International Journal of Agricultural Technology 2021Vol. 17(4):1413-1424
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Effect of drip irrigation scheduling and mulching practice on pointed gourd (*Trichosanthes dioica* Roxb.) pot-cultivation in Patuakhali Bangladesh

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Mamun Hossain, S. A. A., Kayum, M. A., Wang, L. and Md. Shahin (2021). Effect of drip irrigation scheduling and mulching practice on pointed gourd (*Trichosanthes dioica* Roxb.) pot-cultivation in Patuakhali Bangladesh. International Journal of Agricultural Technology 17(4):1413-1424.

Abstract Pointed gourd is a tropical vegetable that has been cultivated in the Indian subcontinent which dependent on irrigation for profitable cultivation. Mulching has protected the soil water holding capacity with nutrients could be improved the yield. The effect of irrigation scheduling and mulching application in pointed gourd yield, water use efficiency and fruits physical quality was investigated. The result showed that the highest yield was 45.32 t/ha and lowest was 23.19 t/ha in treatment T_6 (D_2SM) and T_7 ($2D_1$NM) respectively which were significantly influenced by the treatments. In which the highest yield was found to be 44.9 % which greater than the control yield (24.99 t/ha). It showed that the highest irrigation water use efficiency (IWUE) and field water use efficiency (FWUE) was obtained from the treatment of highest yield, which is significantly influenced primarily by mulching application. The result also revealed that the highest individual pointed gourd fruit weight and diameter were obtained 35.50 g and 32.92 mm., respectively in treatment T_5 (D_2PM) which significantly influenced only by irrigation scheduling. However, the highest fruit length was 9.32 cm in T_6 (D_2SM) which significantly influenced by irrigation and mulching together. The results concluded that the drip irrigation scheduling and mulching practices could be contributed successfully to optimize the irrigation for improving the pointed gourd yield.

Keywords: Drip irrigation, Fruits quality, Gourd plant, Rooftop, Yield

Introduction

Pointed gourd (*Trichosanthes dioica* Roxb.) is one of the most important perennial summer dioecious cucurbit and high value vital summer vegetables in tropical and subtropical regions of the world, particularly in some

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region of Bangladesh and India. As of other vegetables pointed gourd is popular considered as dietary and economic value which contributing important share in our daily balanced meal. The fruits of pointed gourd are rich in proteins and vitamin A and also possess medicinal properties that can be lower blood sugar and serum triglycerides (Kumar and Singh, 2012). It is easily digestible, diuretic and laxative, invigorates the heart, brain and useful in the disorder of the circulatory system (Malek, 2009). It has also high industrial value as different types of jam, jelly, and pickles can be made from this vegetable. However, pointed gourd also helps to meet the vegetables crises during summer-rainy season (Hossain *et al.*, 2018a). Therefore it is very much needed to produce pointed gourd to meet the community demand as well as for national food security especially for the peoples of coastal Bangladesh. In Bangladesh pointed gourd are cultivated in most district of Northern part, some region in Dhaka division and in greater Khulna division including Jessore, Jinaidha, Kushtia, Narail, Satkhira district and consumed all over the country (Ara *et al.*, 2016; Hossain *et al.*, 2018a). In southern coastal part of Bangladesh especially districts of Barisal Division, farmers, scientists are unaware to cultivate pointed gourd. Peoples of this coastal region are required to import from cultivated region of Bangladesh to fulfill their demand. That made its price expensive due to travel and others extra-expenditure. Therefore, it is immense important to start pointed gourd cultivation in these coastal districts of Bangladesh. However, in Bangladesh most of the farmers cultivated pointed gourd by traditional way of irrigation. They cultivated either in rainfed condition or using boarder or furrow irrigation method. In both ways, they can not produce improve yield due to depending on rainfall, other than they always supply excess water to the plants. Which punished them by extra cost of water application, caused huge water logging, deteriorated the yield & quality and reduces the water productivity. Thus, water application in time to plants root system using drip method could be enhance the productivity. Which is effective and manageable in reducing excess water as supplying required by the plant.

