Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2021; 10(2): 1546-1550
Received: 15-01-2021
Accepted: 23-02-2021

NN Damor
Department of Agronomy, Collage of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

RM Solanki
Department of Agronomy, Collage of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

JG Hadiyal
Department of Agronomy, Collage of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

BK Dharaiya
Department of Agronomy, Collage of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Corresponding Author:
NN Damor
Department of Agronomy, Collage of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Effect of drip irrigation schedules and fertigation levels on growth parameters and yields of wheat (*Triticum aestivum* L.)

NN Damor, RM Solanki, JG Hadiyal and BK Dharaiya

Abstract
A field experiment was conducted during *rabi* seasons of 2017-18 and 2018-19 to study the effect of drip irrigation schedules and fertigation levels on growth parameters and yields of wheat (*Triticum aestivum* L.). The trial was laid out in split plot design with four replications, assigning total 16 combinations *i.e*. four irrigation schedules (0.6, 0.8, 1.0 PEF and surface irrigation at 0.8 IW/CPE ratio) in main plot and four fertigation levels (50%, 75%, 100% RDF through drip fertigation and 100 % RDF through soil application) in sub plots. The revealed that drip irrigation scheduling at 1.0 PEF enhance growth parameters and yields which ultimately resulted in higher grain and straw yields of *rabi* wheat over drip irrigation scheduling at 0.6 PEF and in fertigation levels 100 % RDF through drip significantly increase growth parameters and yields of *rabi* wheat over 50% RDF through drip fertigation.

Keywords: Growth parameters, yields, drip irrigation schedule, fertigation levels, wheat

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important staple food grains of human race. India is the second largest producer and consumer of wheat in the world after China. Wheat contributes substantially to the national food security by providing more than 50% of the calories to the people who mainly depend on it. The main wheat growing countries in the world are USSR, USA, China, India, Canada, Australia, France, Pakistan and Turkey. The total area under wheat cultivation in India is about 29.14 million ha. India produced 102.19 million tonnes of wheat during the year 2018-19 (Anon., 2019a) [2]. Among the major cereal crops grown in India, wheat stands next to rice in area and production, but stands first in productivity. The area under wheat in Gujarat is about 0.80 million ha with a total production of 2.40 million tonnes. So, the productivity comes out to be 2919 kg ha^{-1} (Anon., 2019b) [3].

The three main cultivated species of wheat are *Triticum aestivum, Triticum durum* and *Triticum dicoccum.* In Gujarat, mostly *Triticum aestivum* and *Triticum durum* are grown. *Triticum aestivum* (Bread wheat) is mainly cultivated in Mehsana, Banaskantha, Sabarkantha, Kheda and Saurashtra region, while, *Triticum durum,* also known as Bhalia wheat is grown in the Bhal tract of the state. Whereas, *Triticum dicoccum* is cultivated in Ghed region. The productivity of wheat in Gujarat is equal to national average but lower than northern states like Punjab and Haryana as the shorter duration of winter season here does not provide much congenial climatic condition for its growth.

Irrigation scheduling means deciding, when to irrigate?, how to irrigate? and how much to irrigate?. Wheat season commences after withdrawal of monsoon either as rain fed crop on stored soil moisture or as an irrigated crop. If we take irrigated crop of wheat, we should know the irrigation requirement of crop, various approaches are use to schedules irrigation *viz*, depletion of available soil moisture, critical growth stages for irrigation and climatological approaches. In climatological approach, we measure the values of pan-evaporation. Since evaporation is directly related to ET of crop, irrigation is scheduled based on necessity of the crop. This PEF (Pan Evaporation Fraction) method of irrigation scheduling too is based on this approach itself, where, on the basis of daily pan evaporation data we are applying irrigation on every alternate day. The global water soluble fertilizer market has grown exponentially in the last few years and the growth is expected to continue. Water soluble fertilizers are the fertilizers that can be dissolved in water and added or leached out of the soil easily. It is easy to manage the precise amount of nutrients available to plants with the help of water soluble fertilizers. In terms of volume, the water soluble fertilizer market is estimated to grow at a CAGR (compound annual growth rate) of 5.3% from 2013 to 2019, reaching 9251.2 thousand metric tons by (Anon., 2019c) [4].

