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# Effect of Pulse Irrigation (Drip) Influencing Different Irrigation Levels on Growth and Yield Parameters of White Onion (*Allium cepa* L.)

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**Abstract**

**A field experiment was conducted during two consecutive rabi seasons from November, 2014 to April, 2015 on sandy clay loam soil at Dapoli, India. The experiment was arranged in twelve treatment combinations with strip plot design as horizontal factor (main treatment) having one continuous irrigation ($P_1$), two pulses ($P_2$), three pulses ($P_3$) and four pulses ($P_4$), while vertical factor (sub treatment) as irrigation levels *viz*. $I_1$ (0.80 $ET_C$), $I_2$ (1.0 $ET_C$) and $I_3$ (1.2 $ET_C$) treatments. Results indicated that the average seasonal water applied to white onion under pulse irrigation (drip) through different irrigation levels varied from 274.46 mm for $I_1$ (0.8 $ET_C$) to 408.46 mm for $I_3$ (1.2 $ET_C$) irrigation levels. The interaction effect revealed that highest polar diameter (63.88 mm), geometric mean diameter (59.51 mm), equatorial diameter (63.16 mm), average bulb weight (112.05 g) and yield (38.52 t·ha$^{-1}$) of white onion was found in treatment combination $I_2P_4$ followed by $I_3P_4$. Average water use efficiency was found maximum for $I_1P_4$ (11.93 q·ha$^{-1}$·cm$^{-1}$) treatment combination followed by $I_1P_3$ (11.33 q·ha$^{-1}$·cm$^{-1}$) and $I_2P_4$ (10.99 q·ha$^{-1}$·cm$^{-1}$) treatment combination. The maximum cost of production of ₹ 4,64,956 ha$^{-1}$ and ₹ 4,61,614, gross returns of ₹ 9,85,000 ha$^{-1}$ and ₹ 9,60,000 ha$^{-1}$, net returns of ₹ 5,35,989 ha$^{-1}$ and ₹ 5,14,331 ha$^{-1}$ and B C ratio of 2.12 and 2.08, were observed for $I_2P_4$ and $I_3P_4$ treatment combinations respectively. The observed water use efficiency was found maximum in $I_1P_4$ (12.93 q·ha$^{-1}$·cm$^{-1}$) treatment combination followed by $I_1P_3$ (12.68 q·ha$^{-1}$·cm$^{-1}$) and $I_2P_4$ (11.56 q·ha$^{-1}$·cm$^{-1}$) treatment combination. It was concluded that 100 per cent crop water requirement be supplied with four pulse (drip) irrigation under agronomic and climatic conditions of Dapoli in Konkan region of Maharashtra, India.**

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## Introduction

The large scale use of drip irrigation system started in 1970s in Australia, Israel, Mexico, New Zealand, South Africa and USA to irrigate vegetables and orchards and its coverage was reported as 56,000 ha (Kulkarni *et al.* 2006). World irrigated area covers 299 m ha out of which India is having irrigated area 62 m ha (ICID 2016).

Pulse irrigation (drip) is the concept where small part of the per day water requirement is given in fraction with a predetermined time of fraction (Dole 1994). There are spatial application interventions that can be used in drip irrigation, such as pulsing of water, which may produce similar moisture and solute distribution in the soil by using low discharge rates. Pulsing is composed of a series of irrigation cycles where each cycle is composed of an irrigation phase and a resting phase (Phogat *et al.* 2012). Small increase in the horizontal spread of moisture under pulsing compared with continuous irrigation observed by Skaggs *et al.* (2010), which was the result of water dissipation during the redistribution phase. High irrigation frequency might provide desirable conditions for water movement in soil and for uptake by roots (Segal *et al.* 2000). Several experiments have shown, vegetable crops gave positive responses to high frequent drip irrigation. Application of larger water applications produce greater spreading, but in both the horizontal and vertical directions. Increased vertical spreading may be undesirable because water moving below the active root zone can result in wastage of water, loss of nutrients, and groundwater pollution. Thus the goal is to maximize the relative horizontal to vertical water movement for a given water application (Skaggs *et al.* 2010). Vegetable crops, such as onions and potatoes, have a sparse rooting system and are unable to use all the soil water within the root zone (Michael 1978). In regard to onion cultivation, many reasons could be attributed to low productivity, in which poor water and nutrient management practices contribute significantly (Palled *et al.* 1998). Being a shallow-rooted crop, onion is sensitive to water stress and requires frequent and light irrigation to avoid water deficiency and to adequately recharge the plant root zone (Koriem *et al.*1994).