Therefore, this study aimed to improve yield, water use efficiency and physical quality of pointed gourd under drip irrigation with mulching that could be meet the everyday demand and have the food security in southern Bangladesh.

Materials and methods

Experimental site and environmental situation

The experiment was conducted at the research area of Patuakhali Science and Technology University (PSTU) under the Department of

Agricultural Engineering (AGE) during February to August 2020. The location of PSTU is 90° 38′ East longitude and 22° 46′ North latitude. Average elevation of ground level of Patuakhali district is 5m from the sea level. The Patuakhali district is a coastal zone located in Ganges Tidal Floodplain (AEZ-13) being in the nearby Bay of Bengal, which has subtropical monsoon climate characterized by high temperature, heavy rainfall, often excessive humidity and fairly marked seasonal variations. These area are extremely vulnerable to salinity intrusion into agricultural land, frequently cyclone, storm and tidal surge, flooding and tidal inundation. From the weather data available in 2019, Patuakhali district has the annual mean temperature, annual total precipitation and average relative humidity are 29.33^0C, 1116 mm and 65.50%, respectively. The yearly sunshine duration is 2908 hours in which the percentage of solar radiation is 66.0%. The soil condition of these area is permanently wet basin and muck and alluvial topsoil with 1.2 g/cm^3 bulk density and consisted high water holding capacity (Banglapedia, 2015).

Experimental design

To find the impact of drip irrigation scheduling with mulching application on pointed gourd yield, water use efficiency and quality, the experiment was conducted as two factors in Randomized Complete Block Design (RCBD) with four replications, Factor A was irrigation frequency and factor B was mulching. Therefore, total nine treatment combinations were designed including irrigation frequency and mulching application were as follows:

T_1) D_1NM = Irrigation daily one time (D_1) + No Mulch (NM)
T_2) D_1PM = Irrigation daily one time (D_1) + Plastic Mulch (PM)
T_3) D_1SM = Irrigation daily one time (D_1) + Straw Mulch (SM)
T_4) D_2NM = Irrigation Daily two times (D_2) + No Mulch (NM)
T_5) D_2PM = Irrigation Daily two times (D_2) + Plastic Mulch (PM)
T_6) D_2SM = Irrigation Daily two times (D_2) + Straw Mulch (SM)
T_7) $2D_1$NM = Irrigation one time each two days ($2D_1$)+ No Mulch (NM)
T_8) D_1PM = Irrigation one time each two days ($2D_1$) +Plastic Mulch (PM)
T_9) $2D_1$SM = Irrigation one time each two days ($2D_1$) + Straw Mulch (SM)

The details of experimental layout are depicted in Figure 1. The control (Ck) was designed by daily one time irrigation with no mulching condition (D_1NM) for comparison. Each treatment was designed with four replications, which each of 35 cm height and 35 cm upper diameter plastic pot (16 liter size) in total 0.385 m^2 soil surface areas. A gravity drip irrigation system was set with a small water tank put on a tank stand, lateral drip tube (16 mm dia), micro

drip tube (4 mm dia), dripper control valve (16 mm dia), Tee connector (16 mm dia) and micro-dripper (2 L/hr capacity). Suitable amount of soil were collected and prepared well by mixed with 25 kg (@ 8.3 t/ha) dry cow-dong, 25 kg (@ 8.3 t/ha) worm humus, 2 kg urea (@600 kg/ha), 2 kg phosphate (TSP) (@600 kg/ha), 2 kg potash (MP) (@600 kg/ha) for filling the plastic pot. The pots were placed in each micro-dripper position and then filled with prepared soil. The designed pots were covered by two layers 0.04 mm thick blue plastic polyethyelene sheet and locally available rice straw for mulching application. So that, after sawing the pointed gourd plant's root sucker or stem cutting the polyethyelene sheet and straw were applied as mulching to cover the surface.