The factors such as ease of application, innovative production practices, new product offerings, increased availability and mechanized irrigation systems are driving the market for water soluble fertilizers globally. The main obstacle is high cost of water soluble fertilizers in comparison to regular soil applied fertilizers.

Materials and Methods

The experiment was conducted in plot no. C-7 at Instructional farm, Department of Agronomy, Collage of Agriculture, Junagadh Agricultural University, Junagadh - 382001 during the *rabi* season of 2017-18 and 2018-19. The soils of experimental field was clayey and in texture having medium in organic carbon content (0.69 and 0.60 %), medium in available nitrogen (251 and 258 kg/ha), medium in available phosphorus (29.48 and 30.89 kg/ha) and medium in available potash (193 and 196 kg/ha). The trial was laid out in Split Plot Design (SPD) with four replications assigning 16 treatment combinations of four drip irrigation schedules (0.6, 0.8, 1.0 PEF and surface irrigation at 0.8 IW/CPE ratio) in main plots, four fertigation levels (50%, 75%, 100% RDF through drip fertigation and 100 % RDF through soil application) in sub plot. Wheat (GW-496) was sown according to maintaining 22.5 cm row-to-row distance with the seed rate of 120 kg per ha at 5 cm depth. Irrigation and fertilizer application given based on the experimental treatments. Other cultural operations *viz*. and plant protection measures were applied as need based.

Results and Discussion

Effect of drip irrigation schedules

Growth parameters *viz*. plant height at 30, 60 DAS and at harvest (Table 1), dry matter plant^{-1} at 30, 60 DAS and at harvest (Table 2), number of tillers m^{-1} row length at 30, 60 DAS and at harvest (Table 3), number of effective tillers m^{-1} row length at harvest (Table 4) and grain and straw yields (Table 5) were recorded significantly higher when crop was irrigated through drip at 1.0 PEF during 2017-18, 2018-19 and on pooled data basis. However, significantly minimum days to required to days to 50% flowering and maturity (Table 4) were recorded when wheat crop irrigated through drip at 0.6 PEF during 2017-18, 2018-19 and on pooled data basis.

The higher growth parameters and yields were recorded in the drip irrigation scheduled at 1.0 PEF might be due to change in photosynthesis process, which is most significant process influence crop production and is also inhibited by drought stress by Abdelraouf *et al*. (2013) [1]. The all growth characters were negatively affected by deficit irrigation treatment as compared with the normal water supply by Eissa *et al*. (2018) [11]. The similar findings were also reported by Bandyopadhyay *et al*. (1997) [7], Himmat Rao *et al*. (2014) [12], Bhunia *et al*. (2015) [9], Karangiya *et al*. (2019) [15] and Awaad and Deshesh (2019) [6].

Water stress interferes with both the reduction of photo assimilates and the import of assimilated materials in to the developing grains by Abdelraouf *et al*. (2013) [1]. Chouhan *et al*. (2015) [10] reported that effectiveness of drip irrigation system in conserving soil moisture in effective root zone which was continuously available throughout the growing period and results in less water stress in root zone of crop. Bhowmik *et al*. (2018) [8] concluded that uniform and adequate availability of water and better conductive rhizosphere for higher uptake of nutrients which in turn boost the yield attributes through more photosynthates towards the sink and also reported that increase in yields might due to more irrigations providing constant wetting of root zone which might have favored greater release of nutrients from soil.

Effect of fertigation levels

Growth parameters *viz*. plant height at 30, 60 DAS and at harvest (Table 1), dry matter plant^{-1} at 30, 60 DAS and at harvest (Table 2), number of tillers m^{-1} row length at 30, 60 DAS and at harvest (Table 3), number of effective tillers m^{-1} row length at harvest (Table 4), days to 50% flowering (Table 4), days to maturity (Table 4), grain and straw yields (Table 5) were recorded significantly higher when crop was fertilized with 100 % RDF through drip fertigation during 2017-18, 2018-19 and on pooled data basis.

Abdelraouf *et al*. (2013) [1] reported that increase in plant height may be due to the stimulation of cell division and inter node elongation. Kassem and suker (2009) [16] revealed that injection pump method recorded the tallest plant height. Himmatrao *et al*. (2014) [12] reported adequate supply of RDF might have stimulated increased activity of meristematic cells, cell elongation of internodes, carbohydrate metabolism, protein synthesis, nucleotides, protoplasm enzymes and chlorophyll formation involves in various metabolic processes which have a direct impact on vegetative phase and efficient sink formation and greater sink size, greater carbohydrate translocation from vegetative plant parts to the grains ultimately reflected in higher grain yield of wheat. Ibrahim *et al*. (2016) [13] reported that application of 80% fertilizer dose through fertigation reduced nutrient leaching from the root zone and increased its absorption by the growing plants, compared to the application of the recommended fertilizer dose of 60% through fertigation.