Mega-cities like Pune and Mumbai are closer to this region, in turn give the commercial importance to white onion crop. This crop can be cultivated effectively in South Konkan region comprising of Ratnagiri and Sindhudurg district having predominant lateritic soil. The lateritic soil is having high infiltration rates resulting in increased vertical movement of water (Mane *et al.* 2011). Pulse irrigation (drip) can be used effectively for increasing the horizontal spread in heavy infiltrating soils (Abdelraouf *et al.* 2012).

## Material and Methods

The field experiment was conducted during *rabi* seasons of 2014 to 2015 in the Instructional Farm of Department of Irrigation and Drainage Engineering, College of Agricultural Engineering and Technology, Dapoli. The experimental site is situated at 17$^{0}$ 45' 13.1" N latitude and 73$^{0}$ 10' 47.4" E longitudes and altitude of 174 m above MSL. Climatic conditions are humid with average annual rainfall at Dapoli region is 3635 mm (Mandale 2016). The average minimum and maximum temperatures are 18.5 $^{0}$C to 31.0 $^{0}$C, respectively. The relative humidity ranges from 55 percent to 99 per cent (Gaikwad 2013). The experimental design was strip plot and replicated four times. The unit plot size was 27.50 × 9.70 m having single bed of 3 × 1.20 m. Onion seedlings were transplanted in the plots on 15 January 2015 at the age of six weeks. Plant to plant and row to row spacing were 10 cm and 15 cm, respectively. The soil type of experimental field was sandy clay loam in texture having pH- 6.5, EC- 6.0 cm·hr$^{-1}$, bulk density- 1.68 g·cm$^{-3}$, basic infiltration rate- 6.0 cm·hr$^{-1}$, field capacity- 26.01 and permanent wilting point- 12.50.

In the horizontal strips (main treatments), there were four pulse (drip) irrigation treatments

$P_1$ = Continuous irrigation

$P_2$ = Two pulses irrigation

$P_3$ = Three pulses irrigation

$P_4$ = Four pulses irrigation

Time interval between successive pulse treatments was 30 minutes. In the vertical strips (sub treatment), there were three irrigation levels

$I_1 = 0.8\ ET_C$

$I_2 = 1.0\ ET_C$

$I_3 = 1.2\ ET_C$

where,

$ET_C$ = Crop evapotranspiration (mm·day$^{-1}$)

The plots were fertilized with recommended dose of soluble fertilizer 150:75:25 kg·ha$^{-1}$ (Anon. 2012) N, $P_2O_5$ and $K_2O$ respectively. Nine millimetre of irrigation water applied immediately after planting to establish the seedlings. The moisture content was determined by using gravimetric method. The inline lateral of 16 mm with 4 lph discharge having 30 cm spacing at 1.0 kg·cm$^{-2}$ operating pressure was used. The daily water requirement of white onion (*Alium cepa* L.) under pulse (drip) irrigation was worked out based on Penman Monteith method (Allen *et al.* 1998). The available discharge and uniformity coefficient of the drip system was recorded as 3.94 L·ha$^{-1}$ and 96.0 %, respectively. Irrigation treatment was stopped before 15 days of harvesting. The onion bulbs were harvested on 2$^{nd}$ May 2015. Various periodic biometric observations were recorded on five randomly selected plants of white onion at 20 days interval from 30 DAT to 70 DAT from each plot of treatments. Statistical analysis was done by ANOVA appropriate for the strip plot design by using SAS software.

## Results and Discussion

### *Depth of water applied for white onion crop*

The reference evapotranspiration, crop evapotranspiration, and total seasonal gross depth of water applied are presented in the Table 1.

It was discerned from Table 1 that total reference evapotranspiration during the crop growth period was 375.0 mm. Crop evapotranspiration was found as 328.4 mm. Maximum total water applied for white onion under irrigation treatment $I_3$ (1.2 $ET_C$) was found 408.7

mm followed by treatments $I_2$ (1.0 $ET_C$) and $I_1$ (0.8 $ET_C$).

It was observed that the crucial characteristics of biometric observations such as number of leaves, plant height and neck diameter increases with increasing number of pulse treatments (Table 2). Individual effect of number of leaves, plant height and neck diameter were significant for pulse irrigation (drip) treatments at 30, 50 and 70 DAT respectively.

