Journal of Applied Horticulture, 22(1): 67-70, 2020

DOI: 10.37855/jah.2020.v22i01.13

Journal of Applied Horticulture

ISSN: 0972-1045

# Effect of fertigation and drip irrigation on yield and quality of watermelon [*Citrullus lanatus* (Thunb.) Matsum. & Nakai]

**S.K. Nisha*, I. Sreelathakumary and S. Vijeth**

*Department of Olericulture, College of Agriculture, Vellayani 695 522, Kerala, India. *Email:nishask2@gmail.com*

## Abstract

The study was conducted to evaluate the influence of different levels of fertigation and drip irrigation on yield and quality of watermelon. Fertigation treatments were 75, 100 and 125 % recommended dose of fertilizer (RD). Irrigation treatments were 0.6 and 0.8 evapotranspiration (ET) rates. One control was taken with surface irrigation and conventional soil application of fertilizers. Levels of fertigation and irrigation exerted significant influence on number of fruits plant$^{-1}$ and yield plant$^{-1}$. Total yield was highest at 100 % RD (91.1 t ha$^{-1}$) compared to 125 % RD (80.13 t ha$^{-1}$). Fertigation at 100 % RD recorded highest number of fruits which was on par with 125 % RD. There was increase in number of fruits plant$^{-1}$ and fruit yield with increase in irrigation level from 0.6 to 0.8 ET. Fertigation at 100 % RD recorded the highest yield of 8.51 kg plant$^{-1}$. Fertigation and irrigation levels had no influence on fruit weight. TSS, lycopene, ascorbic acid and sugar contents did not increase with deficit irrigation of 0.6 ET.

**Key words:** *Citrullus lanatus*, watermelon, fertigation, irrigation

## Introduction

Watermelon [*Citrullus lanatus* (Thunb.) Matsum. & Nakai] is a popular fruit of the family Cucurbitaceae, cultivated all over the world. In India, it is grown in an area of 1.01 lakh hectare with a production of 25.2 lakh tonnes (GOI, 2018). Watermelon is a rich source of lycopene and citrulline. It contains more than 91 % water and therefore, water supply during critical stages of plant growth and fruit development is very important. Water availability for irrigation will be a major constraint for agriculture in coming years. So strategies to reduce water loss are the need of the hour. Use of micro irrigation facilities like drip system can play a major role towards this end. In drip irrigation, water is delivered near the plant root zone in a precise quantity so as to maintain soil moisture content close to field capacity. Drip irrigation also increases the uptake of plant nutrients and water use efficiency.

Fertigation is the process of applying fertilizer along with irrigation. It allows placement of nutrients directly into root zone through emitters during critical periods of nutrient requirement. Fertigation allows an accurate and uniform application of nutrients to the wetted area where most active roots are concentrated. Fertigation can improve nutrient use efficiency by supplying nutrients and water precisely avoiding excess concentrations of fertilizer in the soil and consequent leaching (Bar-Yosef, 1999). The nutrient use efficiency of fertigation is about 90 per cent compared to that of conventional methods, where it is only 40-60 per cent. Drip fertigation is highly profitable as it saves input, labour and energy to about 54 per cent than that of conventional methods. The application efficiency of water and nutrients is improved by drip fertigation. At the same time marketable yield is maintained or improved (Monaghan *et al.*, 2010). Under water scarce conditions, fertigation is considered as the most effective tool for managing nutrients and irrigation water.

Mineral nutrition is one of the important factors contributing to watermelon yield. However, the suggested rates varied considerably. Goreta *et al.* (2005) found that total and marketable yields did not increase with nitrogen rates above 115 kg ha$^{-1}$. Increased use of fertilizer led to rise in yield and dry weight of watermelon fruits (Hendericks *et al.*, 2007) but stronger infestation of gummy stem blight and downy mildew was observed with increased nitrogen fertigation (Santos *et al.*, 2009).

Generally, in watermelon deficit irrigation (Leskovar *et al.*, 2004) and various levels of fertilizers supplied through fertigation had no influence on fruit quality like lycopene and vitamin C (Andrade Junior *et al.,* 2009; Prabhakar *et al.*, 2013). But Wakindiki and Kirambia (2011) reported decrease in soluble solids with increase in irrigation. Marketable yield decreased linearly in response to an increase in water stress (Simsek *et al.*, 2004; Fernandes *et al.*, 2014).

