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Effect of irrigation regime and mulching on growth, yield and yield attributing character of *rabi* maize (*Zea mays* L.) in Tarai region

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Abstract
A field study was conducted in the *rabi* seasons of 2016-17and 2017-18 at the Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar to study the effect of irrigation regime and mulching on growth, yield and yield attributing character of *rabi* maize (*Zea mays* L.) in *tarai* region. The treatments consisted of 3 level of irrigation regime viz., I_1; 20% DASM, I_2; 30% DASM and I_3; 40% DASM in main plots and 4 level of organic mulches viz., M_1; no mulch, M_2; green gram straw mulch @ of 5 t ha^{-1}, M_3; maize straw mulch @ of 5 t ha^{-1} and M_4; lantana straw mulch @ of 5 t ha^{-1} in sub-plots. All the 12 treatment combinations were tested in split plot design with 3 replications. The results revealed that irrigation applied at 20% depletion of available soil moisture (I_1) showed maximum value of leaves per plant (12.8 and 12.6), plant height (244.2 and 217.5 cm at harvest stage), 100-grain weight (30.5 and 28.8 g), early days of emergence (10.4 and 11.4 plant day $^{-1}$) and days to 50% tasseling (114.6 and 116.6 days) whereas root length (263.4 and 258.5 cm), root length density (0.71 and 0.69 cm cm^{-3}), root weight per plant (123.9 and 136.8 g) and grain yield (8503.5 and 7943.5 kg ha^{-1}) of maize showed maximum values at 30% depletion of available soil moisture (I_2) during 2016-17 and 2017-18, respectively.
Among different mulches, green gram mulch @ of 5 t ha^{-1} (M_2) recorded significantly highest value of growth parameters, yield and yield attributing characters of maize over other mulches and no mulch during 2016-17 and 2017-18. However, interaction of green gram straw @ of 5 t ha^{-1} (M_2) as mulch with 30% depletion of available soil moisture (I_2) showed best results over other treatment combinations.

Keywords: Irrigation regime, mulching, growth, yield, yield attributing character, *Zea mays* L.

Introduction
Among the cereal crops maize is the most important crop because of its higher productivity and vides variety of uses like food for humans and cattle, raw materials for dairy products and industries etc. It requires high water during growth period. During crop period, 500-750 mm of well distributed rain is conducive to proper growth. At any growth stage, water deficiency reduces growth and production of the maize crop. Deficit soil moisture at vegetative stage of the crop reduces cell division and expansion, plant height and leaf area, while at tasseling and flowering stages, the number of grains per cob and post pollination, the kernel weight resulting in significant yield loss ranging from 40-50% (Lauer, 2003) [7]. *Rabi* maize has more yield potential and is more responsive to fertilizer than other seasonal crops resulting in more turn-over of the nutrients from the soil (Singh and Zaidi, 1998) [13]. Availability of optimum moisture in the soil enhances the efficiency of applied nutrients. Any reduction of soil moisture at these stages will considerably reduce the grain yield. Therefore, it is necessary to evaluate irrigation scheduling and different organic mulches so as to realize higher yield and economic returns.
Deficit irrigation is a technique in which irrigation is done during drought sensitive growth stages of a crop. Outside these periods, irrigation is limited or even unnecessary if rainfall provides a minimum supply of water. Whereas mulch is one of the management practices which improve the water use efficiency of soil. Mulching conserve water and improve irrigation efficiency in agriculture, especially in the areas where water resources are limited and regulated.

There is a need to measure the irrigation requirement of crop on the basis which consider the relationship between crop, soil and climate. Mulching can affect the soil temperature and soil water content (Acharya *et al*., 2005) [1] and directly affect on the grain yield of crops (Nwokeocha, 2000) [9].

Materials & Methods

A field study was conducted in the *rabi* seasons of 2016-17and 2017-18 at the Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar. The experimental soil was sandy loam with initial value of pH 6.97, electrical conductivity of 0.25 dSm^{-1}, organic of carbon 0.78%, available N of 200.7 kg ha^{-1}, available P of 20.2 kg ha^{-1} and available K of 194.9 kg ha^{-1}. The treatments consisted of 3 level of irrigation regime viz., I_1; 20% DASM (depletion of available soil moisture), I_2; 30% DASM (depletion of available soil moisture) and I_3; 40% DASM (depletion of available soil moisture) in main plots and 4 level of organic mulches viz., M_1; no mulch, M_2; green gram mulch @ of 5 t ha^{-1}, M_3; maize straw mulch @ of 5 t $ha^{-1}$and M_4; lantana straw mulch @ of 5 t ha^{-1} in sub-plots. All the 12 treatment combinations were tested in split plot design with 3 replications.

