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RESEARCH PAPER

Effect of crop geometry, drip irrigation and bio-regulator on growth, yield and water use efficiency of wheat (*Triticum aestivum* L.)

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Abstract : A field experiment was conducted during *Rabi* season, 2011-12 at Niche Area Excellence Farm, Bikaner to study the effect of crop geometry, drip irrigation and bio-regulator on growth, water use efficiency and yield of wheat (*Triticum aestivum* L.). The experiment was conducted in Randomized Block Design with three irrigation schedules *viz.*, 60, 80 and 100 per cent ETc, two crop geometry levels *viz.*, 22cm paired row spacing-4 rows (120 cm lateral spacing) and 22 cm normal spacing sowing (60 cm lateral spacing) and two levels of bioregulator *viz.*, control (water spray) and thiourea (500 ppm) foliar spray twice at vegetative stage and flowering stage. The study indicated that there was increase in dry matter accumulation, plant height, grain yield and biological yield with increase in irrigation level from 60 per cent ETc to 100 per cent ETc. The study further indicated that dry matter accumulation and plant height was maximum in paired row as compared to normal planting whereas grain yield, biological yield and harvest index were maximum in normal planting as compared to paired row planting. The study indicated that dry matter accumulation significantly increase only 60 and 120 DAS and plant height at only 120 DAS with the thiourea (500 ppm) as compared to control. The study also indicated that the interaction effect of irrigation and geometry gave maximum grain yield, biological yield and WUE at 100 per cent ETc +60 cm drip line spacing, maximum harvest index at 60 per cent ETc + 60 cm drip line spacing whereas maximum WUE at 80 per cent ETc + 60 cm drip line spacing.

Key Words : Crop geometry, Drip irrigation, Bio-regulator

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INTRODUCTION

Availability of water through drip irrigation directly influence the growth and yield of wheat. Drip irrigation on wheat will gain higher yield, save more water with traditional system (GoaYang *et al.*, 2010). Drip irrigation method is very beneficial in water scarcity condition particularly in arid and semi-arid region. Drip irrigation method significantly improved yield and water use efficiency compared with level-basin irrigation method under condition of deficit water (Wang JionDlong *et al.*, 2013). Drip irrigation provide more water saving than other method of irrigation. Drip irrigation applied to wheat was more efficient with 20 per cent extra water saving in comparison with surface irrigation (Kharrou *et al.*, 2011). Crop geometry affect the growth and yield of the wheat crop. Planting geometry showed significant effect on tillering of the wheat but no improvement in grain yield (Ahmad *et al.*, 2009). Double row planting increased kernel weight significantly (4-10 %) without yield loss by moderately suppressing maximum stem number (7-14 %) and spike and

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Table A: Month wise irrigation events and irrigation water applied (mm)

Months	Irrigation events	Drip irrigation (mm)		
		60% ETc	80% ETc	100% ETc
November (15-30)	8	25.96	34.62	43.27
December	15	55.99	74.65	93.32
January	16	87.22	76.75	95.94
February	14	64.54	56.79	70.99
March (1-20)	10	93.03	52.11	65.13
Total	63	326.74	294.92	368.65

kernel number (up to 14 %) (Kato and Osawa, 2013). Application of thiourea increase total soluble protein, amino acid and chlorophyll content in wheat, this caused substantial increase in plant height, peduncle length, peduncle weight and grain weight (Ashthir *et al.*, 2013). Thiourea (500 ppm) significantly increased grain yield, straw yield and harvest index as compared to water spray (Singh *et al.*, 2013). Foliar application of thiourea at the rate 0.05 per cent recorded 5.7 per cent higher grain yield over control (Dayanand *et al.*, 2013).