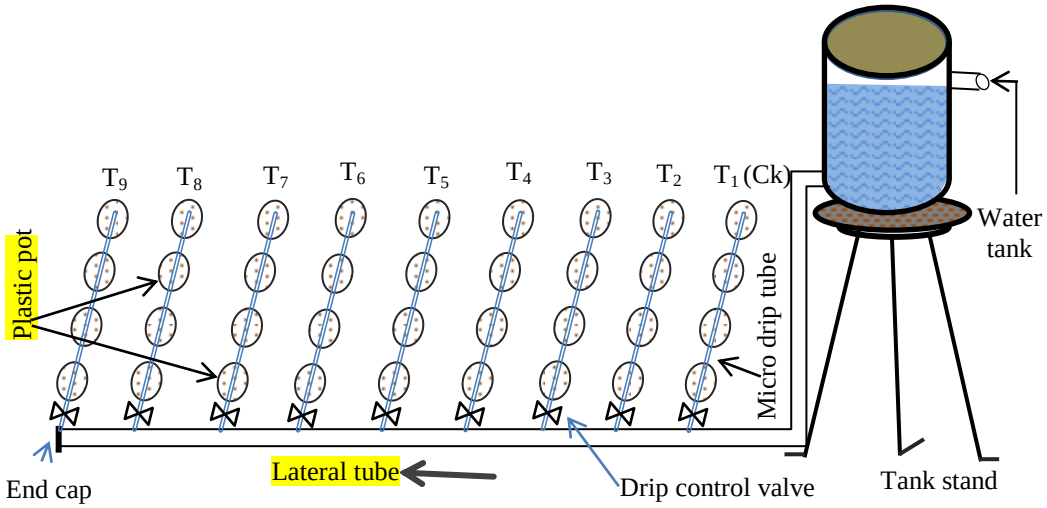

Figure 1. Experimental layout

Crop management

The pointed gourd is a local variety, 'Mukta moni' was planted at early February using two root suckers or stem cutting in each pot. The root sucker or stem cutting (20-30 cm long) was collected from previous plants, made it circle and then sawing at 3-5 cm depth from the topsoil of each pot. During sawing, female and male plant ratio (80:20) in each treatment were maintained. The distance maintained between two adjacent pots and two treatments were 0.914 m and 1.22 m respectively. To ensure maximum plant germination rate at initial stage, suitable amount of water was applied in all treatments equally for the first month.

The pointed gourd plants vines were arranged vertically around 1.2 meter height using bamboo stick and then made a 0.84 m^2 trellis/espalier

(growing surface area) on air for each replication in total of 30.24 m^2 area for growing plants as shown in Figure 2. The total length of the cultivation period including growing, flowering, fruiting and harvesting was in 6 to 7 months starting from February to August. The pointed gourd establishment area was measured from each pot's espalier area and then converted into a hectare for comparison. Other agronomic management such as pruning, pest control, hand pollination etc. were applied equally for all treatments.

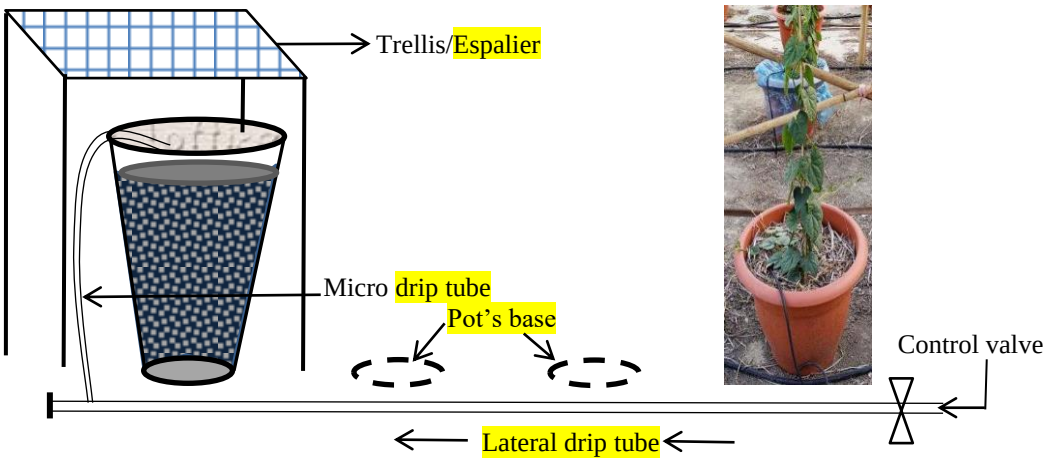

Figure 2. Schematic illustration of treatment design

Water management

The experiment was placed in rainfed condition. Irrigation was given according to soil moisture status and stage of crop growth situation. The amount of irrigation up to field capacity (FC) was calculated every time by dripper flow capacity (2 L/hr). During rainfall no irrigation was given due to available soil moisture content. According to the treatments, monthly average amount of irrigation (mm) and past year rainfall status during cropping period are given in Table 1.