Sowing of hybrid maize variety 'P-3396' was done in the second week of November in both the years. The seed rate of 25 kg ha^{-1} with row to row spacing of 60 cm and plant to plant spacing of 20 cm in maize. The crop was fertilized with recommended dose of 120:60:40 kg N, P_2O_5 and K_2O and 25 kg $ZnSO_4$ per hectare. Nitrogen phosphorus and potassium were supplied through NPK fertilizer (12:32:16) and remaining N and K_2O through urea and Muriate of potash, respectively. One third of N and full dose of P_2O_5, K_2O and $ZnSO_4$ were applied in the opened furrow and remaining nitrogen was applied through top dressing over rows in two equal splits at the time of knee high and tasseling stages. Different types of air dried chopped material of plants were spread at the rate of 5 t ha^{-1} between the rows as mulch just after sowing of maize. The grain yield of maize was recorded at 14% moisture. Irrigation was applied according to desired depletion of moisture content of soil from field capacity level.

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Result & Discussion

Growth parameters

Speed of emergence, leaves per plant and plant height at harvest stage

Speed of emergence, leaves per plant and plant height significantly varied among irrigation regimes during both the years except leaves per plant during 2017-18. Irrigation applied @ 20% depletion of available soil moisture (I_1) resulted maximum value for seedling emergence (10.4 and 11.4 plant day^{-1}), leaves per plant (12.8 and 12.6 at harvest) and plant height (244.2 and 217.5 cm at harvest) over 30 (I_2) and 40% (I_3) depletion of available soil moisture during 2016-17 and 2017-18, respectively (Table-1). This might be due to moisture present at 20% depletion of available soil moisture might provides most favourable condition for seedling emergence and plant growth. These findings were in agreement with the results of Aulakh *et al*. (2013) [3] and Ashagre *et al*. (2014) [2].

The mulch also had significant effect on speed of emergence, leaves per plant and plant height during 2016-17 and 2017-18. The maximum value of speed of emergence (9.8 and 10.6 plant day^{-1}) was found in treatment where maize straw mulch was applied @ of 5 t ha^{-1} (M_3) whereas application of green gram straw @ of 5 t ha^{-1} as mulch showed (M_2) maximum values of leaves per plant (12.8 and 12.6) and plant height (240.9 and 217.5 cm at harvest) over no mulch (M_1) during 2016-2017and 2017-18, respectively (Table-1). All mulching materials had resulted in significant higher speed of emergence, leaves per plant and plant height than the control. This may be due to mulch induce high soil temperature, largely through stabilization by insulation and conserve soil moisture. Similar results were observed by Uwah and Iwo (2011) [14]; Zerga *et al.* (2017) [16] and Priya *et al*. (2018) [10].

The combined effect of irrigation regime and organic mulch had significant effect on speed of emergence but non-significant effect on leaves per plant and plant height at harvest stage during both the years. The maximum value of speed of emergence (11.5 and 12.7) was observed in treatment combination I_1 with M_3 (maize straw mulch @ of 5 t ha^{-1}) followed by (11.4 and 12.0) in case of I_2 (30% depletion of available soil moisture) with M_4 (lantana leaves mulch @ of 5 t ha^{-1}) and minimum value of speed of emergence (4.7 and 5.9) was observed in I_4 (40% depletion of available soil moisture) with M_1 (no mulch) combination during 2016-17 and 2017-18, respectively.

Root length, root length density and root weight per plant at tasseling stage

Irrigation regime had significant effect on root length, root length density and root weight per plant during 2016-17 and 2017-18. The data showed that irrigation applied at 30% depletion of available soil moisture showed significant highest value of root length (263.4 and 258.5 cm), root length density (0.71 and 0.69 cm cm^{-3}) and root weight per plant (123.9 and 136.8 g) of maize as compared to 20% (I_1) and 40% depletion of available soil moisture (I_3) during 2016-17 and 2017-18, respectively (Table-2). This might be due to the presence of optimum soil moisture condition at 30 per cent available soil moisture depletion which provides favourable soil physical condition such as root penetration for root growth. Significantly highest value of root length density (6.82 cm cm^{-3}) and root weight density (0.56 mg cm^{-3}) was recorded at 0-20 cm depth of maize where irrigation given at 3 days interval as compared to other treatments (Sangakkara *et al.*, 2010) [12].

