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Effect of irrigation scheduling and mulches on growth and yield of wheat (*Triticum aestivum* L.) in Central Punjab

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Abstract
An experiment was conducted during *Rabi* season of 2017 at Experimental Farm of Department of Agriculture, Mata Gujri College, Shri Fatehgarh Sahib, Punjab to study the effect of irrigation scheduling and mulching on wheat (*Triticum aestivum* L.) in Central Punjab. The experiment was laid out in randomized block design with eight treatments *viz.* T_2 - mulch paddy (5 t/ha) + irrigation (at CRI stage), T_3 - mulch wheat (5 t/ha) + irrigation (at CRI stage), T_4 - stubble sugarcane (2 t/ha) + irrigation (at CRI stage), T_5 - mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage), T_6 - mulch wheat (5 t/ha) + irrigation (at CRI & MT stage), T_7 - mulch paddy (5 t/ha) + irrigation (at CRI & MT stage), T_8 - irrigation (at CRI, MT, J & M stage) were compared with T_1- control treatment. The treatments were replicated thrice. On the basis of result summarized the maximum growth parameters viz. Plant height (cm), number of tillers in running meter, leaf area index and dry matter accumulation (g/m) were maximum with the application of T_5 - mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage) followed by T_8 - irrigation (at CRI, MT, J & M stage) and T_7 - mulch paddy (5 t/ha) + irrigation (at CRI & MT stage) at 60, 90 DAS and at harvest stage. Best results in terms of yield attributes and yield with the application of T_5 - mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage) which was at par with T_8 - irrigation (at CRI, MT, J & M stage). Application of T_5 - mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage) gave the maximum net return of Rs. 86320.23 ha and maximum benefit: cost ratio is 1.75.

Keywords: irrigation scheduling, lai, mulches, yield attributes

Introduction
Wheat (*Triticum aestivum* L.) is an annual plant of Gramineae family. It is the world most widely cultivated food crop. In India, area, production and average yield of wheat is 30.71 mha, 97.44 mt and 3172.30 kg/ha respectively (Anonymous 2016-2017) [2]. Surface water gets depleted by runoff water from agricultural fields containing pesticides, fertilizers and waste chemicals from industries and sewage from cities and rural areas. The fall in groundwater levels owing to excessive removal for agricultural and other uses with high costs of fuel and electrical energy used in drawing groundwater. However, a holistic strategy to evolve integrated solutions for multiple problems has been elusive (Singh *et al*. 2016) [12]. The vertical effort practices *viz.* irrigation management, application of mulches increase the duration of moisture availability with an increase in the amount of available moisture in the soil.

Water is one of the most important factors that are necessary for proper growth, balanced development and higher yield of all crops. Water deficiency affects plant growth and grain yield (Hussain *et al*., 2004) [15]. Irrigation management is one of the important managerial activities and effects the effective utilization of water by crop. Maximum grain yield (2.27 t/ha) was obtained with application of 200 mm irrigation treatment (Shirazi *et al*. 2014) [11]. Under scarcity of water, four irrigation schedules at crown root initiation, tillering, flowering and milking stages recorded higher grain yield resulting in saving two irrigation for wheat (Kumar *et al*. 2015) [8]. Irrigation at jointing and anthesis improved grain yield by an average of 12.70 and 18.65% as compared with no irrigation in wheat (Zhang *et al*. 2017) [14].

Mulch is one of the important agronomic practices for conserving soil moisture and modifies soil health. Mulch works as a protective layer for soil that stimulates root growth and suppresses the weed growth. Mulching significantly increased yield, water use efficiency, nitrogen use efficiency up to 60% compared with no mulch (Qin *et al*. 2015). Wheat straw mulch reduces evaporation by 50 % under wheat and saved about 80 mm water during wheat growth season (Singh *et al*. 2016) [12].