***Growth parameters of white onion***

The highest number of leaves, plant height and neck diameter were found in $P_4$ (four pulse) treatment followed by $P_3$ (three pulse) treatment, respectivly.

Highest number of leaves (5.60, 6.43 and 7.53, respectively), plant height (45.58, 58.00 and 68.97 cm, respectively) and neck diameter (7.67, 13.72, 19.76 mm, respectively) was found at 30, 50 and 70 DAT respectively. These results corroborated by findings of Abdelraouf *et al.* (2013) and Mohamed *et al.* (2012).

It was discerned from Table 2 that amongst the different irrigation levels of 1.2 ETc recorded statistically higher number of leaves at 50 and 70 DAT and was at par with irrigation provided at 1.0 ETc. In case of plant height irrigation level of 1.0 ETc recorded significant plant height at 50 DAT and was at par with irrigation levels of 1.2 ETc while, irrigation levels of 1.2 ETc recorded significantly higher plant height at 70 DAT. Irrigation levels showed non-significant effect at 30 DAT in case of number of leaves, plant height and neck diameter at 50 DAT. These results are corroborated by the findings of Bagali *et al.* (2012) that the irrigation interval at one day ($M_1$) and two days ($M_2$) at 100 % percent PE increased the plant height significantly and this may be due to increased neck girth and number of leaves of white onion crop.

The interaction effect revealed that non-significant effect was observed for number of leaves, plant height and neck diameter at 30 DAT, 50 DAT and 70 DAT respectively.

***Yield***

The data in the Table 3 revealed that influencing irrigation levels through different pulse treatment $P_2$ (two pulse), $P_3$ (three pulse) and $P_4$ (four pulse) treatments and continuous irrigation ($P_1$) increased significantly the yield parameters like bulb diameter, average bulb weight and yield of white onion. The highest mean polar diameter (61.30 mm), geometric mean diameter (58.41 mm), equatorial diameter (60.86 mm), average bulb weight (107.38 g) and yield (36.50 $t \cdot ha^{-1}$) of white onion was found in $P_4$ (four pulse ) treatment, respectively.

Yield parameters like the highest geometric mean diameter (54.24 mm), equatorial diameter (55.53 mm), average bulb weight (95.97 g) and yield (33.15 $t \cdot ha^{-1}$) of white onion was found in $I_3$ (1.2 $ET_C$), except polar diameter (57.07 mm) in $I_2$ (1.0 $ET_C$) irrigation levels, respectively. Similar effect of irrigation on size of onion bulb was also observed by Olalla *et al.* (2004). Increase in the bulb yield is mainly attributed to positive association between yield and yield contributing parameters like bulb weight and size in terms of equatorial and polar diameter of the bulb.

The shorter interval of irrigation ensures optimum

**Table 1.** Month wise gross depth of water applied and seasonal irrigation applied (mm) of white onion under three irrigation treatments.

| Irrigation levels | January* | January** | February | March | April# | Seasonal $ET_O$/ $ET_C$/ Gross depth (mm) |
|---|---|---|---|---|---|---|
| $ET_O$ | 12.1 | 41.5 | 109.8 | 134.3 | 77.3 | 375.0 |
| $ET_C$ | 8.5 | 20.0 | 85.5 | 131.0 | 74.2 | 328.4 |
| $I_1$ (0.8 $ET_C$) | 8.8 | 24.2 | 71.2 | 108.3 | 61.9 | 274.5 |
| $I_2$ (1.0 $ET_C$) | 8.8 | 30.2 | 89.0 | 135.5 | 162.6 | 340.9 |
| $I_3$ (1.2 $ET_C$) | 8.8 | 36.2 | 106.8 | 162.8 | 92.9 | 408.7 |

* General irrigation for establishment of the crop from 15th January to 18th January, 2015