Alam *et al*. (2003) [5] found that split application of N at first and second irrigation time by fertigation was superior to top dressing.. Abdelraouf *et al*. (2013) [1] reported that yield attributes and yields were obtained by improved nitrogen use efficiency due to increase in plant height and number of spikelets m^{-2}. Jabran *et al*. (2011) [14] reported that fertigation of the nutrients including nitrogen, phosphorus and potassium at grain development stage helped to produce more number of fertile tillers and spikelets per spike and least number of unfertile tillers. These results are similar to those reported by Kassem and Suker (2009) [16].

Interaction effect

The interaction effect between drip irrigation schedules and fertigation levels (I X F) on dry matter plant^{-1} at harvest (Table 2) was found significant during 2018-19 and in pooled results. Significantly the highest dry matter plant^{-1} of 28.0 and 27.0 g were noted under treatment combination I_3F_3 (Drip irrigation scheduled 1.0 PEF and 100 % RDF through fertigation) during 2018-19 and on pooled data basis, respectively.

The interaction between drip irrigation schedules and fertigation levels (I x F) for grain yield was found significant during 2017-18, 2018-19 and in pooled results (Table 4). Application of irrigation through drip at 1.0 PEF and fertilized the crop with 100 % RDF through (I_3F_3) produced significantly maximum grain yield of 4856, 5251 and 5053 kg ha^{-1} during 2017-18, 2018-19 and on pooled data basis, respectively and which was remained statistically at par with treatment combination I_3F_2 during 2017-18 and 2018-19.

The interaction effect between drip irrigation schedules and fertigation levels (I x F) on straw yield found significant during 2018-19 and in pooled results (Table 4). Significantly maximum straw yield of 5436 and 5588 kg ha^{-1} during 2018-19 and on pooled data basis, respectively were recorded when crop was irrigated through drip at 1.0 PEF and fertilized with 100% RDF through drip fertigation (I_3F_3) and it was remained statistically at par with treatment combination I_3F_2 during 2018-19 and in pooled results. Significantly minimum straw yield of 2820 and 3201 kg ha^{-1} during 2018-19 and in pooled

results, respectively were recorded under treatment combination I_1F_1 (irrigating the crop at 0.6 PEF through drip and fertilizing the crop with 50% RDF through fertigation) during 2018-19 and on pooled data basis, respectively.
Abdelraouf *et al.* (2013) [1] reported that interaction between reducing fertigation treatment from 100 % to 50 % RDF and reducing irrigation requirement from 100 to 50 % on grain, straw and biological yields were reported significant. These results are similar to findings reported by Karangiya *et al.* (2019) [15].

Table 1: Effect of drip irrigation schedules and fertigation levels on plant height of wheat

Treatment	Plant height (cm)								
	At 30 DAS			At 60 DAS			At harvest		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Drip irrigation schedules (I)									
I_1: Drip irrigation 0.6 PEF	27.9	25.9	26.9	55.1	51.9	53.5	79.7	74.7	77.2
I_2: Drip irrigation 0.8 PEF	30.6	27.9	29.3	57.9	54.1	56.1	83.6	79.2	81.4
I_3: Drip irrigation 1.0 PEF	32.2	29.3	30.8	60.7	56.2	58.4	86.7	82.8	84.7
I_4: Surface irrigation at 0.8 IW/CPE ratio	29.3	27.2	28.2	56.8	52.7	54.8	82.1	77.8	79.9
S.Em. ±	0.51	0.48	0.35	1.02	0.88	0.67	1.43	1.23	0.94
C.D. (P=0.05)	1.65	1.56	1.05	3.28	2.83	2.01	4.57	3.96	2.81
C.V. (%)	6.88	7.07	6.97	7.13	6.59	6.89	6.89	6.30	6.62
Fertigation (F)									
F_1: 50 % RDF	28.2	26.7	27.4	56.0	51.9	53.9	80.7	75.8	78.3
F_2: 75 % RDF	30.4	27.9	29.2	58.2	54.3	56.3	83.8	79.6	81.7
F_3: 100 % RDF	31.8	29.1	30.5	59.4	55.5	57.4	84.9	81.0	82.9
F_4: 100% RDF through soil application	29.6	26.7	28.1	56.9	53.2	55.1	82.7	78.1	80.4
S.Em. ±	0.31	0.28	0.21	0.64	0.57	0.43	0.82	0.78	0.57
C.D. (P=0.05)	0.88	0.81	0.59	1.84	1.63	1.21	2.37	2.25	1.60
C.V. (%)	4.10	4.09	4.10	4.44	4.24	4.35	3.97	3.99	3.98
I×F interaction									
S.Em. ±	0.62	0.57	0.42	1.28	1.14	0.86	1.65	1.57	1.14
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of drip irrigation schedules and fertigation levels on dry matter plant^{-1} of wheat

