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Optimization of High Density Planting with Drip Irrigation in Rabi Onion

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Irrigation scheduling is necessary for increasing onion production in an Agro-climatic zone III A and B of Bihar, where water is becoming scarce gradually and a limiting factor for onion production. Field experiments were conducted during the Rabi season of 2013-14 and 2014-15 at the experimental farm, Nalanda College of Horticulture, Noorsarai, Nalanda. The objectives were to standardize high density planting with drip irrigation and to study the yield performance and storability on onion in Nalanda region. The treatments consisted of factorial combination of three irrigation intervals (2, 4 and 6 days) and four population densities (2000000, 1333333, 1000000 and 666666 plants/ha) corresponding to 10 x 5, 10 x 7.5, 10 x 10 and 15 x 10 cm respectively. The experiments were laid out in randomized block design replicated three times. Results revealed that the highest marketable

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yield was significantly favoured by 2 days interval followed by 4 days. However, lower plant spacing 10 x 5 cm recorded higher plant height, minimum maturity days, grass and marketable bulb yield were significantly higher with plant spacing 10 x10 cm followed by 15 x10 cm. The marketable bulb yield was significantly higher with interaction of T_7 (10 x10 cm with 2 days irrigation interval) 1000000 plant density and 2 days irrigation interval than other treatment combinations. From the results of the study, it can be concluded that 2 days interval irrigation with a plant density of 1000000 (10x10 cm) plants per hectare can be practised for maximum onion bulb yield.

Keywords: Onion; irrigation scheduling; plant density; yield.

1. INTRODUCTION

Onion *(Allium cepa L.)* is an important vegetable crop valued for the distinctive pungent or mild flavour and for the essential ingredients of the cuisine of many region [1] about 5.30 million hectares of land are cultivated to onion in the world. World production of onion is estimated at over the average yield is about 16.70 tonne per hectare [2]. Onion is a major spice in diet. It ranks as the 2nd most important vegetable based on the level of consumption and other uses.

The main production of onion in Bihar is during Rabi season between Octobers to May where irrigation is available. The Rabi season crop is sown in October-November and transplanted in December-January into flat beds of 2 meter wide, 6-8 meter long, water is supplied as surface irrigation, since major production is in Rabi Season, irrigation is on essential organic practice. Farmers irrigate by flooding the flat beds at interval of 5-7 days. Irrigation is particularly very important for bulb development stages to prevent cracking of the bulb and reduction in marketable bulb yield [3]. Appropriate irrigation scheduling and quantity of irrigation water is essential required for maximum bulb production, determination of rate, type, timing of fertilizers and soil amendments. Onion production in the sub-tropics is said be limited by a number of factors. i.e. factors ranges from moisture stress, good management practices irrigation scheduling intervals and plant population density or plant arrangement to ensure good crop growth . However, high irrigation frequency can pose a threat of water logging, leaching of applied fertilizes, high salt build up as well as logging in onion which all results in low yield. Proper irrigation schedule in onion reduces water by 0.9% and leads to yield increase [4]. If farmers could schedule their irrigation properly, it will invariably cut down cost involved in water application and increase yield. Water is inadequate in most areas where onion production is prevalent. Water application must be done efficiently to ensure profitability while at the same time maximizing yields. This study deems it justified to look into the optimum combination of watering regime and optimum population density needed to maximum bulb onion yield. This experiment was conducted to study the optimum plant population for increase yield of onion and standardize the irrigation interval by higher growth and yield of onion in a sub-tropical environment.

