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Effect of Different Fertigation Levels on Growth and Yield Parameters of Onion crop in Red Loamy Soils, Anantapuramu District

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ABSTRACT

The effect of different fertigation levels on onion crop growth and yield parameters in red loamy soils of Anantapuramu district were assessed in research, the variety 'Nashik red' was tested using randomized block design with five different treatments i.e., 100%, 80%, 60%, 40% RDF and Control with the four number of replications. The growth and yield parameters namely plant height, the number of leaves per plant, dry matter content (g plant^{-1}), neck thickness of the bulb (mm), a polar diameter of the bulb (cm), equatorial diameter of the bulb (cm), average bulb weight (g), yield of onion bulbs (t ha^{-1}) are measured. From the results, observed that average of plant height (70.18 cm), number of leaves (15.20), dry matter content (27.95 g plant^{-1}), neck thickness of bulb (19 mm), polar diameter of bulb (5.43 cm), equatorial diameter of bulb (7.28 cm), average bulb weight (129.30 g), yield of onion bulbs (51.61 t ha^{-1}) parameters were found superior in T1. however, it was on par with control in many observations. The significantly highest yield of onion was obtained in treatment T1(100% RDF) where 100% WSF was followed in 13 splits apportioned as per crop growth stages through the drip irrigation system.

Key words : *Fertigation, Growth parameters, Yield Parameters, Onion Crop*

Introduction

The onion (*Allium cepa* L., from Latin cepa "onion") is also called the bulb onion. But some of us termed as common onion, is used as a vegetable and that is the most cultivated species of the genus Allium. The shallot is a botanical variety of the onion. The shallot was recognized as an individual species until 2010. The onion is usually a biannual or permanent plant, but is annually branded and picked during its initial season of production. India ranks first with an area of 882 thousand hectares (2013-2014) accounting for around 26.30% of the world's onion-cropped area (Indian Horticulture Database, NHB Gurgaon 2014).

'Fertigation' is the method of application for supplying water-soluble fertilizers to crops with the source of a micro irrigation system. The right method of nutrient application through fertigation seemed to be the most saving of labours and helps for vegetative growth in critical stages which seems too high productivity and nutrient use efficiency.It

can be defined as yield (biomass) per unit input (Fertilizer, nutrient content).Fertilizer application methods for field crops and orchard crops were different from each other. Fertilizer application methods for field crops are broadcasting, deep placement, foliar application, surface incorporation, fertigation. The application methods for fertilizer for orchards are ground application in rings, foliar application, trunk insertion. The drip irrigation method increases the crop yield to 25-30% and by reducing the large amounts of water up to the extent of 40-60% (Sivanappan, 1979).

Drip fertigation enables accurate use of measures of water and fertilizer and prevents leaching to deeper soil layers (Hartz and Hochmuth, 1996). Localized nutrient solution application around emitters restricts the region of the soil moist surface and inhibits the weathering of the plant leaves. Flow irrigation with drop fertilization may produce favourable circumstances of growth with reduced disease and weed propagation (Rumpel *et al.*, 2004).

Field-based vegetables with diffused fertilization are typically inadequately supplied with nitrogen and less potassium. Fertigation is therefore done largely with nitrogen and every so often potassium under field circumstances (Hartz and Hochmuth, 1996). The usage of complicated solutions, macro and micro-elements are unusual as well cultivated soils contain numerous plant nutrients that are essential in contrast to most inert greenhouse substrates. Plants fertigated with nitrogen or with a multi-element solution had a greater leaf surface and produced higher fresh and dry weights as compared with broadcast fertilization (Kaniszewski *et al.*, 1999). The main objective of the present study is to know the effect of different fertigation levels on onion crop biometric and yield parameters.