Table 1: Effect of irrigation regime and mulching on speed of emergence (Plant day^{-1}), leaves per plant and plant height (cm) of maize at harvest stage

Speed of emergence								
	2016-17				**2017-18**			
	Main plot (MP)				**Main plot (MP)**			
Sub plot (SP)	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
M_1	8.6	7.5	4.7	6.9	9.6	8.2	5.9	7.9
M_2	10.4	9.0	5.1	8.1	11.9	9.4	6.2	9.2
M_3	11.5	11.4	6.5	9.8	12.7	12.0	6.9	10.6
M_4	11.2	9.6	5.6	8.8	11.2	10.9	6.5	9.5
Mean	10.4	9.4	5.5		11.4	10.1	6.4	
Effect	MP	SP	SP within MP	SP across MP	MP	SP	SP within MP	SP across MP
SEm±	0.2	0.2	0.5	0.3	0.2	0.2	0.5	0.4
CD (0.05)	0.9	0.5	1.0	1.2	0.9	0.7	1.3	1.3
Leaves per plant								
	2016-17				**2017-18**			
	Main plot (MP)				**Main plot (MP)**			
Sub plot (SP)	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
M_1	12.4	11.8	11.5	11.9	12.1	11.9	11.8	11.9
M_2	13.5	12.7	12.1	12.8	12.9	12.7	12.3	12.6
M_3	12.5	11.9	11.6	12.0	12.6	12.2	12.0	12.3
M_4	12.8	12.1	11.9	12.3	12.9	12.3	12.2	12.5
Mean	12.8	12.1	11.8		12.6	12.3	12.1	
Effect	MP	SP	SP within MP	SP across MP	MP	SP	SP within MP	SP across MP
SEm±	0.04	0.1	0.1	0.2	0.1	0.1	0.3	0.2
CD (0.05)	0.2	0.4	NS	NS	NS	0.3	NS	NS
Plant height								
	2016-17				**2017-18**			
	Main plot (MP)				**Main plot (MP)**			
Sub plot (SP)	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
M_1	239.4	231.6	227.2	232.7	209.4	199.8	195.2	201.5
M_2	248.2	238.9	235.8	240.9	222.9	216.6	213.1	217.5
M_3	243.6	231.6	229.0	234.8	218.3	207.2	197.9	207.8
M_4	245.6	233.8	231.8	237.1	219.4	213.7	201.3	211.5
Mean	244.2	234.0	230.9		217.5	209.3	201.9	
Effect	MP	SP	SP within MP	SP across MP	MP	SP	SP within MP	SP across MP
SEm±	1.4	1.7	2.8	2.9	2.5	1.7	4.9	3.6
CD (0.05)	5.5	5.1	NS	NS	9.9	5.2	NS	NS

Table 2: Effect of irrigation regime and mulching on root length (cm), root length density (cm cm^{-3}) and root weight per plant (g) of maize at tasseling stage

Root length								
	2016-17				**2017-18**			
	Main plot (MP)				**Main plot (MP)**			
Sub plot (SP)	**I_1**	**I_2**	**I_3**	**Mean**	**I_1**	**I_2**	**I_3**	**Mean**
M_1	249.7	249.8	232.5	244.0	245.5	247.5	223.1	238.7
M_2	278.8	289.7	266.3	278.2	266.8	278.6	259.8	268.7
M_3	252.0	255.0	244.3	250.4	249.7	254.3	236.4	246.8
M_4	258.6	259.3	254..7	254.7	250.2	253.6	238.6	247.5
Mean	259.7	263.4	247.3		253.0	258.5	239.5	
Effect	MP	SP	SP within MP	SP across MP	MP	SP	SP within MP	SP across MP
SEm±	2.8	2.0	7.6	5.1	2.2	1.7	6.3	4.4
CD (0.05)	11.3	6.1	NS	NS	8.7	5.2	NS	NS
Root length density								
	2016-17				**2017-18**			
	Main plot (MP)				**Main plot (MP)**			
Sub plot (SP)	**I_1**	**I_2**	**I_3**	**Mean**	**I_1**	**I_2**	**I_3**	**Mean**
M_1	0.66	0.67	0.62	0.65	0.65	0.66	0.59	0.63

