 IW/CPE ratio), I_4: (0.6 IW/CPE ratio)
N_1: 75 % of recommended dose of N, N_2: Recommended dose of N, N_3: 125 % of recommended dose of N

Table.6 Effect of irrigation and N levels on bulb polar diameter (cm)

Treatments	2015-16				2016-17				Pooled			
I \ N	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
I_1	4.17	4.39	4.61	4.39	4.33	4.63	4.98	4.65	4.25	4.51	4.79	4.52
I_2	3.92	4.19	4.30	4.14	4.03	4.45	4.89	4.46	3.98	4.32	4.60	4.30
I_3	3.82	4.05	4.13	4.00	3.79	4.09	4.39	4.09	3.81	4.07	4.26	4.05
I_4	3.63	3.87	3.89	3.80	3.63	3.84	3.99	3.82	3.63	3.86	3.94	3.81
Mean	3.89	4.13	4.23	4.08	3.95	4.25	4.56	4.25	3.92	4.19	4.40	4.17
$CD_{(0.05)}$												
I		0.05				0.01				0.05		
N		0.04				0.08				0.05		
I×N		0.08				0.17				0.09		

I_1: (1.2 IW/CPE ratio), I_2: (1.0 IW/CPE ratio), I_3: (0.8 IW/CPE ratio), I_4: (0.6 IW/CPE ratio)
N_1: 75 % of recommended dose of N, N_2: Recommended dose of N, N_3: 125 % of recommended dose of N

Table.7 Effect of irrigation and N levels on TSS (˚Brix)

Treatments	2015-16				2016-17				Pooled			
I \ N	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
I_1	11.33	12.67	12.80	12.27	12.33	11.93	12.81	12.36	11.83	12.30	12.80	12.31
I_2	11.67	12.33	12.67	12.22	10.80	11.80	12.65	11.76	10.90	12.07	12.67	11.88
I_3	10.67	12.00	12.47	11.71	10.53	11.27	11.80	11.20	10.60	11.63	12.13	11.46
I_4	10.47	11.53	12.67	11.56	9.60	9.93	10.87	10.13	10.03	10.73	11.77	10.84
Mean	11.03	12.13	12.65	11.94	10.82	11.23	12.03	11.36	10.84	11.68	12.34	11.62
$CD_{(0.05)}$												
I		0.23				0.36				0.20		
N		0.20				0.31				0.17		
I×N		0.39				0.63				0.34		

I_1: (1.2 IW/CPE ratio), I_2: (1.0 IW/CPE ratio), I_3: (0.8 IW/CPE ratio), I_4: (0.6 IW/CPE ratio)
N_1: 75 % of recommended dose of N, N_2: Recommended dose of N, N_3: 125 % of recommended dose of N

Lowest (10.47 and 9.60 ºB) TSS was recorded under I_4N_1 during both the years, which was at par with I_3N_1 (10.67 ºB) during 2015-16 and I_4N_2 (9.93 ºB) during 2016-17. Pooled analysis showed that the effect of irrigation and N levels was significant. Under irrigation levels, significantly higher TSS (12.31 ºB) was recorded with I_1 and lower (10.84 ºB) with I_4 level. Under N levels, differences were significant and highest TSS (12.34 ºB) was recorded with 125 per cent N level (N_3) over N_2 (11.68 ºB) and minimum (10.84 ºB) with 75 per cent N level (N_1). The interaction effect (I×N) was also statistically significant and higher TSS (12.80 ºB) was recorded with irrigation at 1.2 IW/CPE ratio and supplied with 125 per cent N (I_1N_3) which was at par with I_2N_3 (12.67 ºB) and minimum TSS (10.03 ºB) under 0.6 IW/CPE ratio with 75 per cent N (I_4N_1).

Change in TSS with irrigation may probably be due to fulfillment of crop water demand and better utilization of nutrient under optimum moisture availability. The results are in consonance with the findings of Chopade *et al.*, (1998) and Fatideh and Asil (2012) in onion.

The study has led to a conclusion that for maximizing growth and yield of onion in Himachal Pradesh, 4 cm irrigation at 1.0 IW/CPE ratio and 125 per cent of recommended dose N (I2N3) could be the best.

References

Adetunji, I.A. 1990. Effect of mulches and irrigation on growth and yield of lettuce in semi arid region. *Biotronics* 19: 93-98.

Alam, M.S., Mallik, S.A. and Costa, D.J. 2010. Effect of irrigation on growth and yield of (*Daucus carota* ssp. *sativus*) carrot in hill valley. *Bangladesh Journal of Agricultural Research* 35: 323- 329.

Bozkurt, S. and Mansuroglu, G.S. 2011. Lettuce yield responses to different drip irrigation levels under open field condition. *Journal of Cell and Plant Science* 2: 12-18.

Bungard, R.A, Wingler, A., Morton, J.D. and Andrews, M. 1999. Ammonium can stimulate nitrate and nitrite reductase in the absence of nitrate in *Climatis vitalba*. *Plant Cell Environment* 22: 859-866.

Chopade, S.O., Bansode, P.N and Hiwase, S.S. 1998. Studies on fertilizer and water management to onion. *PKV Research Journal 22*: 44-47.