Materials and Methods

Study Area

To identify the effect of various fertigation levels on the growth of onion crop and yield attributing characters was conducted during 2018 – 19 Rabi, at the instructional farm, College of Agricultural Engineering, Madakasira. During the study, the maximum temperature (40.69 °C), minimum temperature (10.2 °C), relative humidity varied between 85.7% and 22% and the wind speed varied between 9.75 and 5.10 km hour^{-1}were recorded. The soil of the experimental site was uniform, levelled. It was well-drained, red loamy in texture with 45 cm depth. The soil samples, at a depth of 0-45 cm, were collected for analyzing physical and chemical properties. The soil testing of the samples was carried out at the soil testing laboratory of the Agricultural College, Bapatla. The relevant data on the physical and chemical properties of the experimental site is presented in Table 1. In the present investigation, the irrigation water requirement is determined by using CROPWAT 8.0 model developed by FAO.

Table 1. Physical and Chemical Properties of soil sample

Sl. No.	Characteristics	Composition
	Physical properties	
1	Particle size analysis	
	Sand (%)	30
	Silt (%)	51
	Clay (%)	19
	Textural Class	Red loamy soil
2	Field Capacity (%)	0.2768(cm^3 water/ cm^3 soil)
3	Wilting Point (%)	0.1196 (cm^3 water/ cm^3 soil)
4	Saturation capacity(%)	0.4734 (cm^3 water/ cm^3 soil)
5	Bulk Density (g cm^{-3})	1.66
6	Infiltration rate (cm hr^{-1})	0.77
	Chemical properties	
1	pH	8.72
2	EC (mmhocm^{-1})	0.58
3	Available N (kg ha^{-1})	206.9
4	Available P (kg ha^{-1})	66.6
5	Available K (kg ha^{-1})	600

Treatment Details and Crop Management

The experiment was carried out with 5 treatments (4 different fertigation levels and control treatment details were T1 (Drip with 100% Recommended dose (RD) of fertigation), T2 (Drip with 80% RDF), T3 (Drip with 60% RDF), T4 (Drip with 40% RDF), T5 Control (No fertilizers under drip irrigation)) with the four replications in a randomized block design (RBD), with the selected plot size 4 X 3 mby maintaining the spacing 15 X 7.5 cm. The onion seeds (*Var*. Nashik Red) are used for test variety and were broadcasted on the experimental site. After 55 days of broadcasting, healthy seedlings were transplanted on 25thDecember 2018. Inland preparation for primary tillage tractor-drawn mouldboard plough was used followed by two harrowing with disc harrow after that secondary tillage with a rotavator. Before final preparation, well rotten FYM was applied in each plot separately and mixed thoroughly. The components of the drip irrigation system like the suction pipe, pumping unit and delivery pipe were connected to main, sub mains (40 mm), manifolds, laterals were placed with the spacing of 0.4 m by the 4 lph emitters maintaining with 0.45m. Drip fertigation system is comprised of primary and secondary filters *i.e.*,sand filter and screen filter along with this backflush assembly is attached to the sub-main. Electric motor, pump set, air release valve, control valve, bypass valve, pressure gauges and fertilizer tank are also fixed in this system. The soil present in the experimental site was uniform and levelled. The soil samples were collected at a depth of 0-45 cm, to analyse the physical and chemical properties of the experimental site. It was red loamy in texture. The testing of the soil samples was carried out at the soil testing laboratory of the Agricultural College, Bapatla.

Recommended doses of fertilizers are (NPK) 150:60:60 kg ha^{-1}. Soil test results of N:P:K were 20.69:66.6:60 kg ha^{-1}. In soil test results, it was found that nitrogen (N) is low, phosphorous is high and potash is high. Fertilizers were applied in 13 number of splits apportioned as per the crop growth stages with drip irrigation system.

Biometric and Yield Parameters

Yield imputes viz., plant population, plant height, number of sympodial branches plant, dry matter content, neck thickness of the bulb and diameter of the bulb for onion crop were absorbed by maintaining standard procedures.