Mulching and optimum time and number of irrigation reduce is possible ways to reduce the density and weight of weed (Awasthy *et al*. 2014) [3]. The better growth yield and economic return of wheat was recorded in treatment of combination of mulching levels and irrigation schedule, mulch application @ 6000 kg/ha and irrigation schedule of 1.0 IW/CPE ratio can be used for (Kaur *et al*. 2017) [7]. Therefore, it is essential to find out the response of wheat to limited irrigation schedule at critical stages with the application of mulch to reduce evaporation losses and help in enhanced yield and improve water use efficiency.

Materials and Methods

A field experiment was conducted at Experimental Farm of Department of Agriculture, Mata Gujri College, Fatehgarh sahib, Punjab during *Rabi* season of 2016-2017. The experiment laid out in randomized block design with three replicated. The treatment details are as T_1 - control, T_2 - mulch paddy (5 t/ha) + irrigation (at CRI stage), T_3 - mulch wheat (5 t/ha) + irrigation (at CRI stage), T_4 - stubble sugarcane (2 t/ha) + irrigation (at CRI stage), T_5 - mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage), T_6 - mulch wheat (5 t/ha) + irrigation (at CRI & MT stage), T_7 - mulch paddy (5 t/ha) + irrigation (at CRI & MT stage), T_8 - irrigation (at CRI, MT, J & M stage). The soil of experiment field gangetic alluvial having clay loam texture with pH (7.6), medium in organic carbon (0.52%), electrical conductivity (0.56 dS/m at 25 °C), available P_2O_5 (14.46 kg/ha), K_2O (171.15 kg/ha) and N (320.18 kg/ha). The pre-treated seed variety WH 1105 were sown by hand drilling in between the rows by using wheat seed at the rate of 100 kg/ha with a spacing of 22.5 cm on 25th November, 2016. The recommended dose of fertilizers of NPK for wheat is 120, 60, 40 kg/ha. Applied 1/3 dose of nitrogen and full dose P_2O_5 and K_2O as basal and remaining dose of nitrogen was applied in two split at 30 DAS and 60 DAS. Irrigation was given as per treatments. Mulching was applied on week after emergence of crop. Mulch paddy (5 t/ha), mulch wheat (5 t/ha) and stubble sugarcane (2 t/ha) were applied according to the treatments. The major agronomical done as per requirement. Regular biometric observations were recorded at periodic intervals of 30 DAS, 60 DAS, and 90 DAS and at harvest stage of five selected plant. Yield attributes parameters were recorded just before harvesting of crop. The crop was harvested on 20th April 2017 when the straw and spike colour turns into yellow and grains are fully ripened and then tied into the labelled bundles. The sun dried weight of bundles was recorded. The threshing of crop was done with the help of tractor drawn thresher. Thus grain yield of each plot was recorded. Statistical data were analysed by standard procedure by Gomez & Gomez, 1984) [4].