Data measurement

Yield measurement

The pointed gourd fruits harvesting was started at 40 days after germination of root sucker. Fruits were harvested from each pot's plant trellis area (0.84 m^2) at 5-6 days interval. An electronic balance was used to weight

the harvested fruits separately from each replication and yield (kg/m^2) was determined using equation (1) as follows (Hossain *et al*., 2018b):

$$\text{Yield} = \frac{\text{Total weight of harvested pointed gourd (kg)}}{\text{Total area of harvested pointed gourd (m}^2\text{)}} \quad \ldots\ldots\ldots\ldots (1)$$

The cumulative yield values from entire harvesting period as at the end of August were calculated into ton/hectare (t/ha).

Table 1. Monthly average water application and rainfall status during cropping season

Month		Cropping period						
		Feb	**Mar**	**April**	**May**	**June**	**July**	**Aug**
Rainfall (mm)$_{2019}$		14.40	20.90	8.80	36.60	181.00	315.50	178.10
Irrigation (mm)	T_1 (CK)	24.70	24.38	36.25	21.33	14.63	10.58	13.98
	T_2	20.85	18.08	28.98	13.20	11.10	9.48	12.68
	T_3	21.93	20.00	29.95	12.40	11.40	9.23	12.35
	T_4	25.60	34.90	46.73	23.33	15.15	12.03	15.20
	T_5	22.48	25.23	36.30	16.15	13.70	11.93	14.08
	T_6	23.98	24.35	37.18	15.28	14.25	10.95	13.28
	T_7	25.55	30.75	41.23	18.05	13.40	11.10	14.15
	T_8	23.33	25.50	37.18	12.83	11.18	10.48	12.33
	T_9	22.60	25.08	36.28	13.83	11.13	10.23	12.85
Irrigation CV (%)		7.01	19.90	14.53	23.99	12.98	9.04	7.30
Irrigation (LSD$_{0.05}$)		0.511	2.623	2.877	2.304	0.823	0.205	0.168

Irrigation water and field water use efficiency calculation

The irrigation water use efficiency (IWUE) was calculated by the equation (2) considering only the amount of water application as used in previous research (Hossain *et al*., 2018b) as follows:

$$\text{IWUE} = \frac{Y}{m} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where, IWUE is irrigation water use efficiency (kg/m^3), Y is pointed gourd fruits yield (kg/ha) and m is crop water consumption (m^3/ha). The amount of irrigation was considered as crop water consumption (m) because of drip water application, in which no runoff, percolation and leaching loss. However, field water use efficiency (FWUE) was calculated by equation (3) as the total amount of water applied to the crop field including rainfall during total crop growing season (Islam *et al*., 2017). In that case, losses (runoff, percolation etc.) of rainfall water are not considered in the calculation.

$$\text{FWUE} = \frac{Y}{W_u} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where, FWUE is field water use efficiency (kg/m^3), Y is pointed gourd fruits yield (kg/ha) and W_u is seasonal crop water use in the field (m^3/ha).

Fruits physical quality measurement

The pointed gourd fruits weight (FW), length (FL) and diameter (FD) which representing fruits physical quality were determined during the harvesting period by randomly selected of twelve fruits from each treatment. The fruits were collected from entire harvesting period in different time. The FW (g), FL (cm) and FD (mm) were determined using standard equipment such as electronic balance, measuring tape and Vernier caliper respectively.

Data analysis

To assess the significant effects of different treatments on pointed gourd yield, water use efficiency and fruits physical quality, data were statistically analyzed by general linear model (Univariate). The analysis of least significant differences (LSD) at $P = 0.05$ level was analyzed to check the significant difference between means. All statistical processes were administered by IBM-SPSS statistics 23.0 version software.