Plant population

The commencing plant population was noticed by calculating the plant'spopulation from chosen plots after 30 days of transplanting and the terminal plant population is listed by considering the count of plants from each net plot just before harvesting.

Height of the plant

For recording various observations, five plants were randomly selected from each plot and tagged for identification. The height of the plant was reported by considering the extent of shoot from the base level to the tip of the immense leaf slanting vertically at 30, 60, 90 DAT and at the reaping stage. The average of the five plants in total blocks was calculated for additional computing and it is indicated in centimeters (cm).

Number of leaves per plant

The total number of fully grown, green and photosynthetically active leaves per plant was recorded continuously at 30, 60, 90 DAT and the harvest. The average number of leaves per plant was calculated.

Dry matter content

Dry matter is an index of the overall growth of the plant. Three plants per plot were sampled randomly for the determination of the total dry matter in respect of the parts, i.e. leaves and bulb. The leaves and bulb were separated and chopped into small pieces, packed into brown paper bags and labeled properly and air-dried first and then dried in the hot air oven at about 65 ºC temperature for 24 hours. The final constant weight was recorded. The dry matter was taken at 30, 60, 90 DAT and the harvest.

Neck thickness of the bulb

The neck thickness below the joint of leaf lamina of three randomly selected bulbs was recorded by Vernier calliper at 30 days' interval from 30thDAT up to the harvest. These measurements were expressed in millimeters.

Diameter of bulb

Polar diameter of the bulb

The polar diameter of five randomly selected bulbs was recorded by Vernier calliper at harvest in cm. Polar diameter is the distance between the onion

crown and the point of root attachment to the onion.

Equatorial diameter of the bulb

The diameter of five randomly selected bulbs was recorded by Vernier calliper at harvest in cm. The equatorial diameter is the maximum width of the onion in a plane perpendicular to the poles.

Yield studies

Average bulb weight

The average bulb weight of five randomly selected bulbs in grams from each plot was weighed on an electronic balance and expressed as grams (g).

Yield of onion bulbs per plot

The weight of harvested bulbs was recorded for each plot separately. The yield of onion bulbs on a hectare basis is calculated for each treatment.

Field Water Use Efficiency

Field water use efficiency is the ratio of yield of the crop and seasonal water requirement of the crop (Michael, 2010).

$$WUE = \frac{Y\ (kgha-1)}{WR\ (mm)}$$

Where,
FWUE = Field Water Use Efficiency, kg ha^{-1} mm^{-1}
Y = Yield of crop kg ha^{-1}
WR = Seasonal water requirement, mm

Fertiliser Use Efficiency(FUE)

Fertilizer use efficiency is the ratio of crop yield and total N, P and K fertilizers applied (Jaya kumar *et al*., 2015).

$$FUE = \frac{\text{Yield (q/ha}^{-1})}{\text{Total fertilizer applied (kg ha}^{-1})}$$

Results and Discussion

Height of the plant

Higher plant height was noticed in T1 (Table 1) showed significantly more plant height (38.2, 62.75, 70.18 and 70.18 cm respectively) as compared to all other treatments and control. The control showed lower plant height from starting of the crop to harvest which significantly differed from the remaining treatments. The reason may be the supply of required nutrients at the required time. The results are nearly matching with the observations noticed by Bhonde *et al*. (2003) and Mali (2006) at all the growth stages (100% RD of fertigation).

Number of leaves per plant

The data relating to the total count of leaves per plant is shown in Table 2. It reveals that the number of mature leaves per plant is significantly influenced due to the applied various treatments of fertigation management. The higher number of leaves was observed in T1(100% RD of fertigation) at 30 DAT, 60 DAT, 90 DAT, and at harvest as 6.85, 13.05, 15.20, and 15.20 respectively. The minimum number of leaves as 4.35, 7.40, 8.80 and 8.80 cm at 30 DAT, 60 DAT, 90 DAT and at harvest, respectively were recorded in control (no fertilizer treatment). These activities are rapidly performed in the early growth stages of the crop, i.e. up to 60-65 days (Jones and Mann, 1963).