In Kerala, watermelon is cultivated only in a very limited area of 100 ha (GOI, 2018), even though the demand for the fruit is very high. Being a high value crop, its exploitation on commercial scale can generate handsome income to farmers. Generally watermelon is cultivated using surface irrigation with soil application of fertilizers. For crops like cucumber, cowpea, bittergourd, tomato *etc.* adoption of fertigation is more and often overuse of fertilizers is seen. The effect of irrigation strategies and interaction with fertigation rates is not well investigated in watermelon under sandy clay loam soils of southern Kerala. This study was performed to explore the effects of different fertigation and drip irrigation levels on yield and quality of watermelon.

## Materials and methods

The field experiment was conducted at the research field of Department of Olericulture, College of Agriculture, Vellayani, Kerala Agricultural University during 2015-2016. The site was located at 08° 25`53.7`` N and 76° 59`15.8`` E at an altitude of 29 m above mean sea level. Mechanical composition and moisture characteristics of the soil are provided in Table 1. The treatments were factorial combinations of three fertigation levels (75 %, 100 % and 125 % recommended dose (RD) of 70:50:120 NPK $ha^{-1}$) and two irrigation levels (0.6 and 0.8 evapotranspiration (ET) rates) arranged in randomized block design with three replications and control with surface irrigation and normal soil application of fertilizer. The watermelon hybrid Prachi, with mini sized fruit, identified as the best watermelon hybrid suitable for south Kerala condition (Nisha and Sreelathakumary, 2017) was used.

Table 1. Physical composition and moisture characteristics of the soil

| Particulars | Value |
|---|---|
| A. Mechanical composition | |
| Coarse sand (%) | 16.30 |
| Fine sand (%) | 30.50 |
| Silt (%) | 25.80 |
| Clay (%) | 26.10 |
| Textural class | Sandy clay loam |
| B. Soil moisture characteristics | |
| Particle density (g $cc^{-1}$) | 2.30 |
| Bulk density (g $cc^{-1}$) | 1.40 |
| Maximum water holding capacity (%) | 23.70 |
| Porosity (%) | 31.10 |
| Field capacity (%) | 21.90 |
| Permanent wilting point (%) | 9.10 |

The experimental area was deeply ploughed up to 50 cm and weeds and stubbles were removed. Farm yard manure @ 25 t $ha^{-1}$ was applied before last ploughing. Raised beds of one meter width and one foot height were taken with channels of 50 cm between beds; so that the row to row spacing was 1.5 m. Drip lines were laid with a lateral per bed and drippers with a discharge rate of 2 L $hour^{-1}$ spaced every 60 cm. The beds were covered with silver on black polyethylene mulch of 50 µ thickness. Seedlings were raised in protrays using cocopeat and vermicompost as media. Twelve days old seedlings at 2-3 true leaf stage were transplanted to main field at 60 cm spacing. Uniform irrigation was given to the seedlings up to one week after transplanting. Irrigation scheduling was started from first week onwards. Drip irrigation was scheduled daily to meet the crop water requirement based on the pan evaporation data of previous day from Class A open pan evaporimeter near the trial plot. Total irrigation applied was 184.02 mm, 239.79 mm and 330.86 mm for 0.6 ET, 0.8 ET and control respectively. Fertigation was done at three days interval using fertigation pump. The data was analysed statistically by applying the techniques of analysis of variance (Panse and Sukhatme, 1985).

## Results and discussion

The effects of different levels of fertigation and drip irrigation on yield and quality characters are presented in Tables 2 and 3. There was significant difference among treatments for number of fruits $plant^{-1}$. Fertigation at 100 % RD recorded highest number (4.13) which was on par with 125 % RD (3.76). Among the irrigation treatments, 0.8 ET registered the highest number of fruits $plant^{-1}$. Fruit weight was not influenced by different treatments. Levels of fertigation and irrigation exerted significant influence on yield $plant^{-1}$. Fertigation at 100 % RD recorded the highest yield (8.51 kg per plant) followed by 75 % RD (7.55 kg) which was on par with 125 % RD (7.52 kg). Fertigation at 100 % RD significantly increased number of fruits $plant^{-1}$, yield $plant^{-1}$ and yield $hectare^{-1}$. Nitrogen promotes vegetative growth and P stimulates root development. Better vegetative growth leads to enhanced chlorophyll content along with higher stomatal conductance and thereby increased photosynthesis. Moreover, sufficient availability of K might have encouraged increased transport of photosynthates to the sink leading to higher yield (Maluki *et al.*, 2016). Under open condition, fruit weight was not influenced by fertilizer dose. Similar result was reported by Andrade Junior *et al.* (2009), where fruit yield was more influenced by number of fruits than fruit weight. The yield attributes like fruit weight, fruits $plant^{-1}$ and yield $plant^{-1}$ were decreased at the highest fertilizer level (125 % RD) tried. This might be attributed to early fruit set in lower nodes which resulted in competition between the fruit and vegetative parts during early fruit development. Moreover early formed fruits also recorded reduced fruit weight (Watanabe, 2014). Increased concentration of soluble fertilizers increases the osmotic potential of soil solution, causing reduction in water uptake by the plant roots (Maluki *et al.*, 2016). The application of fertilizer through drip was found superior to conventional solid