2. MATERIALS AND METHODS

The experiment was conducted during Rabi seasons of 2013-14 and 2014-15, at experimental farm of Nalanda College of Horticulture, Noorsarai, Nalanda. The experimental site is located from 65 km of Patna at the latitude and longitude of 25°.2748' and 85°.4569' respectively. The treatments consisted of three irrigation intervals (2, 4 and 6 days) and four plant spacing 10 x 5, 10 x 7.5, 10 x 10 and 15 x 10 cm accommodating to 2000000, 1333333, 1000000 and 666666 plants/ha respectively. The treatments were laid out in a factorial randomized design with three replications. Irrigation was allocated to the main plots while plant population density occupied the sub-plots. All plots received adequate watering (at 3 days intervals) for two weeks for proper crop establishment before imposition of irrigation treatment. Net plot size was 3.6 x 1.8 (6.5 m^2). In both experiments seedling of Agrifound light red (ALR) were raised in nursery beds for 7 weeks before transplanting. The nursery was prepared by constructing raised seed beds to which adequate quantities of well rotten farm yard manure (FYM) was applied. About 100 gm of onion seeds were sown on seed beds (size 3 x 0.75 m) in lines spaced at 5cm distance and lightly covered with a thin layer of compost and dry soil. The beds were then covered with paddy mulch and the watered lightly using a can. The

mulch was removed as soon as the seed germinated in order to expose them to sunlight. Watering was sustained lightly but regularly until the seedling was due for transplanting seven weeks later. The experimental field was cleaned; ploughed, harrowed and raised beds of size 3.6 x 1.8 m were constructed. Transplanting of the 7 weeks old seedling into the raised beds was done on 5th January, 2013 and on 8th January 2014. The transplanted seedling was watered immediately to minimize transplanting shock. The fertilizer dose NPK @ 125:60:80 kg/ha applied to the plots. Whole quantity of phosphorus, potash and half of nitrogen were applied as basal dressing and rest of nitrogen were applied in two equal doses at 30 and 45 days after transplanting as top dressing. The plots were kept free of weeds throughout the experimental period. The hand weeding was done when required. While, pests/ disease were kept under control by applying Decis and Saaf @ 2 ml and 2 gm per litter of water, respectively. Data was recorded on the number of leaf per plant, plant height, maturity days, neck thickness, polar & equatorial diameter and onion bulb yield. Collected data were analysed using factorial randomized block design.

3. RESULTS AND DISCUSSION

Data for all the growth and yield attributing traits recorded and pooled over two years. The maximum number of leaves/plant and plant height (cm) was recorded 6.87 and 71.37 cm respectively with two days interval of drip irrigation (I_1) which was significantly higher than 4 days (I_2) and 6 days (I_3) interval of drip irrigation. It might be due to adequate supply of irrigation helps to keep moist inside active root zone which leads to proper growth of onion plants. The similar effect of irrigation frequency on the growth parameters have been investigated by Sanjay et al. [5] the data presented in Table 1, indicated that the maximum number of leaves/plant was recorded 7.02 with wider spacing because of less competition for space, light, air and nutrients. Whereas, plant height recorded 73.16 cm with closer spacing (S_1). It was due to fact that closer spacing has higher competition for light, space and air with plants and tends to grow upward. The interaction effect between irrigation interval and geometry was significantly recorded with (S_4 x I_1) when planted at 15 x 10 cm. along with 6 days interval of drip irrigation which was due to wider spacing facilitate the less competition for light, space and air and adequate supply of water.

The more number of days to maturity 93.42 was recorded with 2 days interval of the drip irrigation whereas impact on neck thickness has not been found significant difference among treatments. The impact of spacing on maturity days was significantly higher with wider spacing (15 x 10 cm) which was at par to S_3 and S_2. The effect of spacing on neck thickness was recorded non-significant. The interaction between irrigation interval and planting geometry was recorded non-significant effect on maturity days and neck thickness.

The mean polar diameter and equatorial diameter (cm) of onion as affected by irrigation frequency and planting geometry are presented in Table 1. The maximum polar diameter and Equatorial diameter 5.15 and 4.96 cm respectively were significantly recorded with the 2 days interval of drip irrigation. However the trend in increasing manner with lesser days interval of irrigation could be linked to adequate supply of the water provide optimum moisture level inside the active root zone which controls most of the plant physiological processes including bulb development. Similar opinion have been given by Dorcas et al. [1] high temperature reduce the rate of photosynthesis in most plants whereas, the rate of evapo-transpiration was very high. Therefore, keeping more number of days of irrigation interval has greatly derived the plants, the available dry matter for optimum photosynthesis hence less dry matter is partitioned to the bulb which might have resulted in reduced yield and size of the bulb.