Result and Discussion

Effect of irrigation scheduling and mulches on growth attributes

The result of the present study indicated that growth parameters of plant such as plant height, number of tillers in running meter, leaf area index (LAI) and dry matter accumulation of wheat crop were significantly influenced by different irrigation scheduling and mulching treatments (Table 1). Among the irrigation scheduling and mulching treatments, maximum plant height, number of tillers in running meter, leaf area index (LAI) and dry matter accumulation was recorded with the application of T_3 - mulch wheat (5 t/ha) + irrigation (at CRI stage) followed by T_5 - mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage) and T_6 - mulch wheat (5 t/ha) + irrigation at (CRI & MT stage) at 30 DAS. Maximum plant height, number of tillers in running meter, leaf area index (LAI) and dry matter accumulation was recorded with the application of T_5 - mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage) followed by the T_8 - irrigation (at CRI, MT, J & M stage) and T_7 - mulch paddy (5 t/ha) + irrigation (at CRI & MT stage) at 60 DAS. However, the maximum plant height, number of tillers in running meter, leaf area index (LAI) and dry matter accumulation was recorded with the application of T_5 - mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage) followed by the T_8 - irrigation (at CRI, MT, J & M stage) at 90 DAS and at harvest stage. At 30 DAS application of T_3 - mulch wheat (5 t/ha) + irrigation (at CRI stage) gave best results in growth parameters (plant height, number of tillers in running meter, leaf area index (LAI), dry matter accumulation) because at this stage optimum supply of soil moisture to all treatments at crown root initiation stage except control treatment. Wheat straw mulch maintenance of favourable soil moisture balance in the root zone and weed management resulting in higher growth attributes then paddy and sugarcane straw. However at 60, 90 DAS and at harvest stage, the best result in growth parameters is obtained with the application of T_5 - mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage) because when irrigation scheduled in combination with straw mulching could reduce the irrigation application. Mulching not only help in moisture conservation, weed management but after decomposition add nutrients in the soil uptake by plant help in increasing the growth parameters. Increase in growth parameters at higher moisture regimes might be due to maintenance of adequate and continuous moisture to plant which maintained good establishment of roots and various metabolic processes. Mulching help in controlling weeds and prevailing soil cover, both of which reduce water loss through decreased transpiration and evaporation. Similar results were reported by Ahmed *et al*. (2007) [1] Gupta *et al*. (2016) [5] and Singh *et al*. (2017) [13].

Effect of irrigation scheduling and mulches on yield attributes

The yield attributes characters *viz.* no. of effective tillers, no. of grains spike^{-1}, spike length, test weight were significantly influenced by irrigation scheduling and mulching treatments as compared to control treatment. Application of T_5 - mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage) recorded higher yield attributes and were at par of treatment T_8 - irrigation (at CRI, MT, J & M stage). Thus, the result indicated that increase in yield contributing characters of plots treated with application of T_5 - mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage) was due to levels of irrigation scheduling with mulching increases the soil moisture and nutrient availability to plant roots in turn, leading to higher grain yield. Similar results were reported by Sarwar *et al*. (2013) [10] and Singh *et al*. (2017) [13].

Effect of irrigation scheduling and mulches on yield

Yield is the result of co-ordinate interplay of various growth characters. Grain (q/ha) and straw yield (q/ha) were significantly influenced by different treatments. Application of T_5 - mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage) was recorded higher grain yield followed by T_8 - irrigation (at CRI, MT, J & M stage) and T_7 - mulch paddy (5 t/ha) + irrigation (at CRI & MT stage). However in case of maximum straw yield was recorded under application of T_5 -

mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage) followed by T_8 - irrigation (at CRI, MT, J & M stage) and T_7 - mulch paddy (5 t/ha) + irrigation (at CRI & MT stage). The higher yield this is due to the strongly effect of irrigation frequency and mulch on grain yield. It might be due to maintained adequate available moisture in the root zone throughout the crop growth period. Mulch being a barrier to evaporation loss maintained more moisture in the soil, which supported large no of productive shoots and enabled them to bear more grain. The minimum grain yield was recorded under control treatment due to relative soil moisture stress at critical stages and subsequently net photosynthesis reduced due to increase in rate of photorespiration resulting in decreased grain yield of wheat without irrigation scheduling and mulching. Similar results were reported by Huang *et al*. (2005) [6], Mubeen *et al*. (2013), Awasthy *et al*. (2014) [3] and Singh *et al*. (2016) [12].

Table 1: Effect of irrigation scheduling and mulches on growth attributes of wheat