Table 2. Effect of fertigation and drip irrigation on yield of watermelon

| Treatments | Fruits $plant^{-1}$ | Fruit weight (kg) | Yield $plant^{-1}$ (kg) | Yield (t $ha^{-1}$) |
|---|---|---|---|---|
| Fertigation | | | | |
| 75 %RD | 3.59 | 2.17 | 7.55 | 80.41 |
| 100 %RD | 4.13 | 2.24 | 8.51 | 91.10 |
| 125 %RD | 3.76 | 2.11 | 7.52 | 80.13 |
| SE(m)± | 0.126 | 0.097 | 0.056 | 2.554 |
| CD at 5 % | 0.393 | NS | 0.715 | 7.947 |
| Irrigation level | | | | |
| 0.6 ET | 3.60 | 2.06 | 7.28 | 77.49 |
| 0.8 ET | 4.06 | 2.28 | 8.42 | 90.25 |
| SE(m)± | 0.101 | 0.083 | 0.187 | 2.085 |
| CD at 5 % | 0.315 | NS | 0.582 | 6.489 |
| Control | 3.71 | 1.51 | 5.12 | 52.76 |

NS-Non significant

Table 3. Effect of fertigation and drip irrigation on quality of watermelon

| Treatments | TSS (°Brix) | Lycopene (mg 100 $g^{-1}$) | Ascorbic acid (mg $100g^{-1}$) | Reducing sugar (%) | Non reducing sugar (%) |
|---|---|---|---|---|---|
| Fertigation | | | | | |
| 75 %RD | 12.62 | 6.32 | 3.85 | 3.07 | 3.88 |
| 100 %RD | 13.01 | 6.37 | 3.95 | 3.07 | 3.91 |
| 125 %RD | 12.53 | 6.36 | 4.05 | 3.09 | 3.90 |
| SE(m)± | 0.230 | 0.006 | 0.147 | 0.460 | 0.018 |
| CD at 5 % | NS | NS | NS | NS | NS |
| Irrigation level | | | | | |
| 0.6 ET | 12.81 | 6.28 | 3.75 | 3.06 | 3.87 |
| 0.8 ET | 12.62 | 6.43 | 4.15 | 3.10 | 3.91 |
| SE(m)± | 0.189 | 0.007 | 0.118 | 0.039 | 0.013 |
| CD at 5 % | NS | NS | NS | NS | NS |
| Control | 12.61 | 6.32 | 3.80 | 3.05 | 3.90 |

NS-Non significant

fertilizer application (Choudhari and More, 2002; Sharma *et al.*, 2011). Fertigation treatments recorded higher values for number of fruits plant$^{-1}$ and fruit weight than conventional soil application of fertilizers. Similar observation was also made by Prabhakar *et al.* (2013).

The highest fruit yield of 8.42 kg per plant was recorded at 0.8 ET against 7.28 kg with irrigation at 0.6 ET. Proper balance of moisture in plants not only increases the photosynthesis but also helps in higher uptake of nutrients to meet accelerated rate of growth and ultimately yield. The drip irrigation levels gave higher yield of watermelon than surface irrigation. The increased yield under drip irrigation system might have resulted due to excellent soil-water-air relationship with higher oxygen concentration in the root zone, higher uptake of nutrients (Deolankar *et al.*, 2004) and continuous maintenance of higher soil moisture content to fulfil the evapotranspirational need of the crop. Leskovar *et al.* (2003) reported highest total yield at 1.0 ET (53.9 t ha$^{-1}$) compared to 0.5 ET (26.8 t ha$^{-1}$). Reduction in number of fruits plant$^{-1}$ and total yield caused by deficit irrigation are similar to those obtained by Erdem *et al.* (2001), Bang *et al.* (2004), Rouphel *et al.* (2008) and Kirnak and Dogan (2009). However, McCann *et al.* (2007) reported that irrigation levels had no significant effect on yield of seedless watermelon.