The significant effect of planting geometry on polar diameter and equatorial diameter of onion 5.34 and 5.11 cm respectively were recorded when planted at 15 x 10 cm (S_4). It was due to availability of optimum space/plant compared to high plant density implies closer spacing and ultimate reduction in space /plant limits the expansion of bulb due to small space for bulbing. The interaction between irrigation interval and plant spacing recorded significant differences and the maximum polar diameter and equatorial diameter 6.21 and 5.96 cm respectively were recorded with combination of plant spacing at 15 x 10 cm under 2 days interval of drip irrigation ($S_4 I_3$).

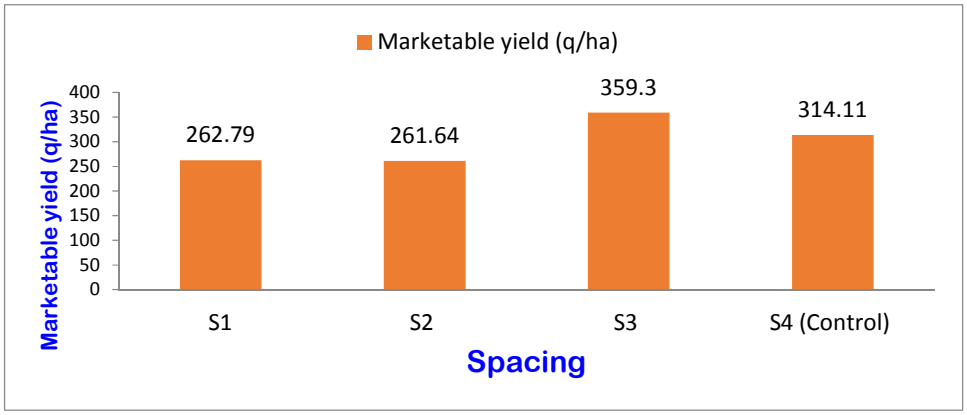
Table 1. Individual effect of HDP and drip irrigation level on growth & yield attributes of Rabi onion. (Pooled data 2013-14 and 2014-15)

Treatments	No. of leaves / plant	Plant height (cm)	Maturity days	Neck thickness (cm)	Polar diameter (cm)	Equatorial Diameter (cm)	Gross yield (q/ha)	Marketable yield (q/ha)
Irrigation level								
I_1	6.87	71.32	93.42	1.18	5.15	4.96	326.78	314.63
I_2	6.64	70.47	91.97	1.22	4.50	4.51	314.08	301.46
I_3	6.39	68.65	91.13	1.21	4.04	4.04	296.53	282.30
SEm ±	**0.084**	**0.325**	**0.202**	**0.033**	**0.126**	**0.124**	**3.737**	**3.696**
CD@ 5 %	**0.174**	**0.671**	**0.418**	**NS**	**0.260**	**0.256**	**7.713**	**7.629**
Spacing								
S1	6.20	73.16	91.85	1.19	3.45	3.37	275.74	262.79
S2	6.46	71.84	92.16	1.23	4.33	4.27	275.52	261.64
S3	6.85	69.02	92.23	1.20	5.19	5.26	371.22	359.30
S4 (Control)	7.02	66.54	92.46	1.19	5.34	5.11	327.38	314.11
SEm ±	**0.097**	**0.375**	**0.234**	**0.038**	**0.146**	**0.143**	**4.315**	**4.268**
CDat5% level	**0.201**	**0.775**	**0.482**	**NS**	**0.300**	**0.295**	**8.906**	**8.809**

Table 2. Interaction effect of HDP and drip irrigation level on growth & yield attributes of Rabi onion (Pooled data 2013-14 and 2014-15)