** Pulse treatments were imposed on 19th Jan, 2015

\# Water application terminated on 16th April, 2015

**Table 2.** Individual and interaction effect of biometric observation of white onion

| Pulse/ irrigation treatments | Number of leaves DAT | | | Plant height (cm) DAT | | | Neck diameter (mm) DAT | | |
|---|---|---|---|---|---|---|---|---|---|
| | 30 | 50 | 70 | 30 | 50 | 70 | 30 | 50 | 70 |
| Continuous ($P_1$) | 4.60 | 5.61 | 6.27 | 34.61 | 50.73 | 59.97 | 6.09 | 11.66 | 15.75 |
| Two ($P_2$) | 4.72 | 5.80 | 6.61 | 35.82 | 51.86 | 63.58 | 6.32 | 12.00 | 17.59 |
| Three ($P_3$) | 5.39 | 6.17 | 7.11 | 39.83 | 54.91 | 67.07 | 6.98 | 12.66 | 18.60 |
| Four ($P_4$) | 5.60 | 6.43 | 7.53 | 45.58 | 58.00 | 68.97 | 7.67 | 13.72 | 19.76 |
| S.E. | 0.10 | 0.06 | 0.07 | 1.60 | 0.62 | 0.55 | 0.13 | 0.16 | 0.32 |
| C.D. at 5 % | 0.29 | 0.18 | 0.20 | 4.76 | 1.85 | 1.62 | 0.40 | 0.51 | 1.02 |
| $I_1$ (0.8) $ET_C$ | 4.92 | 5.83 | 6.55 | 38.16 | 51.50 | 63.47 | 6.57 | 12.01 | 16.52 |
| $I_2$ (1.0) $ET_C$ | 5.27 | 6.03 | 6.97 | 40.06 | 55.31 | 64.42 | 6.94 | 12.86 | 18.91 |
| $I_3$ (1.2) $ET_C$ | 5.04 | 6.15 | 7.12 | 38.65 | 54.81 | 66.81 | 6.79 | 12.66 | 18.35 |
| S.E.(m)± | 0.10 | 0.08 | 0.18 | 0.92 | 0.38 | 0.51 | 0.10 | 0.31 | 0.19 |
| C.D. at 5 % | NS | 0.24 | 0.55 | 2.84 | 1.18 | 1.58 | NS | NS | 0.64 |
| Interactions | | | | | | | | | |
| $I_1P_1$ | 5.00 | 6.20 | 6.20 | 40.92 | 55.37 | 63.65 | 8.30 | 11.51 | 13.27 |
| $I_1P_2$ | 5.10 | 6.40 | 6.40 | 41.25 | 56.77 | 64.03 | 8.40 | 11.63 | 16.55 |
| $I_1P_3$ | 5.35 | 6.30 | 7.05 | 42.15 | 59.04 | 66.64 | 10.08 | 12.05 | 17.97 |
| $I_1P_4$ | 5.60 | 6.75 | 7.45 | 47.69 | 61.68 | 69.02 | 11.41 | 12.86 | 18.31 |
| $I_2P_1$ | 5.08 | 6.00 | 6.90 | 42.08 | 57.59 | 62.59 | 9.10 | 11.60 | 16.81 |
| $I_2P_2$ | 5.30 | 6.15 | 7.20 | 44.99 | 60.40 | 67.11 | 10.26 | 12.15 | 18.10 |
| $I_2P_3$ | 5.75 | 6.85 | 7.85 | 48.08 | 63.10 | 70.54 | 11.89 | 13.06 | 19.20 |
| $I_2P_4$ | 6.55 | 6.75 | 8.25 | 51.68 | 65.47 | 72.20 | 12.43 | 14.62 | 21.52 |
| $I_3P_1$ | 5.15 | 6.13 | 7.18 | 42.11 | 58.43 | 65.59 | 9.60 | 11.87 | 17.15 |
| $I_3P_2$ | 5.20 | 6.65 | 7.35 | 46.58 | 60.99 | 68.77 | 11.23 | 12.22 | 18.14 |
| $I_3P_3$ | 5.85 | 6.80 | 7.60 | 47.77 | 62.19 | 70.14 | 11.53 | 12.87 | 18.65 |
| $I_3P_4$ | 6.15 | 6.90 | 8.00 | 49.51 | 63.89 | 71.31 | 12.09 | 13.67 | 19.45 |
| S.E.(m)± | 0.13 | 0.19 | 0.29 | 2.81 | 0.87 | 0.97 | 0.54 | 0.46 | 0.50 |
| C.D. at 5 % | NS | NS | NS | NS | NS | NS | NS | NS | NS |

growth of the crop by assuring balanced water and nutrient supply throughout the crop growth period. Similar result for bulb yield was reported by Quadir *et al.* (2005). It can be evident from the Table 3 that among the different treatment combination $I_2P_4$ (four pulse treatment ($P_4$) with $I_2$ (1.0 $ET_C$) irrigation levels) treatment combination was found significantly superior over $I_1P_1$ (continuous irrigation ($P_1$) with $I_1$ (0.8 $ET_C$) irrigation levels) and at par with $I_3P_4$ (irrigation level 1.2 $ET_C$ and three pulse treatment).