M_2	0.74	0.79	0.71	0.75	0.71	0.75	0.69	0.72
M_3	0.67	0.68	0.64	0.66	0.66	0.66	0.63	0.65
M_4	0.68	0.69	0.65	0.67	0.66	0.67	0.63	0.66
Mean	0.69	0.71	0.65		0.67	0.69	0.64	
Effect	MP	SP	SP within MP	SP across MP	MP	SP	SP within MP	SP across MP
SEm±	0.01	0.01	0.04	0.04	0.01	0.01	0.03	0.03
CD (0.05)	0.02	0.02	NS	NS	0.03	0.02	NS	NS
Root weight per plant								
	2016-17				**2017-18**			
	Main plot (MP)				**Main plot (MP)**			
Sub plot (SP)	**I_1**	**I_2**	**I_3**	**Mean**	**I_1**	**I_2**	**I_3**	**Mean**
M_1	91.3	101.2	70.0	87.5	105.7	129.2	91.6	108.8
M_2	114.1	136.5	89.9	113.5	133.9	142.3	118.7	131.6
M_3	105.7	126.1	83.6	105.1	123.5	136.7	103.2	121.2
M_4	108.6	131.6	86.2	108.8	126.4	139.0	102.8	122.7
Mean	104.9	123.9	82.4		122.4	136.8	104.1	
Effect	MP	SP	SP within MP	SP across MP	MP	SP	SP within MP	SP across MP
SEm±	0.4	1.0	0.9	1.5	1.1	1.4	2.2	2.4
CD (0.05)	1.8	3.0	5.3	4.8	4.5	1.3	8.0	7.8

Table 4: Effect of irrigation regime and mulching on days to 50 per cent tasseling and silking

Days to 50% tasseling								
	2016-17				**2017-18**			
	Main plot (MP)				**Main plot (MP)**			
Sub plot (SP)	**I_1**	**I_2**	**I_3**	**Mean**	**I_1**	**I_2**	**I_3**	**Mean**
M_1	117.2	117.8	119.1	118.0	120.1	119.4	121.1	120.2
M_2	111.8	115.8	116.4	114.7	111.4	116.0	119.0	115.5
M_3	114.1	116.5	118.1	116.2	116.1	116.3	119.4	117.3
M_4	115.5	116.5	118.4	116.8	118.8	118.4	119.7	118.9
Mean	114.6	116.7	118.0		116.6	117.5	119.8	
Effect	MP	SP	SP within MP	SP across MP	MP	SP	SP within MP	SP across MP
SEm±	0.3	0.5	1.6	1.4	0.7	0.6	2.3	2.1
CD (0.05)	1.1	1.5	NS	NS	0.9	1.8	NS	NS
Days to 50% silking								
	2016-17				**2017-18**			
	Main plot (MP)				**Main plot (MP)**			
Sub plot (SP)	**I_1**	**I_2**	**I_3**	**Mean**	**I_1**	**I_2**	**I_3**	**Mean**
M_1	121.8	123.0	125.1	123.3	123.7	126.3	127.0	125.7
M_2	116.1	119.4	120.0	118.5	118.0	119.8	121.3	119.7
M_3	120.4	121.1	121.8	121.1	120.5	122.0	122.7	121.7
M_4	121.0	121.4	123.7	122.1	121.6	122.3	124.0	122.6
Mean	119.8	121.2	122.7		120.9	122.6	123.7	
Effect	MP	SP	SP within MP	SP across MP	MP	SP	SP within MP	SP across MP
SEm±	0.8	0.9	2.2	2.4	0.9	1.0	1.6	1.6
CD (0.05)	NS	2.6	NS	NS	NS	2.8	NS	NS

The mulch also showed significant effect on root length, root length density and root weight per plant during both years. Among different mulches, green gram mulch @ of 5 t ha^{-1} (M_2) showed significantly higher value of root length (278.2 and 268.4 cm), root length density (0.75 and 0.72 cm cm^{-3}) and root weight per plant (113.5 and 131.6 g) over other mulches during 2016-17 and 2017-18, respectively (Table-2). The significant increases in root length, root weight per plant in mulch plot as compared to no mulch may due to application of organic mulches added organic carbon to the soil which improve soil physical condition, provide favourable soil temperature and also helped to increases soil moisture retention. Jayaswal *et al.* (2018) [5] reported that among organic mulches, sugarcane straw mulch recorded highest value of root length (19.52 cm), fresh weight (172.00 g) and dry weight (13.76) of root of carrot.