Treatment	Dry matter plant^{-1} (g)								
	At 30 DAS			At 60 DAS			At harvest		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Drip irrigation schedules (I)									
I_1 : Drip irrigation 0.6 PEF	4.3	3.5	3.9	9.0	9.9	9.4	21.4	21.0	21.2
I_2 : Drip irrigation 0.8 PEF	4.8	4.0	4.4	9.7	10.7	10.2	22.8	23.2	22.9
I_3 : Drip irrigation 1.0 PEF	5.2	4.3	4.8	10.1	11.2	10.7	23.5	24.6	24.1
I_4 : Surface irrigation at 0.8 IW/CPE ratio	4.5	3.8	4.1	9.3	10.3	9.8	22.0	21.6	21.8
S.Em. ±	0.1	0.1	0.0	0.14	0.16	0.10	0.39	0.39	0.27
C.D. (P=0.05)	0.2	0.2	0.1	0.46	0.50	0.32	1.26	1.25	0.82
C.V. (%)	5.69	5.30	5.56	6.07	6.01	6.04	7.04	6.92	6.98
Fertigation (F)									
F_1: 50 % RDF	4.3	3.7	4.0	8.8	9.5	9.1	20.2	20.4	20.3
F_2: 75 % RDF	4.8	4.0	4.4	9.7	10.8	10.2	23.1	23.2	23.2
F_3: 100 % RDF	5.1	4.1	4.6	10.1	11.5	10.8	24.4	24.6	24.5
F_4: 100% RDF through soil application	4.7	3.9	4.3	9.4	10.2	9.8	22.1	22.2	22.1
S.Em. ±	0.03	0.04	0.1	0.09	0.09	0.16	0.24	0.24	0.17
C.D. (P=0.05)	0.1	0.1	0.5	0.26	0.25	0.74	0.70	0.70	0.48
C.V. (%)	2.91	3.63	3.24	3.84	3.36	3.59	4.33	4.30	4.31
I×F interaction									
S.Em. ±	0.1	0.1	0.1	0.18	0.17	0.13	0.49	0.48	0.34
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	1.39	0.96

Table 3: Effect of drip irrigation schedules and fertigation levels on number of tillers m^{-1} row length of wheat

Treatment	Number of tillers m^{-1} row length								
	At 30 DAS			At 60 DAS			At harvest		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Drip irrigation schedules (I)									
I_1 : Drip irrigation 0.6 PEF	56.5	57.6	57.1	68.3	71.1	69.7	79.2	80.7	79.9
I_2 : Drip irrigation 0.8 PEF	59.8	60.2	60.0	70.6	73.2	71.9	81.2	83.3	82.3
I_3 : Drip irrigation 1.0 PEF	61.0	62.6	61.8	75.0	77.6	76.3	86.3	88.5	87.4
I_4 : Surface irrigation at 0.8 IW/CPE ratio	57.5	57.9	57.7	69.0	71.8	70.4	79.7	82.0	80.9
S.Em. ±	1.03	1.10	0.75	1.40	1.34	0.97	1.59	1.58	1.12
C.D. (P=0.05)	3.31	3.52	2.24	4.50	4.30	2.89	5.09	5.05	3.33
C.V. (%)	7.05	7.39	7.23	7.97	7.33	7.64	7.81	7.56	7.68
Fertigation (F)									