The interaction effect revealed that highest polar diameter (63.88 mm), geometric mean diameter (59.51 mm), equatorial diameter (63.16 mm), average bulb weight (112.05 g) and yield (38.52 t·ha$^{-1}$) of white onion was found in treatment combination $I_2P_4$ (irrigation level 1.0 $ET_C$ and four pulse treatment) followed by $I_3P_4$ (irrigation level 1.2 $ET_C$ and four pulse treatment), respectively. These results corroborated by findings of Zin El-Abedin (2006), Feng- Xin *et al.* (2000), Beenson (1992).

It can be seen from the Table 3 that the quality attributes of white onion like total soluble solid increases with increase from continuous drip irrigation $P_1$ (7.11 $^0$Brix ) to four pulse drip irrigation $P_4$ (9.81$^0$Brix). The highest

**Table 3.** Individual and interaction effect of yield parameters of white onion.

| Pulse/ irrigation treatments | Polar diameter (mm) | Geometric mean diameter (mm) | Equatorial diameter (mm) | Average bulb weight (g) | Yield ton per (hectare) | TSS (Brix) |
|---|---|---|---|---|---|---|
| Continuous ($P_1$) | 49.12 | 46.90 | 48.07 | 68.92 | 27.26 | 7.11 |
| Two ($P_2$) | 53.09 | 49.53 | 50.52 | 83.22 | 28.89 | 7.80 |
| Three ($P_3$) | 57.10 | 54.53 | 55.55 | 98.97 | 33.64 | 9.14 |
| Four ($P_4$) | 61.30 | 58.41 | 60.86 | 107.38 | 36.50 | 9.81 |
| S.E. (m)± | 0.86 | 0.43 | 0.40 | 1.27 | 0.91 | 0.15 |
| C.D. at 5 % | 2.56 | 1.27 | 1.19 | 3.76 | 2.70 | 0.44 |
| $I_1$ (0.8) $ET_C$ | 51.80 | 49.41 | 50.92 | 77.94 | 29.30 | 7.55 |
| I2 (1.0) $ET_C$ | 57.07 | 53.38 | 54.79 | 94.96 | 32.27 | 8.82 |
| I3 (1.2) $ET_C$ | 56.59 | 54.24 | 55.53 | 95.97 | 33.15 | 9.03 |
| S.E.(m)± | 0.93 | 0.67 | 0.33 | 0.78 | 0.25 | 0.15 |
| C.D. at 5 % | 2.86 | 2.05 | 1.03 | 2.39 | 0.78 | 0.46 |
| Interactions | | | | | | |
| $I_1P_1$ | 46.84 | 44.30 | 45.49 | 57.07 | 25.24 | 6.65 |
| $I_1P_2$ | 48.80 | 46.56 | 47.26 | 65.13 | 26.26 | 6.81 |
| $I_1P_3$ | 53.68 | 51.40 | 53.67 | 88.82 | 31.99 | 8.33 |
| $I_1P_4$ | 57.87 | 55.37 | 57.27 | 100.75 | 33.71 | 8.44 |
| $I_2P_1$ | 49.70 | 47.89 | 48.94 | 71.81 | 27.25 | 7.23 |
| $I_2P_2$ | 56.44 | 50.50 | 51.16 | 88.64 | 29.64 | 7.90 |
| $I_2P_3$ | 58.25 | 55.64 | 55.91 | 107.32 | 33.66 | 9.70 |
| $I_2P_4$ | 63.88 | 59.51 | 63.16 | 112.05 | 38.52 | 10.44 |
| $I_3P_1$ | 50.82 | 48.52 | 49.77 | 77.88 | 29.29 | 7.47 |
| $I_3P_2$ | 54.02 | 51.53 | 53.13 | 95.90 | 30.76 | 8.70 |
| $I_3P_3$ | 59.38 | 56.56 | 57.09 | 100.77 | 35.28 | 9.40 |
| $I_3P_4$ | 62.14 | 60.35 | 62.15 | 109.34 | 37.26 | 10.56 |
| S.E.(m)± | 0.71 | 0.71 | 0.74 | 2.19 | 0.81 | 0.10 |
| C.D. at 5 % | 2.04 | NS | NS | NS | NS | 0.28 |

TSS 9.03 $^0$Brix at $I_3$ (1.2 $ET_C$) probably due to fulfilment of optimum demand of crop for moisture and their proper utilization. This corresponds to earlier finding of Vagen and Slimestad (2008). From pooled data effect of interaction inferred maximum TSS was found 10.56 ($^0$Brix) in treatment combination $I_3P_4$, which was significantly more than other treatment combination.