Dry matter content

The data related to the plant dry content (g plant^{-1}) of onion is shown in Table 3 and Figure 4. It revealed that treatments at 30 DAT, 60 DAT, 90 DAT and at Harvest T1(100% RD of fertigation) is 0.71, 15.05, 23.85 and 27.95g plant^{-1}, T2 (80% RD of

Table 2. Effect of different fertigation levels on plant height (cm) of onion crop

S. No.	Treatments	Plant Height in cm			
		30 DAT	60 DAT	90 DAT	At harvest
T1	100% fertigation	38.20	62.75	70.18	70.18
T2	80% fertigation	35.18	59.35	63.80	63.80
T3	60% fertigation	32.35	59.08	62.44	62.44
T4	40% fertigation	29.92	52.38	60.28	60.28
T5	Control	26.88	51.95	53.80	53.80
	SE(d)	0.96	2.54	1.29	1.29
	LSD	2.12	5.60	2.84	2.84
	CV (%)	4.20	6.30	2.93	2.93

fertigation) is 0.61, 12.93, 20.90 and 24.43g plant^{-1}, T3(60% RD of fertigation) 0.56, 9.90, 17.91 and 21.92g plant^{-1}, T4 (40% RD of fertigation) 0.48 7.05 14.95 and 19.89 g plant^{-1}, control (No fertigation under DI) 0.38, 5.95, 12.34 and 17.00 egg plant^{-1}. Treatment T1 (100% RDF) recorded maximum plant dry matter over other rest treatments and control at all growing stages of drip fertigated onion crop. The minimum dry matter at 30 DAT, 60 DAT, 90 DAT and at harvest, respectively recorded in control (no fertilizers under DI). T1 is at par with remaining all rest treatments and control at 30 DAT, 60 DAT, 90 DAT and at harvest. The highest CV was recorded as 3.76 at T1. These observed values are in close conformation with Deho *et al*. (2002).

Neck thickness of bulb

Data about the influence of various treatments on the neck thickness of the onion bulb is showed in Table 4. It revealed that significantly higher mean neck thickness of 10.00, 18.40, 16.28, 19.00 and 11.75 cm at 30 DAT, 60 DAT, 90 DAT, and at harvest, respectively were recorded in T1(100% RDF) than other treatments throughout the crop period.

To know the effect of different treatments ANOVA was performed and presented in AppendixB. In all cases, $F_{cal}>F_{tab}$ and the null hypothesis were rejected, showing that there is a significant difference in all treatments. To know the difference between individual treatments standard error of deviation, LSD, Coefficient of variation was calculated and presented in Table 4. However, at 60 DAT, 90 DAT and harvest T1, T2, T3 and T4was on par with control. The coefficient of Variation was 6.34 observed in Periodical neck thickness (mm) of onion bulb at 30 DAT. These results are in confirmation with Jitendra Kumar *et al*. (2010).

Diameter of bulb

Data pertaining to the influence of various treatments on the polar and equatorial diameter of the bulb is presented in Table 5. It revealed that significantly higher mean polar and equatorial diameters of 5.43 and 7.28 cm at the time of harvesting respectively were observed in T1 (100% RD of fertigation) than other treatments.