F_1: 50 % RDF	55.9	57.8	56.8	66.6	70.4	68.5	78.9	81.2	80.1
F_2: 75 % RDF	59.2	60.0	59.6	72.2	74.2	73.2	82.2	84.8	83.5
F_3: 100 % RDF	61.2	61.9	61.6	74.3	77.0	75.6	84.7	84.8	84.7
F_4: 100% RDF through soil application	58.5	58.6	58.6	69.7	72.0	70.9	80.8	83.6	82.2
S.Em. ±	0.71	0.69	0.49	0.77	0.73	0.53	0.90	0.91	0.64
C.D. (P=0.05)	2.04	1.97	1.39	2.22	2.10	1.50	2.58	2.61	1.80
C.V. (%)	4.85	4.61	4.73	4.37	3.99	4.18	4.40	4.35	4.38
I×F interaction									
S.Em. ±	1.42	1.37	0.99	1.54	1.46	1.06	1.80	1.82	1.28
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4: Effect of drip irrigation schedules and fertigation levels on number of effective tillers m^{-1} row length, days to 50 % flowering and maturity of wheat.

Treatment	Number of effective tillers m^{-1} row length			Days to 50 % flowering			Days to maturity		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Drip irrigation schedules (I)									
I_1 : Drip irrigation 0.6 PEF	55.7	57.2	56.5	54.4	50.0	52.2	96.6	96.3	96.4
I_2 : Drip irrigation 0.8 PEF	58.5	59.2	58.9	55.0	57.5	56.3	100.1	99.2	99.7
I_3 : Drip irrigation 1.0 PEF	59.8	61.8	60.8	57.9	58.5	58.2	102.5	103.0	102.7
I_4 : Surface irrigation at 0.8 IW/CPE ratio	56.9	58.7	57.8	54.6	55.1	54.9	97.6	97.9	97.7
S.Em. ±	0.74	0.90	0.58	0.74	0.81	1.47	1.24	1.44	0.95
C.D. (P=0.05)	2.38	2.88	1.73	2.39	2.61	NS	3.98	4.61	2.83
C.V. (%)	5.16	6.09	5.65	5.40	5.91	5.66	5.01	5.82	5.43
Fertigation (F)									
F_1: 50 % RDF	55.6	56.4	56.0	53.6	53.2	53.4	95.1	96.6	95.8
F_2: 75 % RDF	58.4	60.1	59.3	56.0	55.7	55.9	100.1	99.9	100.0
F_3: 100 % RDF	59.6	61.8	60.7	57.4	57.3	57.4	101.8	101.3	101.6
F_4: 100% RDF through soil application	57.3	58.5	57.9	55.0	54.9	54.9	99.9	98.5	99.2
S.Em. ±	0.53	0.59	0.39	0.45	0.47	0.32	0.83	1.00	0.65
C.D. (P=0.05)	1.52	1.68	1.11	1.28	1.35	0.91	2.38	2.88	1.84
C.V. (%)	3.67	3.96	3.82	3.21	3.42	3.31	3.34	4.06	3.71
I×F interaction									
S.Em. ±	1.05	1.17	0.79	0.89	0.94	0.65	1.66	2.01	1.30
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 5: Effect of drip irrigation schedules and fertigation levels on number grain and straw yields of wheat

Treatment	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Drip irrigation schedules (I)						
I_1 : Drip irrigation 0.6 PEF	3564	3859	3712	4357	4014	4185
I_2 : Drip irrigation 0.8 PEF	4083	4254	4169	4770	4594	4682
I_3 : Drip irrigation 1.0 PEF	4232	4507	4369	5065	4719	4892
I_4 : Surface irrigation at 0.8 IW/CPE ratio	4053	4133	4093	4524	4398	4461
S.Em. ±	119	126	87	142	125	94
C.D. (P=0.05)	383	406	259	454	400	281
C.V. (%)	12.01	12.12	12.07	12.14	11.30	11.75
Fertigation (F)						
F_1: 50 % RDF	3659	3645	3652	4066	3947	4007
F_2: 75 % RDF	4053	4309	4181	4905	4556	4731
F_3: 100 % RDF	4382	4684	4533	5221	4971	5096
F_4: 100% RDF through soil application	3838	4115	3976	4524	4250	4387
S.Em. ±	80	93	61	112	101	75
C.D. (P=0.05)	231	268	174	323	291	214
C.V. (%)	8.07	8.91	8.52	9.63	9.15	9.41
I×F interaction						
S.Em. ±	160	186	123	225	202	151
C.D. (P=0.05)	461	535	347	NS	581	581