Interaction treatments	No. of leaf / plant	Plant height (cm)	Maturity days	Neck thickness (cm)	Polar diameter (cm)	Equatorial Diameter (cm)	Gross yield (q/ha)	Marketable yield (q/ha)
T_1 (S_1I_1)	6.15	74.87	93.25	1.14	3.88	3.62	291.90	278.43
T_2 (S_1I_2)	6.10	73.77	91.56	1.25	3.36	3.40	271.20	258.63
T_3 (S_1I_3)	6.33	70.84	90.74	1.19	3.12	3.10	264.13	251.30
T_4 (S_2I_1)	6.64	72.43	93.20	1.18	4.58	4.41	287.93	272.90
T_5 (S_2I_2)	6.58	71.85	92.18	1.25	4.28	4.31	276.20	262.50
T_6 (S_2I_3)	6.15	71.23	91.11	1.24	4.12	4.09	262.43	249.53
T_7 (S_3I_1)	7.25	69.92	93.21	1.19	5.91	5.85	382.50	372.13
T_8 (S_3I_2)	6.69	69.57	92.23	1.21	5.08	5.11	371.77	358.70
T_9(S_3I_3)	6.62	67.68	91.26	1.21	4.55	4.71	359.40	347.07
T_{10}(S_4I_1)	7.44	68.08	94.03	1.20	6.21	5.96	344.80	335.03
T_{11}(S_4I_2)	7.17	66.67	91.93	1.17	5.29	5.21	337.17	326.00
T_{12}(S_4I_3)	6.47	64.86	91.41	1.22	4.39	4.25	300.17	281.30
T_{13}(Control)	6.63	70.15	92.18	1.20	4.57	4.50	312.47	299.46
SEm ±	0.169	0.65	0.40	0.06	0.25	0.24	7.47	7.39
CD at 5 % level	0.349	NS	NS	NS	0.52	0.51	NS	15.26

The highest gross yield and marketable yield were influenced by planting geometry. The highest gross yield and marketable yield was recorded with closer planting density of 10 00000 plant/ ha followed by 666666 plant/ ha whereas, the least yield recorded with ultra-closer spacing with 1333333 and 2000000 plant/ha. It was due to fact that the higher population density with 1000000 plant/ha was adequate plant density which is a predetermining factor for per unit area



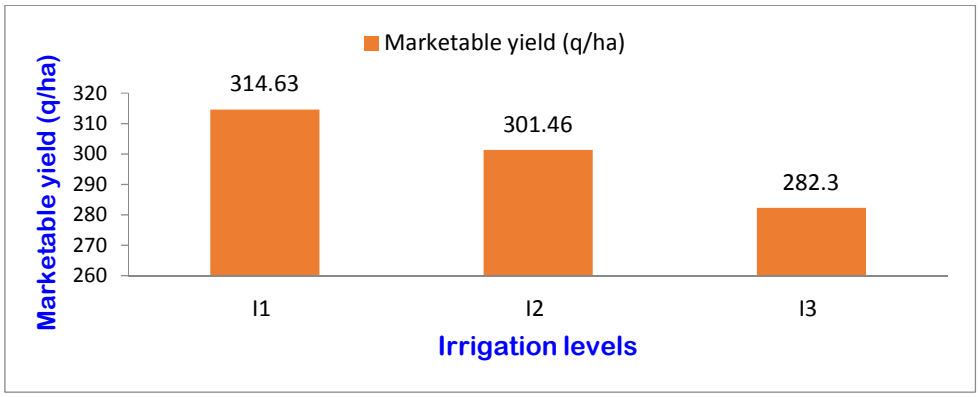


Fig. 1. Individual effect of HDP (A) and drip irrigation level (B) on growth & yield attributes of Rabi onion