Interaction of irrigation regime with different mulches showed non-significant on root length and root length density but showed significant effect on root weight per plant during both years (Table-2). However, irrigation applied at 30% depletion of available soil moisture (I_2) with green gram mulch (M_2) @ of 5 t ha^{-1} showed significantly higher value of 136.5 and 142.3 g root weight per plant over other treatment combination during 2016-17 and 2017-18, respectively.

Yield attributing parameters

Cobs length and 100-grain weight

The significant effect of irrigation given at different available soil moisture depletions on 100-grain weight but in case of cobs length it showed non-significant effect during first year and significant during second year. Among various irrigation regimes, irrigation applied at 20% depletion of available soil moisture (I_1) showed significant highest value of 30.5 and 28.8 g 100- grain weight during 2016-17 and 2017-18, respectively whereas cobs length showed significant highest value of 14.0 cm during 2017-18 (Table-3). Balaswamy *et al*. (1986) [4] recorded the higher cob length and grain weight/cob in maize of 15.47 cm and 236.29 g, respectively, due to scheduling of water at 40 per cent ASMD over 60 and 80 per cent ASMD.

The mulching had significant effect on cobs length and 100-grain weight during both the years. Application of green gram straw mulch @ of 5 t ha^{-1} (M_2) showed significant highest values of 15.7 and 14.0 cm cobs length and 30.5 and 29.1 g of 100-grain weight over no mulch (M_1) during 2016-17 and 2017-18, respectively (Table-3). This might be due to greater soil moisture storage capacity of green gram mulch for longer period of time as compared to other organic mulches. Similarly, Yaseen *et al*. (2014) [15] showed that 1000 grain weight (306.5 g) was found maximum in treatment where wheat straw mulch was applied @ of 15 Mg ha^{-1} and showed significant difference as compared control but cob length (14.7 cm) did not showed any significant difference.

The interactions of irrigation regime and mulching recorded non-significant effect on cobs length and 100 grain weight during both the years.

Days to 50% tasseling and silking

The data indicated significant effect of irrigation regime on days to 50% tasseling but showed non-significant effect on days to 50% silking during both the years. However, irrigation at 20 per cent available soil moisture depletion (I_1) showed the minimum days to 50 per cent tasseling (114.6 and 116.6) which get increased on increasing the irrigation interval during 2016-17 and 2017-18, respectively (Table-4). The early tasseling and silking with 20 per available soil moisture depletion than 30 and 40 per cent available soil moisture depletion might be due to favourable soil moisture condition during all the stages of crop growth, consequently there was synchronous flowering as evident from narrow tasseling-silking interval. Kuchanur *et al*. (2013) [6] also reported that in maize, moisture stress increased significantly the days required to 50% anthesis, 50% silking and anthesis-silking interval.

All the mulching level showed significant difference on days to 50 per cent tasseling and silking during 2016-17 and 2017-18. The green gram straw mulch @ of 5 t ha^{-1} (M_2) had the minimum days to 50 per cent tasseling of (114.7 and 115.5) and to 50 per cent silking of (118.5 and 119.7) whereas, M_1 (no mulch) had the maximum days of (118.0 and 120.2) 50 per cent tasseling and days of (123.3 and 125.7) 50 per cent silking during 2016-17 and 2017-18, respectively (Table-4). Application of mulching showed less days to attained 50 per cent tasseling and silking than control (M_1). This might be due to the increased in soil temperature by application of mulching materials from low value to optimum value reduces the days to 50 per cent tasseling and silking. In *rabi* maize, Ram *et al.* (2017) [11] reported early days to 50% tasseling (70 days each) in treatment where black and white polythene mulch were applied as compared to control and other treatments

The combined application of different irrigation regime with different mulching level showed non-significant difference on days to 50 per cent tasseling and silking during both the years.