Evett, S.R, Schwartz, R., Mazahrih, N.T., Jitan, M.A. and Shaqir, I.M. 2011. Soil water sensors for irrigation scheduling: Can they deliver a management allowed depletion, (*ed*.) U. Yermiyahu, A Ben-Gal, A Dag 888: 231-238

Fatideh, M.M. and Asil, M.H. 2012. Onion yield, quality and storability as affected with different soil moisture and nitrogen regimes. *South Western Journal of Horticulture, Biology and Environment* 3: 145-165.

Gill, G., Humphreys, E., Kukal, S., and Walia, U. 2011. Effect of water management on dry seeded and puddled transplanted rice. Part 1: Crop performance. *Field Crops Research* 120(1): 112-122.

Goudra, K.H.B. and Rokhade, A.K. 2001. Effect of irrigation schedules and methods on growth and yield of cabbage. *Journal of Agricultural Science* 14: 721-723.

Gulsum, S.M., Sefer, B., Melisa, K. and Selda, T. 2010. The effects of nitrogen forms and rates under different irrigation levels on yield and plant growth of lettuce. *Journal of Cell and Plant Science* 1: 33-40.

Hegde, D.M. and Srinivas, K.1989. Studies on irrigation and nitrogen requirement of tomato. *Indian Journal of Agron*omy 34: 157-162.

Kemal, Y.O. 2014. Effects of irrigation and nitrogen levels on bulb yield, nitrogen uptake and water use efficiency of shallot (*Allium cepa* var. *ascalonicum* Baker). *African Journal of Agricultural Research* 8: 4637-4643.

Kuchenbuch, R.O., Ingram, K.T. and Buczko, U. 2006. Effects of decreasing soil water content on seminal and lateral roots of young maize plants. *Journal of Plant Nutrition and Soil Science* 169: 814-848.

Kumari, M. 2013. *Scheduling of irrigation in cauliflower* (*Brassica oleracea* var. *botrytis* L.) *under mid hill conditions of Himachal Pradesh.* M.Sc. Thesis. Department of Soil Science and Water Management, Dr Yaswant singh Parmar University of Horticulture and Forestry, Solan.81p.

Lingaiah, D., Katti, G.S. and Shaik, M. 2005. Influence of drip irrigation on crop growth, yield and water use efficiency in cabbage (*Brassica oleracea*). *International Journal of Agricultural Sciences* 1: 110-111.

Lorenz, O.A. and Maynard, D.N. 1980. *Knoff's Handbook for Vegetable Growers*. 2nd edn.

Neeraja, G., Reddy, K.M., Reddy, I.P., Reddy, Y.N. 1999. Effect of irrigation and nitrogen on growth, yield and yield attributes of *rabi* onion (*Allium cepa* L.) in Andhra Pradesh. *Vegetable Sciences* 26: 64-68.

Patel, G.N., Patel, P.T. and Patel, P.H. 2008. Yield, water use efficiency and moisture extraction pattern of summer groundnut as influenced by irrigation schedules, sulphur levels and sources. *Journal of Agriculture Research,* 6: 1-4.

Rahman, M.J., Mondol, M.A.I., Rahman, M.N., Begum, R.A. and Alam, M.K. 2007. Effect of irrigation and nitrogen on tomato yield in the grey terrace soil of Bangladesh. *Journal of Soil Nature* 1: 1-4.

Rathore, A.C. and Singh, J.N. 2009. Optimization of nitrogen application and irrigation for improved growth and spike production of tuberose (*Polianthus tuberose* L.). *Indian Journal of Soil Conservation* 37: 45-49.

Sanchez, C.H.A. 2000. Response of lettuce to water and nitrogen on sand and the potential for leaching of nitrate-N. *Horticulture Science* 35: 73-75.

Sharma, R.P., Datt, N. and Chander, G. 2009. Effect of vermicompost, farmyard manure and chemical fertilizers on yield, nutrient uptake and soil fertility in okra (*Abelmoschus esculentus*)-onion *(Allium cepa* L.) sequence in wet temperate zone of Himachal Pradesh. *Journal of the Indian Society of Soil Science* 57: 357-361.

Singh, N., Sood, M.C. and Singh, S.P. 2010. Optimizing irrigation water and nutrient requirement of potato (*Solanum tuberosum* L.) under drip fertigation. *Progressive Agriculture* 10: 192- 195.

Tolga, E., Levent, A., Yesim, E., Serdar, P., Murat, D., Hakan, O. and Huseyin, T.G. 2010. Yield and quality response of drip irrigated broccoli (*Brassica oleracea* L. *var. italica*) under different irrigation regimes, nitrogen applications and cultivation periods. *Agricultural Water Management* 97: 681–688.

How to cite this article:

Samir Bhatti, J.C. Sharma and Ridham Kakar. 2019. Effect of Irrigation and Nitrogen Levels on Growth, Yield and Quality Parameters of Onion (*Allium cepa* L.) in Himachal Pradesh, India. *Int.J.Curr.Microbiol.App.Sci.* 8(02): 409-418.
doi: https://doi.org/10.20546/ijcmas.2019.802.046