Conclusion

Based on the results of two year experimentation, it seems quite logical to conclude that for getting higher grain yield, wheat crop should be applied two common surface irrigation of 50 mm depth at 0.8 IW/CPE ratio, first common irrigation should be applied immediately after sowing and second common irrigation should be applied 3-4 days after first irrigation and rest of the irrigation scheduled through drip at 1.0 PEF at an alternate days and crop should be fertilized with 100% RDF (120-60-60 kg NPK ha^{-1}) of which 50% RDF as basal and remaining 50% RDF (60-30-30 kg NPK ha^{-1}) in six equal splits at 10 days interval through fertigation started from 10 DAS.

References

1. Abdelraouf RE, El Habbasha, Taha SF, MH Refaie KM. Effect of irrigation water requirements and fertigation levels on growth, yield and water use efficiency in wheat.

Middle-East Journal of Scientific Research 2013;16(4):441-450.
2. Anonymous. Wheat profile – Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers Welfare, Govt. of India 2019a. http,//agricoop.nic.in.
3. Anonymous. Agriculture and Cooperation Department, Govt. of Gujarat, 2019b. www.agri.gujarat.gov.in
4. Anonymous. Water soluble fertilizers market by types (nitrogenous, phosphatic, potassic, micronutrients), applications (fertigation, foliar application), crop types (field, horticultural, turf & ornamentals) & geography trends & forecasts to 2018. Report, Custom Market Research Service, 2019c, 116-117.
5. Alam SM, Azam SS, Akhtar M. Varietal differences in wheat yield and phosphorus use efficiency as influenced by method f phosphorus application. Songklanakarin Journal of Science and Technology 2003;25(2):175-181.
6. Awaad MA, Deshesh THMA. Wheat growth and nitrogen use efficiency under drip irrigation on semi-arid region. Eurasian Journal of Soil Science 2019;8(3):229-236.
7. Bandyopadhyay PK. Effect of irrigation schedule on Evapo-transpiration and water-use efficiency of winter wheat (*Triticum aestivum* L.). Indian Journal of Agronomy 1997;42(1):90-93.
8. Bhowmik T, Bhardwaj AK, Pandyaraj T, Roy A. Productivity, water use efficiency and profitability of drip irrigated wheat in indo-gangetic plains of Uttarakhand, India. International Journal of Current Microbiology and Applied Sciences 2018;7(2):3185-3191.
9. Bhunia SR, Verma IM, Arif M, Gochar R, Sharma NC. Effect of crop geometry, drip irrigation and bio-regulator on growth, yield and water use efficiency of wheat (*Triticum aestivum* L.). International Journal of Agricultural Sciences 2015;11(1):45-49.
10. Chouhan S, Awasthi M, Nema R. Studies on water productivity and yields responses of wheat based on drip irrigation systems in clay loam soil. Indian Journal of Science and Technology 2015;8(7):650-654.
11. Eissa MA, Rekaby SA, Hegab SA, Ragheb HM. Effect of deficit irrigation on drip-irrigated wheat grown in semi-arid conditions of Upper Egypt. Journal of Plant Nutrition 2018;1(1):1-11.
12. Himmatrao MS, Rao PV, Dhake AV. Feasibility of drip irrigation and n-fertigation scheduling for wheat (*Triticum aestivum* L.) in western scarcity zone of Maharashtra. Progressive Research 2014;9:1057-1059.
13. Ibrahim MM, El-baroudy AA, Taha AM. Irrigation and fertigation schedule under drip irrigation for maize crop in sandy soil. International Journal of Agrophysics, 2016;30:47-55.
14. Jabran K, Cheema ZA, Farooq M, Khan MB. Fertigation and foliar application of fertilizer alone and in combination with canola extracts enhances yield in wheat. Crop and Environment 2011;2(1):42-45.
15. Karangiya BA, Mashru HH, Vadher HM. Response of wheat (*Triticum aestivum* L.) under drip fertigation system. International Journal of Current Microbiology and Applied Sciences 2019;8(06):2519-2526.
16. Kassem MA, Suker AL. Effect of fertigation methods in productivity and nitrogen use efficiency for the wheat and barley crops. Misr Journal of Agricultural Engineering 2009;2(26):866-885.