Results

Effect on pointed gourd yield

The effect of treatments on pointed gourd yield is given in Table 2. The highest pointed gourd yielded 45.32 t/ha was obtained with treatment T_6 (D_2SM) by 139.26 mm of water application while the CK (T_1, D_1NM) yielded 24.99 t/ha was found as smaller of all the treatments by 145.83 mm of irrigation. The highest yield was obtained 48.8% and 44.9% greater than the lowest yield 23.19 t/ha in T_7 ($2D_1$NM) and CK yield (24.99 t/ha) respectively (Table 2). The influence of irrigation scheduling and mulching on average pointed gourd yield were depicted in Figure 3. The result showed that an improved yield was obtained by daily two times irrigation using straw mulching compared with plastic mulching.

The statistical analysis showed significant influenced in the pointed gourd yield by irrigation scheduling ($p < 0.01$) and mulching ($p < 0.05$) for all treatments (Table 2). LSD test showed that separately in the treatments as T_1 ($p < 0.01$), T_4 ($p < 0.05$), T_6 ($p < 0.001$), T_7 ($p < 0.05$) and T_9 ($p < 0.05$) which significantly influenced precisely in the pointed gourd yield. According to Tukey's-b test the analysis showed treatment T_1 and T_7 had significant difference with other treatments. It was indicated that irrigation scheduling application had more influenced ($p < 0.001$) in the pointed gourd yield and the degree of influence was enhanced by the mulching treatment than the others.

Table 2. Effects of treatments in the pointed gourd yield, water use efficiency and fruits physical quality using general linear model test

Treatments	Yield (t/ha)	δIWUE (kg/m^3)	αFWUE (kg/m^3)	Fruits Physical quality		
				↓FL (cm)	†FW (gm)	øFD (mm)
T_1 (CK)	24.99±6.05^{1a}	20.26±3.91^{ab}	3.30±0.77^{a}	7.23±1.96^{a}	26.17±7.17^{a}	26.85±5.05^{a}
T_2	35.96±10.93^{ab}	37.77±12.72^{ab}	4.93±1.52^{ab}	7.67±1.97^{ab}	31.33±8.46^{ab}	29.57±5.24^{ab}
T_3	35.43±8.95^{ab}	36.24±10.23^{ab}	4.84±1.24^{ab}	8.03±1.84^{ab}	28.13±10.26^{ab}	29.23±5.53^{ab}
T_4	38.04±7.37^{ab}	26.44±6.06^{ab}	4.88±0.97^{ab}	7.83±1.83^{ab}	32.17±6.22^{ab}	29.45±4.11^{a}
T_5	40.34±10.60^{ab}	34.38±9.21^{ab}	5.37±1.42^{ab}	8.56±2.15^{b}	35.50±8.71^{b}	32.92±4.80^{b}
T_6	45.32±11.43^{b}	39.02±11.12^{b}	6.04±1.56^{b}	9.32±1.85^{a}	31.46±8.64^{b}	32.67±5.83^{b}
T_7	23.19±4.80^{a}	18.07±4.64^{a}	3.04±0.65^{a}	6.64±1.70^{ab}	29.00±6.19^{ab}	26.56±4.36^{ab}
T_8	31.86±6.33^{ab}	28.97±7.49^{ab}	4.28±0.89^{ab}	8.03±1.63^{ab}	30.83±6.37^{ab}	30.14±4.07^{ab}
T_9	34.12±6.34^{ab}	30.96±6.89^{ab}	4.58±0.87^{ab}	7.19±1.88^{ab}	31.71±7.42^{a}	30.30±4.37^{ab}
Statistical test between dependent and independent variables						
CV (%)	20.37	24.84	4.58	10.14	8.71	7.33
$LSD_{0.05}$	3.334	3.713	0.94	0.379	0.960	0.036
P **$_{Irrigation}$**	0.006**	0.112ns	0.012*	0.01**	0.05*	0.01**
P **$_{Mulching}$**	0.025*	0.001***	0.014*	0.05*	0.17ns	0.008**
P **$_{Irrig.*Mulching}$**	0.877ns	0.847ns	0.894ns	0.05*	0.790ns	0.992ns
F-ratio	0.298	0.342	0.271	0.661	0.422	0.067
Mean Square	21.079	24.765	0.355	2.321	25.870	1.582