Table2. Effect of irrigation regime and mulching on root length (cm), root length density (cm cm^{-3}) and root weight per plant (g) of maize at tasseling stage

Grain yield

Irrigation regime had significant effect on grain yield of maize during both years. The significantly maximum value of 8503.5 and 7943.5 kg ha^{-1} grain yield was recorded during 2016-17 and 207-18, respectively, where irrigation applied at 30% depletion of available soil moisture (I_2) over 20% (I_1) and 40% (I_3) depletion of available soil moisture (Fig.1). The highest value of grain yield at 30 per cent available soil moisture depletion might be due to maintaining of optimum soil moisture condition which reduces leaching loss of nutrient and thus, increases their uptake and translocation from other parts of plant to the grain. However, Mahmood and Ahmad (2005) [8] evaluated the effect of irrigation at soil moisture depletion (SMD) on wheat and revealed that grain yield (2966.5 kg ha^{-1}) was greater when irrigation applied at 50% SMD (214.80 mm) and reduced to 2319.1 kg ha^{-1} at 70% SMD (251.42 mm).

Among different types of mulches, green gram straw @ of 5 t ha^{-1} as mulch (M_2) showed significantly highest value of 8415.7 and 7991.0 kg ha^{-1} grain yield over other organic mulches during both years given in (Fig.1). The significant increase in grain yield in mulch plots as compared to un-mulched might be due to significant increases in moisture regime and decrease in evaporation loss during crop growth stages and development. The same trend was also recorded for the grain yield for the different mulching practices. Uwah and Iwo (2011) [14] reported significant increase in grain yield of 5.42 and 5.96 t ha^{-1} during 2007-08 and 2008-09, respectively, of maize under Ganba grass (*Andropogam gayanus*) mulch applied @ 8 t ha^{-1} relative to control.

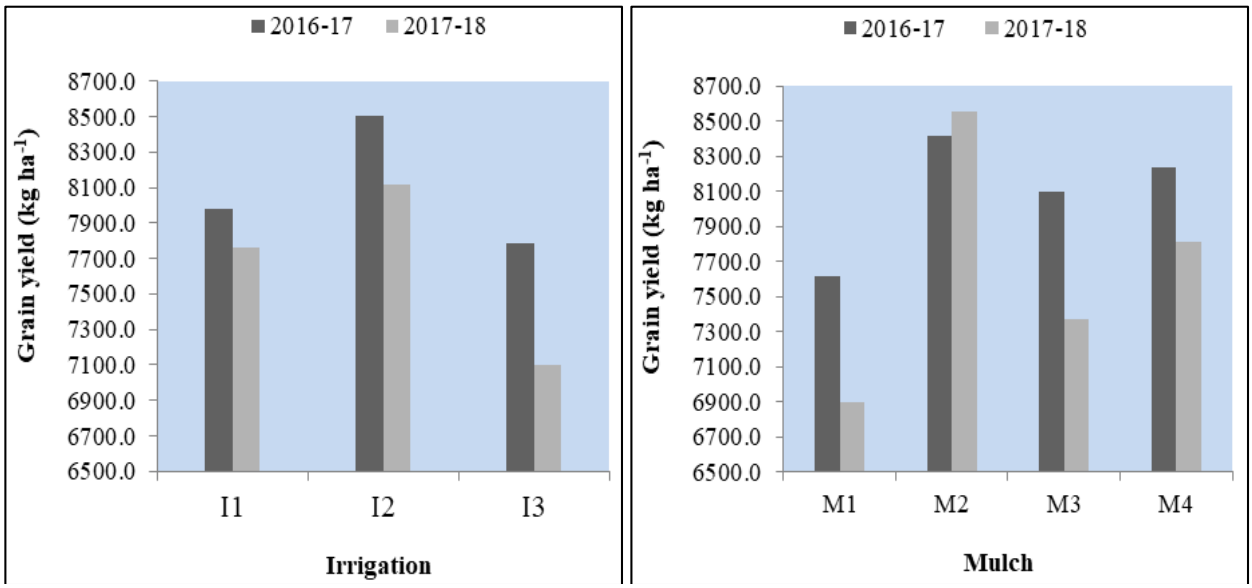

Fig 1: Effect of irrigation regime and mulching on grain yield of maize during 2016-17 and 2017-18

Conclusion

In general, irrigation applied at 30% depletion of available soil moisture showed best results for plant growth parameters, yield attributes and yields during the entire period of crop growth for both season. Among different mulches, green gram straw @ 5 t ha^{-1} used as mulch in soil of *rabi* maize is the best organic sources which increase grain yield of maize and also improve soil health and quality by adding soil organic carbon and nutrient to the soil through microbial decomposition and, maintained soil temperature and moisture by reducing losses of water through run off and drainage.