To know the effect of different treatments ANOVA was performed. In all cases, $F_{cal}>F_{tab}$ and null hypothesis were rejected, showing that there is a significant difference in all the treatments. To know the difference between individual treatments standard error of deviation, LSD, Coefficient of

Table 3. Effect of different fertigation levels on number of leaves per plant of onion crop

S. No.	Treatments	Number of leaves per plant			
		30 DAT	60 DAT	90 DAT	At harvest
T 1	100% fertigation	6.85	13.05	15.20	15.20
T 2	80% fertigation	5.45	11.40	13.65	13.65
T 3	60% fertigation	5.05	9.75	11.60	11.60
T 4	40% fertigation	4.90	8.75	9.90	9.90
T 5	Control	4.35	7.40	8.80	8.80
	SE(d)	0.27	0.29	0.36	0.36
	LSD	0.59	0.64	0.80	0.80
	CV (%)	7.13	4.09	4.33	4.33

Table 4. Effect of different fertigation levels on dry matter content (g plant^{-1}) of onion crop

S. No.	Treatments	Dry matter content (g plant^{-1})			
		30 DAT	60 DAT	90 DAT	At harvest
T 1	100% fertigation	0.71	15.05	23.85	27.95
T 2	80% fertigation	0.61	12.93	20.90	24.43
T 3	60% fertigation	0.56	9.90	17.91	21.92
T 4	40% fertigation	0.48	7.05	14.95	19.89
T 5	Control	0.38	5.95	12.34	17.00
	SE(d)	0.02	0.10	0.13	0.11
	LSD	0.03	0.21	0.280	0.24
	CV (%)	3.76	1.34	1.00	0.69

Table 5. Effect of different fertigation levels on neck thickness (mm) of onion bulb

S. No.	Treatments	Neck thickness (mm) of onion bulb			
		30 DAT	60 DAT	90 DAT	At harvest
T1	100% fertigation	10.00	18.40	19.00	11.75
T2	80% fertigation	8.48	17.33	18.00	10.68
T3	60% fertigation	7.28	15.80	16.28	9.60
T4	40% fertigation	6.23	13.88	14.23	8.65
T5	Control	5.73	11.70	12.53	7.58
	SE(d)	0.34	0.25	0.38	0.19
	LSD	0.75	0.56	0.83	0.41
	CV (%)	6.34	2.32	3.34	2.71

variation was calculated and presented in Table 5. The coefficient of Variation was 3.63 and 4.42 observed in polar and equatorial diameter of onion bulb at harvest. These obtained results are in close conformation with Jitendra Kumar *et al*. (2010).

Yield Studies

Average of bulb weight

Data related to the mean average bulb weight affected by different fertigation treatments are represented in Table 6. The mean average weight of onion bulbs was significantly influenced due to various treatments at harvest. The maximum average weight of onion bulbs obtained in the T1 (100% fertigation) treatment (129.3 g) was significantly higher than other treatments. The least mean weight of onion bulbs (36.6 g) was observed in control (no fertilizers under DI). These results are in close conformation with Warade *et al*. (1995).

Yield of bulb

The data obtained to yield is shownin Table 6 and it is graphically represented in Fig 7. The production of onion bulbs was influenced due to the above-practiced fertigation treatments. The highest bulb yield of onion observed in T1 (100% RD of fertigation) treatment (51.61 t ha^{-1}) was significantly higher than all other fertigation treatments. Finally, it was at par with T4 (80% RD of fertigation). The minimum yield of onion was recorded in control (no fertilizers under DI) (13.59 t h^{-1}). These results are in close conformation with Quereshi and Lawande (2006).

Table 6. Effect of different fertigation levels on diameter (cm) of onion bulb

S. No	Treatments	Diameter (cm) of onion bulb	
		Polar diameter	Equatorial diameter
T1	100% fertigation	5.43	7.28
T2	80% fertigation	5.18	6.40
T3	60% fertigation	4.78	6.19
T4	40% fertigation	4.34	5.50
T5	Control	4.00	4.96
	SE(d)	0.12	0.19
	LSD	0.27	0.42
	CV @5 %	3.63	4.42

Table 7. Effect of different fertigation levels on Yield and yield contributing parameters of onion crop

S. No	Treatments	Yield and yield contributing parameters of onion bulb	
		Average bulb weight (g)	Yield of onion bulbs (t ha^{-1})
T 1	100% fertigation	129.30	51.61
T 2	80% fertigation	107.30	40.20
T 3	60% fertigation	96.83	28.76
T 4	40% fertigation	55.60	15.58
T 5	Control	36.60	13.59
	SE(d)	14.06	0.303
	LSD	30.99	0.67
	CV (%)	23.37	1.43