1/ [1]Mean value ± Standard deviation; δIWUE = Irrigation water use efficiency, αFWUE = Field water use efficiency, ↓FL = fruit length, †FW = fruit weight and øFD = fruit diameter

2/ The same letters within columns indicated mean values were not significantly different according to LSD (p = 0.05) test

3/ *, **, *** level of significance at $P < 0.05$, $P < 0.01$, $P < 0.001$ respectively; ns, non-significance.

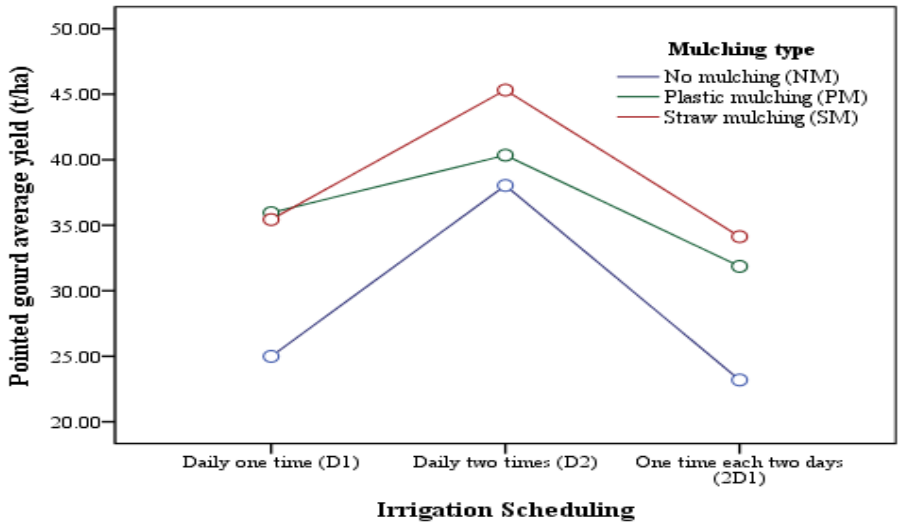

Figure 3. Yield in response of irrigation scheduling and mulching effect

Irrigation water and field water use efficiency

The seasonal irrigation water use efficiency (IWUE) and field water use efficiency (FWUE) showed the variant categorical water productivity of total yield. The effect of treatments on IWUE and FWUE of pointed gourd are given in Table 2. The highest IWUE and FWUE were 39.02 and 6.04 kg/m^3, respectively with treatment T_6 (D_2SM), whereas the minimum IWUE and FWUE were 18.07 and 3.04 kg/m^3 in treatment T_7 ($2D_1$NM) respectively. The results revealed that mainly varied due to the irrigation and types of mulching. A result of irrigation scheduling and mulching effects on irrigation water use efficiency (IWUE) is depicted in Figure 4 in which indicated a pick result of straw mulching with daily two times irrigation. Though in case of plastic mulching with effective result indicated for daily one time irrigation.

The statistical analysis showed that the irrigation scheduling significantly ($p < 0.05$) influenced on FWUE, whereas the mulching treatment significantly influenced on both IWUE ($p < 0.001$) and FWUE ($p < 0.05$). The Tukey's-b test indicated that treatment T_6 and T_7 had significant difference from other treatments for both IWUE and FWUE. However, the interaction effect of irrigation scheduling and mulching together did not significantly influence on IWUE and FWUE.