Total soluble solids (TSS) is the most important quality parameter of watermelon. TSS content was not affected by the fertigation and irrigation levels. El-Beheidi *et al.* (1990) and Gioia *et al.* (2009) reported that total soluble solids was unaffected by fertigation levels in watermelon. Battilani and Solimando (2006) and Andrade Junior *et al.* (2009) also reported no significant differences in fruit quality in watermelon with different fertilizer levels supplied through fertigation. However, increased TSS content with increase in application of P was reported by Maluki *et al.* (2016). Higher TSS was recorded in watermelon receiving fertigation compared to conventional solid fertilizer application (Prabhakar *et al.*, 2013). According to Davis *et al.* (2006) withholding irrigation prior to harvesting increases sugar content and avoid fibrous flesh. Fernandes *et al.* (2014) also reported significant influence of irrigation frequencies on soluble solids content.

Fertigation and irrigation treatments had no significant influence on ascorbic acid content, lycopene, reducing and non reducing sugars. Leskovar *et al.* (2004) reported that vitamin C and lycopene content was unaffected by deficit irrigation in watermelon. Lycopene content in watermelon is related to growth conditions, harvest maturity, accession and ploidy level. In contrast to this, drip irrigation with saline ground water improved quality of watermelon in terms of total sugars and vitamin C (Tingwu *et al.*, 2003).

The results of the present study revealed that the yield of watermelon increased under drip irrigation and fertigation than the conventional surface irrigation and soil application of fertilizer. Deficit irrigation reduced the yield in watermelon, but TSS, lycopene and ascorbic acid contents remained unaffected. For open precision farming in watermelon, the fertigation level of 70:50:120 NPK ha$^{-1}$ was found ideal.

## References


Andrade Junior, S.A., C.R. da Silva, N.S. Dias, B.H.N. Rodrigues and V.Q. Ribeiro, 2009. Response of watermelon to nitrogen fertigation. *Irriga.,* 14(2): 115-122.

Bang, H., D.I. Leskovar, D.A. Bender and K. Crosby, 2004. Deficit irrigation impact on lycopene, soluble solids, firmness and yield of diploid and triploid watermelon in three distinct environments. *J. Hort. Sci. Biotechnol*., 79: 885-890.

Bar-Yosef, B. 1999. Advances in fertigation. *Adv. Agron.,* 65: 1-77.

Battilani, A. and D. Solimando, 2006. Yield, quality and nitrogen use efficiency of fertigated watermelon. *Acta Hort.*, 700: 85-90.

Choudhari, S.M. and T.A. More, 2002. Fertigation, fertilizer and spacing requirement of tropical gynoecious cucumber hybrids. *Acta Hort*., 588: 233-240.

Davis, A.R., C.L. Webber, P. Perkins-Veazie and J. Collins, 2006. Impact of cultivar and production practices on yield and phytonutrient content of organically grown watermelon. *J. Veg. Sci*., 12: 83-91.

Deolankar, K.P., N.N. Firake and D.P. Ingale, 2004. Effect of irrigation methods, forms and levels of NPK on movement and uptake of Entisols. *J. Maharashtra Agr. Univ*., 29(3): 325-327.

El-Beheidi, M.A., A.A. El-Sherbeing and M.H. El-Sawah, 1990. Watermelon growth and yield as influenced by nutrition and irrigation methods in new reclaimed sandy soils. *Egyptian J. Hort*., 17: 447-456.

Erdem, Y., A.N. Yuksel and A.H. Orta, 2001. The effects of deficit irrigation on watermelon yield, water use and quality characteristics. *Pak. J. Biol. Sci*., 4: 785-789.

Fernandes, C.N.V., B.M. de Azevedo, J.R.N. Neto, T.V.A.Viana and G.G. de Sousa, 2014. Irrigation and fertigation frequencies with nitrogen in the watermelon culture. *Bragantia*, 73(2): 106-112.

Gioia, F.D., E. Simonne, D. Jarry, M. Dukes, R. Hochmuthand and D. Studstill, 2009. Real-time drip-irrigation scheduling of watermelon grown with plasticulture. *Proc. Florida State Hort. Soc*., 122: 212-217.

GOI [Government of India], 2018. *Horticultural statistics at a glance 2018*. Ministry of Agriculture and Farmers Welfare, New Delhi, 458p.