Treatments	Plant height (cm)				No. of tillers (m^2)				Dry matter accumulation (g/m^2)				Leaf area index		
	30 DAS	60 DAS	90 DAS	harvest stage	30 DAS	60 DAS	90 DAS	Harvest stage	30 DAS	60 DAS	90 DAS	Harvest stage	30 DAS	60 DAS	90 DAS
T_1- Control	27.59	40.78	60.47	66.33	190.56	230.67	224.76	218.04	251.79	670.18	746.82	848.48	0.723	2.847	3.150
T_2- Mulch paddy (5 t/ha) + irrigation (at CRI stage)	31.20	62.07	85.16	90.81	216.20	351.79	290.09	271.82	268.84	713.46	836.79	966.09	0.803	3.217	3.547
T_3- Mulch wheat (5 t/ha) + irrigation (at CRI stage)	36.30	63.18	88.12	93.56	240.71	356.06	310.06	283.74	300.20	730.26	866.84	1007.11	0.903	3.320	3.653
T_4- Stubble sugarcane (2 t/ha) + irrigation (at CRI stage)	30.33	60.92	82.23	88.46	207.40	248.07	250.10	247.72	262.78	710.04	800.18	930.10	0.793	3.143	3.437
T_5- Mulch wheat (5 t/ha)+ irrigation (at CRI, MT & F stage)	35.29	70.83	99.38	105.18	234.67	400.76	360.18	324.71	290.49	800.96	1000.07	1215.08	0.873	3.997	4.303
T_6- Mulch wheat (5 t/ha) + irrigation (at CRI & MT stage)	33.20	63.43	89.20	94.43	228.67	362.04	314.90	288.09	281.82	721.78	880.28	1026.11	0.843	3.450	3.820
T_7- Mulch paddy (5 t/ha) + irrigation (at CRI & MT stage)	30.54	66.21	90.07	95.04	212.07	375.00	321.72	291.46	265.27	746.94	905.04	1030.16	0.803	3.597	4.000
T_8- Irrigation (at CRI, MT, J & M stage)	31.97	68.23	95.34	100.80	217.33	385.73	340.25	318.05	270.13	771.82	960.10	1144.74	0.810	3.800	4.203
SEm±	1.42	2.33	3.05	3.23	7.70	12.69	12.32	10.85	9.85	25.99	31.28	60.08	0.025	0.126	0.154
C.D. at 5%	4.30	7.06	9.26	9.81	23.35	38.51	37.38	32.92	29.87	78.83	94.87	182.23	0.077	0.383	0.467

Note: CRI - Crown root initiation, MT - Maximum tillering, F - Flowering, J - Jointing, M - Milking stage

Table 2: Effect of irrigation scheduling and mulches on yield attributes and yield of wheat

Treatments	No. of effective tillers (m^2)	No. of grains $spike^{-1}$	Spike length (cm)	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest Index (%)
T_1- Control	220.77	33.54	6.87	29.47	31.00	55.98	86.98	35.52
T_2- Mulch paddy (5 t/ha) + irrigation (at CRI stage)	286.09	42.11	9.13	36.14	42.74	64.81	107.55	39.73
T_3- Mulch wheat (5 t/ha) + irrigation (at CRI stage)	305.00	44.93	10.51	37.28	48.10	67.52	115.62	41.60
T_4- Stubble sugarcane (2 t/ha) + irrigation (at CRI stage)	243.43	40.51	9.12	35.22	41.32	63.54	104.86	40.02
T_5- Mulch wheat (5 t/ha) + irrigation (at CRI, MT & F stage)	345.40	55.29	12.11	45.96	60.26	75.45	135.71	44.68
T_6- Mulch wheat (5 t/ha) + irrigation (at CRI & MT stage)	309.39	46.36	10.09	39.13	53.00	67.90	121.23	43.96
T_7- Mulch paddy (5 t/ha) + irrigation (at CRI & MT stage)	314.07	49.14	10.13	41.11	56.12	69.32	125.95	44.50
T_8- Irrigation (at CRI, MT, J & M stage)	330.06	53.48	11.77	43.99	56.64	71.89	128.53	44.65
SEm±	10.32	1.68	0.64	1.38	2.27	2.38	5.13	2.15
C.D. at 5%	31.30	5.09	1.95	4.18	6.87	7.23	15.55	6.53

Note: CRI - Crown root initiation, MT - Maximum tillering, F - Flowering, J - Jointing, M - Milking stage

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