*Cost analysis of white onion*

It was evident from the Table 4 that cost of production of ₹ 4,64,956 $ha^{-1}$ and ₹ 4,61,614, gross returns of ₹ 9,85,000 $ha^{-1}$ and ₹ 9,60,000 $ha^{-1}$, net returns of ₹ 5,35,989 $ha^{-1}$ and ₹ 5,14,331 $ha^{-1}$ and B:C ratio of 2.12 and 2.08, were observed for $I_2P_4$ and $I_3P_4$ treatment combination, respectively.

**Table 4.** Cost estimation white onion under different treatment combinations

| Treatment combination | Yield ($t \cdot ha^{-1}$) | Cost of production (₹$\cdot ha^{-1}$) | Gross monetary returns (₹$\cdot ha^{-1}$) | Net Income (₹$\cdot ha^{-1}$) | B C Ratio | Depth (cm) | Water use efficiency ( $q \cdot ha^{-1} \cdot cm^{-1}$) |
|---|---|---|---|---|---|---|---|
| $I_1P_1$ | 28.86 | 4,07,467 | 7,21,500 | 3,17,222 | 1.77 | 27.5 | 10.5 |
| $I_1P_2$ | 30.07 | 4,14,101 | 7,51,750 | 3,42,432 | 1.82 | 27.5 | 10.9 |
| $I_1P_3$ | 34.83 | 4,37,115 | 8,70,750 | 4,41,607 | 1.99 | 27.5 | 12.7 |
| $I_1P_4$ | 35.50 | 4,47,878 | 8,87,500 | 4,55,566 | 1.98 | 27.5 | 12.9 |
| $I_2P_1$ | 30.75 | 4,16,173 | 7,68,750 | 3,55,766 | 1.85 | 34.5 | 9.0 |
| $I_2P_2$ | 32.79 | 4,26,264 | 8,19,750 | 3,98,269 | 1.92 | 34.0 | 9.6 |
| $I_2P_3$ | 37.15 | 4,47,612 | 9,28,750 | 4,89,110 | 2.07 | 34.0 | 10.9 |
| $I_2P_4$ | 39.40 | 4,64,956 | 9,85,000 | 5,35,989 | 2.12 | 34.0 | 11.6 |
| $I_3P_1$ | 32.95 | 4,26,159 | 8,23,750 | 4,00,780 | 1.93 | 40.9 | 8.0 |
| $I_3P_2$ | 33.77 | 4,31,169 | 8,44,250 | 4,17,865 | 1.96 | 40.9 | 8.7 |
| $I_3P_3$ | 36.25 | 4,44,687 | 9,06,250 | 4,69,535 | 2.04 | 40.9 | 8.8 |
| $I_3P_4$ | 38.40 | 4,61,614 | 9,60,000 | 5,14,331 | 2.08 | 40.9 | 9.4 |

Water use efficiency was found maximum for $I_1P_4$ (12.9 $q \cdot ha^{-1} \cdot cm^{-1}$) treatment combination followed by $I_1P_3$ (12.7 $q \cdot ha^{-1} \cdot cm^{-1}$) and $I_2P_4$ (11.5 $q \cdot ha^{-1} \cdot cm^{-1}$) treatment combination, respectively.

## Conclusion

In conclusion present study indicated that among the different treatment combination $I_2P_4$ (irrigation level $I_2$ (1.0 $ET_C$) with four pulse treatment ($P_4$)) was found significantly superior over $I_1P_1$ (irrigation level $I_1$ (0.8 $ET_C$) with continuous irrigation ($P_1$)) and at par with $I_3P_4$ (irrigation level 1.2 $ET_C$ and four pulse treatment) treatment combination. The average seasonal water applied to white onion under pulse irrigation (drip) through different irrigation levels was varied from 274.46 mm for $I_1$ (0.8 $ET_C$) to 408.73 mm for $I_3$ (1.2 $ET_C$) irrigation levels. The interaction effects revealed that highest polar diameter (63.88 mm), geometric mean diameter (59.51 mm), equatorial diameter (63.16 mm), average bulb weight (112.05 g) and yield (38.52 $t \cdot ha^{-1}$) of white onion was found in treatment combination $I_2P_4$ followed by $I_3P_4$.

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