Goreta, S., S. Perica, G. Dumicic, L. Buca and K. Zanic, 2005. Growth and yield of watermelon on polyethylene mulch with different spacings and nitrogen rates. *HortSci.,* 40(2): 366-369.

Hendericks, G.S., S. Shukla, K.E. Cushman, T.A. Obreza, F.M. Roka, K.M. Portier, and E.J. McAvoy, 2007. Florida watermelon production affected by water and nutrient management. *HortTechnol*., 17: 328-335.

Kirnak, H. and E. Dogan, 2009. Effect of seasonal water stress imposed on drip irrigated second crop watermelon grown in semi-arid climatic conditions. *Irr. Sci*., 27: 155-164.

Leskovar, D.I., H. Bang, K. Kolenda, J.A. Franco and P. Perkins-Veazie, 2003. Deficit irrigation influences yield and lycopene content of diploid and triploid watermelon. *Acta Hort*., 628: 147-151.

Leskovar, D.I., H. Bang, K.M. Crosby, N. Maness, J.A. Franco and P. Perkins-Veazie, 2004. Lycopene, carbohydrates, ascorbic acid and yield components of diploid and triploid watermelon cultivars as affected by deficit irrigation. *J. Hort. Sci. Biotechnol*.,79: 75-81.

Maluki, M., J. Ogweno and R.M. Gesimba, 2016. Evaluation of nitrogen effects on yield and quality of watermelon grown in coastal regions of Kenya. *Int. J. Plant Soil Sci.*, 9(2): 1-8.

McCann, I., E. Kee, J. Adkins, E. Ernest and J. Ernest, 2007. Effect of irrigation rate on yield of drip irrigated seedless watermelon in a humid region. *Sci. Hort*., 113: 155-161.

Monaghan, J.M., C.R. Rahn, H.W. Hilton and M. Wood, 2010. Improved efficiency for high quality field vegetable production using fertigation. *Acta Hort*., 852: 145-152.

Nisha, S.K. and I. Sreelathakumary, 2017. Performance of watermelon accessions for yield and quality under south Kerala condition. In: *Mainstreaming Biodiversity for Sustainable Development.* Kerala State Biodiversity Board, Thiruvananthapuram. p. 63-68.

Panse, V.G. and P.V. Sukhatme, 1985. *Statistical Methods for Agricultural Workers* (4th Ed.). Indian Council of Agricultural Research, New Delhi, 347p.

Prabhakar, M., S.S. Hebbar and A.K. Nair, 2013. Influence of various sources and levels of fertilizer applied through fertigation on hybrid watermelon grown in rabi-summer. *J. Hort. Sci*., 8(1): 60-64.

Rouphael, Y., M. Cardarelli and G. Colla, 2008. Yield, mineral composition, water relations, and water use efficiency of grafted mini-watermelon plants under deficit irrigation. *HortSci.,* 43(3): 730-736.

Santos, G.R., M.D.C. Neto, H.S.M. de Almeida, L.N. Ramos, R.A. Sarmento, S.O. Lima and E.A.L. Erasmo, 2009. Effect of nitrogen doses on disease severity and watermelon yield. *Hort. Bras*., 27: 330-334.

Sharma, A., R.A. Kaushik, D.K. Sarolia and R.P. Sharma, 2011. Response of cultivars, plant geometry and methods of fertilizer application on parthenocarpic cucumber (*Cucumis sativus* L.) under zero energy polyhouse condition. *Veg. Sci*., 38(2): 215-217.

Simsek, M., M. Kacira and T. Tonkaz, 2004. The effects of drip irrigation regimes on watermelon yield and yield components under semi arid climatic conditions. *Aust. J. Agr. Res*., 55(11): 1149-1157.

Tingwu, L., X. Juan, L. Guangyong, M. Jianhua, W. Jianping, L. Zhinzhong and Z. Jianguo, 2003. Effect of drip irrigation with saline water on water use efficiency and quality of watermelons. *Water Resources Mgt*., 17: 395-408.

Watanabe, S. 2014. Fruit productivity of vertically trained watermelon (*Citrullus lanatus* (Thunb.) Matsum. &Nakai) plants. *JARQ,* 48 (2): 121-131.

Wakindiki, I.I.C. and R.K. Kirambia, 2011. Supplemental irrigation effects on yield of two watermelon (*Citrullus lanatus*) cultivars under semiarid climate in Kenya. *Afr. J. Agr. Res*., 6: 4862-4870.

Received: June, 2019; Revised: October, 2019; Accepted: December, 2019