References

1. Acharya CL, Hati KM, Bandyopadhyay KK, Hillel D, Rosenzweig C, Pawlson DS *et al*. Encyclopedia of Soils in the Environment, Elsevier Publication, USA, A.A. Ramalan, C.U., 2005.
2. Ashagre H, Hamza IA, Tesfaye B, Derebachew D, Ayana B, Tilahun D. Emergence and Seedling Growth of Corn (*Zea mays* L.) as Influenced by Irrigation Schedules on Vertisol. International Research Journal of Plant Science. 2014; 5(1):17-22.
3. Aulakh GS, Vashist KK, Mahal SS. Effect of different irrigation regimes and nitrogen levels on growth parameters and yield of late kharif sown maize (*Zea mays* L.). Crop Research. 2013; 45(1, 2 &3):96-105.
4. Balaswamy K, Reddy BB, Reddy KA, Reddy BB, Reddy MB. Effect of planting patterns mulches and soil moisture regimes on growth and yield attributes of maize. The Madras Agricultural Journal. 1986; 73: 553-557.
5. Jaysawal N, Singh G, Kanojia A, Debbarma B. Effect of different mulches on growth and yield of carrot (*Daucus carota* L.). International Journal of Chemical Studies. 2018; 6(4): 381-384.
6. Kuchanur PH, Salimath PM, Wali MC. Genetic analysis in maize (*Zea mays* L.) under moisture stress conditions. Indian Journal of Genetics and Plant Breeding. 2013; 73(1):36-43.
7. Lauer J. What happens within the corn plant when drought occurs? University of Wiscosin Extension Available from http://www.uwex.edu/ces/ag/issues/drought 2003/corneffect.html.
8. Mahmood N, Ahmad RN. Determination of water requirements and response of wheat to irrigation at different soil moisture depletion levels. International Journal of Agriculture and Biology. 2005; 7(5):812-813.
9. Nwokeocha. Effects of furrow irrigation methods, mulching and soil water suction on the growth, yield and water use efficiency of tomato in the Nigerian Savanna. Agriculture and Water Management. 2000; 45:317-330.
10. Priya N, Ramulu V, Rao PV, Uma Devi M. Effect of Drip Irrigation Schedules and Plastic Mulching on Plant Growth, Yield and Leaf Water Potential of Rabi Maize, International Journal of Pure and Applied Bioscience. 2018; 6(1):183-191.
11. Ram P, Sreenivas G, Rani PL. Impact of sustainable weed management practices on growth, phenology and yield of rabi grain maize (*Zea mays* L.). International Journal of Current Microbiology and Applied Science. 2017; 6(7):701-710.
12. Sangakkara UR, Amarasekera P, Stamp P. Irrigation regimes affect early root development, shoot growth and yields of maize (*Zea mays* L.) in tropical minor seasons. Plant Soil Environment. 2010; 56(5):228-234.
13. Singh RP, Zaidi PH. Technology for increasing production of winter maize (*Zea mays* L.) in India. Indian Farming. 1998; 48(1):42-46.
14. Uwah DF, Iwo GA. Effectiveness of organic mulch on the productivity of maize (*Zea mays* L.) and weed growth. The Journal of Animal & Plant Sciences. 2011; 21:525-530.
15. Yaseen R, Shafi J, Ahmad W, Rana MS, Salim M, Qaisrani SA. Effect of deficit irrigation and mulch on soil physical properties, growth and yield of maize. Environment and Ecology Research. 2014; 2(3):122-137.
16. Zerga K, Alemu M, Tebasa F, Tesfaye B. Impacts of different mulching material on seedling emergence and growth performance of hot pepper (*Capsicum annum* L.) at gurage zone, ethiopia, International Multidisciplinary Research Journal. 2017; 7:01-04.