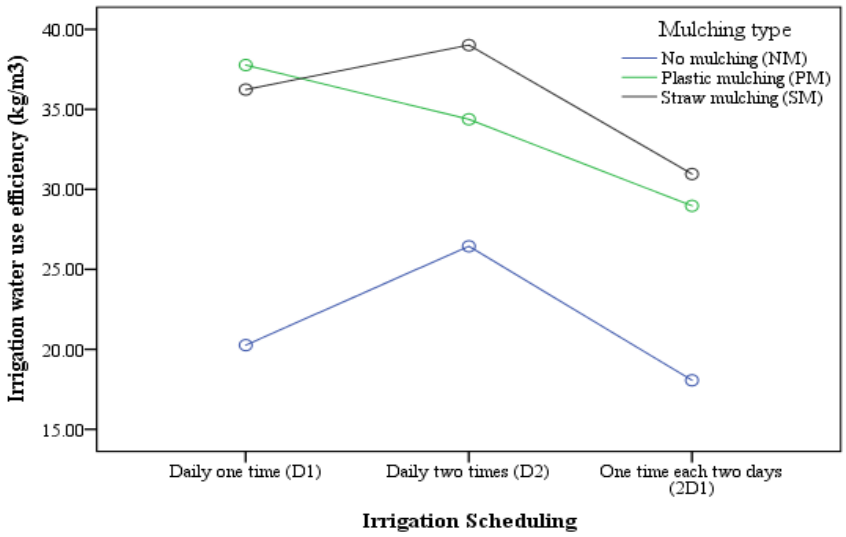

Figure 4. Effect of irrigation scheduling and mulching on irrigation water use efficiency (kg/m^3)

Fruit quality

The physical quality of pointed gourd fruits in terms of fruit length (FL), weight (FW) and diameter (FD) are presented in Table 2. The maximum of 9.32 cm long in the pointed gourd fruit was obtained in treatment T_6 (D_2SM) which showed the smallest of 6.64 cm in treatment T_7 ($2D_1$NM). However, the highest value of fruit weight of 35.50 g was recorded in treatment T_5 (D_2PM), while the lowest value of 26.17 g was in control (CK). The highest value of fruit weight was found 26% greater compared to the CK. The large size of pointed gourd fruit diameter was 32.92 mm in treatment T_5 (D_2PM), whereas the smallest fruit size was 26.56 mm dia. in treatment T_7 ($2D_1$NM).

The statistical analysis showed that pointed gourd averaged fruit length ($p < 0.01$), weight ($p < 0.05$) and diameter ($p < 0.01$) were significantly influenced by irrigation scheduling, while fruit length ($p < 0.05$) and diameter ($p < 0.01$) was significant influenced by mulching application. Indeed, the combination of irrigation scheduling and mulching effects were significantly ($p < 0.05$) influenced only in the fruit length. According to Tukey's-b test for fruit length, treatments T_1 and T_6 had significant differed when compared to other treatments. Similarly, the fruit weight in treatments T_1 and T_9 and fruit diameter in treatments T_1 and T_4 had significant different when compared to other treatments. Therefore, the results indicated that proper irrigation scheduling

with mulching application could produce good physical quality fruits which may earn profitable market price.

Discussion

The result showed an improved pointed gourd yield by application of irrigation scheduling and mulching practices. Many studies reported that the pointed gourd yield in different application, field and environmental situation. Some of them showing the highest value that are similar to the present study, as reported by Alom *et al*. (2013), Islam *et al*. (2015) and Jena *et al*. (2017). Result showed that the improved yield geared by daily two times irrigation with straw mulching. Therefore, it indicated that the available water in soil increased water uptake in plant and enhanced photosynthesis. It suggested that an increased hydration may enhance mitochondrial function and thus metabolism. This also showed that increased hydration leads to an increase in cell volume and increased crop yield. The results showed a plenary view of the pointed gourd yield in different geographical location with climatic variation, in which indicated crop species with water management also played as an influential factor for better yield.

The result showed the higher irrigation water use efficiency (IWUE) compared to the field water use efficiency (FWUE). Few research reported the water use efficiency in pointed gourd cultivation. In which showing the highest value was not high as the present study reported by Rani *et al.* (2012). It showed higher IWUE and FWUE by daily two times irrigation with straw mulching that improved yield. Therefore, it indicated that proper irrigation scheduling with mulching application could produce higher water use efficiency in pointed gourd pot cultivation.