Water and fertilizer use efficiency of the onion crop for different fertigation levels

Water use efficiency of onion

The data relating to water productivity of onion crops as effected by different fertigation levels was presented in Table 8.As per the observations recorded, it is evident that the drip fertigation scheduled (100 % RD of fertigation) recorded maximum water productivity (73.11kg $ha^{-1}mm^{-1}$) followed by drip fertigation scheduled at 80 % RD of fertigation (56.95 kg $ha^{-1}mm^{-1}$), 60 % RD of fertigation (40.74kg $ha^{-1}mm^{-1}$), 40% RD of fertigation(22.10 kg $ha^{-1}mm^{-1}$

Table 8. Water use efficiency of onion as influenced by different treatments

SI. No	Treatments	Total water applied (mm)	WUE (kg $ha^{-1}mm^{-1}$)
T1	100% fertigation	706.2	73.11
T2	80% fertigation	706.2	56.78
T3	60% fertigation	706.2	40.73
T4	40% fertigation	706.2	22.10
T5	Control	706.2	19.23

and control (19.23kg $ha^{-1}mm^{-1}$). Though the bulb yield is increased at a higher level of drip fertigation (100 % RD of fertigation), water use efficiency realized was high (73.11kg $ha^{-1}mm^{-1}$) when contrasted to different lower levels of drip fertigation levels. With the rise in fertigation level,water productivity increasedcontinuously. Similar results were obtained and also close to Wadatkar *et al*. (2002) and Mali (2006).

Fertilizer use efficiency of onion

Fertilizer use efficiency of the crop was considerably increased with the use of drip fertigation compared to control (Table 9). This would be because of the regular application of N, P and K (as splits) mixed with irrigation water to mobilize the root zone and minimize leaching of nutrients from the root zone. As per the observations recorded, it is evident that the drip fertigation scheduled at 100% RD of fertigation recorded maximum fertilizer use efficiency (N 2.76 q ha^{-1}, P 11.5 q ha^{-1} and K 11.5 q ha^{-1}) followed by drip fertigation scheduled at 80 % RD of fertigation (N 2.45 q ha^{-1}, P 11.16 q ha^{-1} and K 11.16 q ha^{-1}), 60 % RD of fertigation (N 2.34 q h^{-1},P 10.65 q ha^{-1} and K 10.65 q ha^{-1}), 40% RD of fertigation and control (N1.9 q ha^{-1}, P 8.66 q ha^{-1}, and K 8.66 q ha^{-1}). Similar results were obtained and also close to Gupta *et al*. (2015) and Jayakumar (2015).

Conclusion

Growth and yield attributing characters of the onion-like height of the plant, total count of leaves, dry matter content, the thickness of bulb neck, average weight of bulb, and yield of bulb were observed more in T1 (100% RD of fertigation); however, it was at par with control in many observations. The significantly higher yield of onion was obtained in treatment T1 (100% RD offertigation) where 100% WSF was followed in 13 splits apportioned as per growing crop stages with drip irrigation system. The treatment T4 (40% RD of fertigation) recorded the lowest yield.

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Table 9. Fertilizer use efficiency of onion

SI. No.	Treatments	Total fertiliser applied (kg ha^{-1})			FUE (q kg^{-1})		
		N	P	K	N	P	K
T1	100% fertigation	187.50	45.00	45.00	2.76	11.5	11.5
T2	80% fertigation	163.83	36.00	36.00	2.45	11.16	11.16
T3	60% fertigation	122.87	27.00	27.00	2.34	10.65	10.65
T4	40% fertigation	81.92	18.00	18.00	1.90	8.66	8.66
T5	Control	-	-	-	-	-	-

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