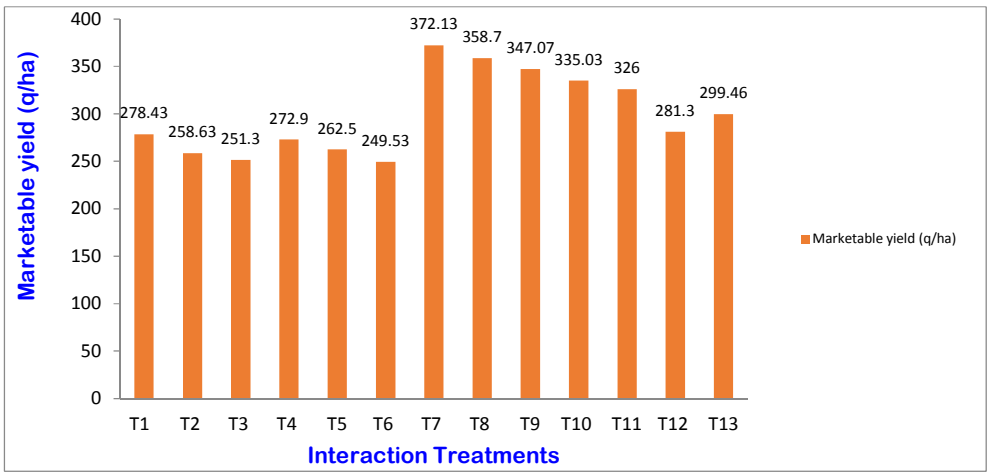


Fig. 2. Effect of HDP and drip irrigation level on marketable yield of Rabi onion

return. The marketable yield of onion increases and bulb diameter decreases with increasing plant population this result was close confirmed with [3] whereas, ultra closing spacing accommodate more number of plant per unit area but onion size was very small and marketable yield and quality gradually reduced. It was due to competition for space, nutrition, sun light and air for optimum growth and development. In a similar experiment by Shock et

al. onion yield and grade were highly responsive to plant population. Onion marketable yield increased, and bulb diameter decreased with increasing plant population [6]. The best growth of onion was observed at planting distance 20 cm x 10 cm [7]. The onion bulb size, gross yield and marketable yield (q/ha) was significantly greater with 2 days irrigation interval. This result is in close with the findings of Amans et al. [8] that reported a significant increase in onion bulb yield by increasing frequency of irrigation. The interaction between spacing and level of irrigation on marketable yield (q/ha) were recorded significant impact when sapling planted at 10 x10 cm (100000 plant/ha) with two days interval drip irrigation level.

4. CONCLUSIONS

On the basis of present investigation, it may be concluded that the marketable bulb yield was significantly higher with 2 days interval of drip irrigation with planting at closer spacing i.e. 10 x10 cm accommodated more number of plant (1000000/ha) than other treatment combinations. Therefore, (S_3 I_1) treatment combination can be practised for maximum onion bulb yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Dorcas AOA, Magaji MD, Singh A, Ibrahim R, Siddiqui Y. Irrigation scheduling for onion (*Allium cepa L.)* at various plant densities in a semi-arid environment. UMT 11th International annual symposium on sustainability science and management 09th -11 July, Terengganu, Malaysia; 2012.
2. Horticulture at a Glance. 2017;454. Available:http://nhb.gov.in
3. Shock CC, Feibert EBG, Saunders LD. Plant population and Nitrogen fertilization for Subsurface Drip-irrigated Onion. Hort Science. 2004;39(7):1722-1727.
4. Donald CM. Competition for light in crops and among crop and pasture plant. Advances in Agronomy. 1983;15:1-118.
5. Sanjay T, Singh Satpute, Khanna Man, Manoj, Singh AK, Ahmad T. Response of drip irrigated onion crop to irrigation intervals and fertigation strategies. Indian J. Hort. 2013;70(2):293-295.
6. Hasan BF. Effect of crop density and ost fertilizer on growth and yield of red onion *(Allium ascalonicum L.)*. Mon Mata: Majalah Ilmiah Universitas Syiah Kuala. 1993;11:82-107.
7. Khan MA, Hasan MK, Miah MAJ, Alam MM, Masum ASMH. Effect of plant spacing on the growth and yield of different varieties of onion. Pakistan Journal of Biological Sciences. 2003;6(18):1582-1585.
8. Amans EB, Japhet SO, Frohlich H. Four onion varieties recommended for release. Report submitted to the Institute for Agric. Research, Samaru, Zaria Nigeria; 1997.

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