The result showed most of the treatment produced better quality pointed gourd fruits. Many studies reported about pointed gourd fruits physical quality. Some of them showing the highest value of fruit length, weight and diameter were larger than the present study as reported by Ara *et al.* (2018) and Hassan and Miyajima (2019). However, Islam *et al.* (2013), Ara *et al.* (2018) and Hassan and Miyajima (2019) reported their findings the most values of fruits length and weight were similar to the present study. The result also showed that fruits physical quality of pointed gourd in mulching condition was obtained better than no mulching practice. Because of mulching can keep the soil water holding capability as long as possible, which could help to develop soil microbes is a source of energy that influence the plant root metabolism. Therefore, it indicated that good physical quality could be achieve by available soil water that may increase by proper irrigation with mulching practices.

Acknowledgements

The authors would like to particular thanks to Patuakhali Science and Technology for funding this research.

References

Alom, M. S., Nag, B. L., Islam, M. N., Ahmed, F. and Akther, S. (2013). Performance of Different Crop Species with Pointed Gourd (*Trichosanthes dioica* Roxb.). Bangladesh Journal of Agricultural Research, 38:523-529.

Ara, N., Moniruzzaman, M., Rahman, K. S., Moniruzzaman, M. and Sultana, R. (2018). Performance of hybrid lines of pointed gourd (*Trichosanthes Dioica* Roxb) for yield and yield attributes. Bangladesh Journal of Agricultural Research, 43:383-393.

Ara, N., Moniruzzaman, M., Rahman, K. S., Moniruzzaman, M. and Sultana, R. (2016). Effect of sex ratios and harvesting stages on yield attributes of pointed gourd. Annals of Bangladesh Agriculture, 20:115-122.

Banglapedia (National Encyclopedia of Bangladesh) (2015). Agriculture, Agroecological Zone. Retried from http://en.banglapedia.org/index.php?title=Agroecological_Zone

Hassan, J. and Miyajima, I. (2019). Morphological and Ecological Characteristics of Pointed Gourd (*Trichosanthes dioica* Roxb.). Journal of the Faculty of Agriculture, Kyushu University, 64:183-189.

Hossain, M. F., Uddin, M. R., Alam, M. A., Akhtar, B. and Hossain, M. (2018a). BARI Hybrid Potol-1: A high yielding variety of pointed gourd. pp.15.

Hossain**,** S. A. A**.** M**.**, Wang, L. and Liu, H. (2018b). Improving Greenhouse Cucumber Production under Deficit Water and Fertilization in Northern China, International Journal of Agricultural and Biological Engineering, 11:58-64.

Islam, M. S., Islam, M. T., Hossain, S. A. A. M., Adham, A. K. M. and Islam, D. (2017). Impacts of dairy farm's wastewater irrigation on growth and yield attributes of maize. Fundam. Applied Agricultural, 2:247-255.

Islam, M. R., Mian, M. A. K., Mahfuza, S. N., Hossain, J. and Hannan, A. (2015). Efficiency of intercropping vegetables and spices relayed with pointed gourd. Bangladesh Agronomy Journal, 18:7-12.

Islam, M. R., Mian, M. A. K., Ara, N. and Hossain, M. F. (2013). Intercropping Lentil and Turmeric Relayed With Pointed Gourd. Bangladesh Journal of Agriculture and Environment, 9:33-37.

Jena, A. k., Suseela, T., KiranPatro, T. S. K. K. and Sujatha, R. V. (2017). Economic viablity of pointed gourd cultivars under coastal Andhra Pradesh. International Journal of Advanced Research, 5:908-910.

Kumar, S. and Singh, B. D. (2012). Pointed Gourd: Botany and Horticulture. Horticultural review, 39:204-238.

Malek, M. A. (2009). In vitro propagation of pointed gourd (*Trichosanthes dioica* Roxb.) through encapsulated shoot tips. Bangladesh Journal of Agricultural Research, 34:555-563.

Rani, R., Nirala, S. R. and Suresh, R. (2012). Effect of fertigation and mulch on yield of pionted gourd in calcareous soil in North Bhihar. Journal of Environment and Ecology, 30:641-645.

(Received: 26 April 2021, accepted: 30 June 2021)