MATERIAL AND METHODS

A field experiment was conducted on wheat during *Rabi* season, 2011-12 at Niche area excellence farm, Bikaner situated in arid north-western plain zone of Rajasthan. The soil was sandy loam in nature, having field capacity 6.5 per cent, PWP 1.52 per cent, bulk density 1.51 g /cc, pH (1:2) 8.4, electrical conductivity (1:2) 0.2 dS/m. The soil was very low in organic matter (0.11 %) and medium in available P (32.6 kg/ha) and high in available K (340 kg/ha). The experiment was laid out in Randomized Block Design with three replications. The treatments consisted of three irrigation levels (60, 80 % and 100 % ETc), two crop geometry levels (22cm paired row spacing -4 row in 120cm lateral drip line spacing and 22 cm normal sowing in 60 cm lateral spacing) and two bio-regulator levels (caonrol-water spray and thiourea 500ppm) foliar spray twice at vegetative and flowering stage. Wheat variety "Raj 3077" was grown with different levels of irrigation, crop geometry and bioregulators. The total irrigation water provided were 326.74, 294.92 and 368.65 mm at 60 per cent, 80 per cent and 100 per cent ETc, respectively (Table A). The total rainfall received during the wheat growing season of 2011-12 was zero. Ground water remained below 10 m throughout the growth period. There was no ground water contribution to crop. The crop was seeded at the rate of 80 kg/ha, in two crop geometries one geometry consisted of paired row -4 rows at 22 cm spacing with the 120 cm lateral spacing of drip line and other geometry of consisted of normal sowing at 22 cm spacing with the 60 cm lateral drip line spacing. The date of sowing was November 15, 2011. Plant protection measures were taken as and when required. All the cultural operations were carried out as per recommendations. The crop was harvested on March 31, 2012. The observations yield and yield attributing parameters were recorded.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Irrigation levels :

Increasing irrigation levels from 60 per cent to 100 per cent ETc under drip increased plant height and yield attributes *viz.*, ear length, effective tiller per meter length, grain per panicle and test weight (Table 1). Increased plant height and yield attributes with increasing irrigation levels through drip irrigation thus, enhanced grain yield of wheat and highest grain yield of 53.36 q /ha was recorded at 100 per cent ETc against 52.04, 36.73 and 35.82 q /ha with irrigation at 80 per cent, 60 per cent ETc through drip and surface irrigation, respectively (Table 3). GoaYang *et al.* (2010) also reported that drip irrigation on wheat will gain higher yield and save more water with traditional system.

Drip irrigation levels from 60 per cent to 100 per cent ETc saved water by 168.82 to 1.35 mm over surface irrigation which used 370 mm water. Hence, increased yield coupled with less water use in drip irrigation recorded higher water use efficiency (WUE) of 18.26, 17.64 and 14.47 kg/ ha mm at 60 per cent, 80 per cent and 100 per cent ETc, respectively against 9.68 kg / ha mm in surface irrigation. Drip irrigation applied to wheat was more efficient with 20 per cent of water saving in comparison with surface irrigation (Kharrou *et al.*, 2011). Lower water use efficiency in surface irrigation (absolute control) may be due to loss of irrigation water from sandy loam soil through deep percolation resulted in higher water use but lowered grain yield. Drip irrigation system saved quite a large amount of water, that can be useful in horizontal expansion of crop area in winter season when mostly irrigated crops are raised in Rajasthan.

Crop geometry :

The study of two crop geometry levels indicated that plant height and yield attributes (except ear length) *viz.*, effective tiller per meter length, grain per panicle and test weight increased in paired row as compared to normal sowing

at 22cm (Table 1). Increased plant height and yield attributes with paired row thus, enhanced dry matter accumulation in plant 51.0, 78.9, 180.8 and 260.5g/m length at 30, 60, 90 and 120 DAS, respectively in paired row as compared to 50.9, 67.6, 143.5 and 201.35g/m length at 30, 60, 90 and 120 DAS, respectively in normal planting but grain yield, biological yield, harvest index and water use efficiency were lower in paired row than normal planting (Table 2). Ahmed *et al.* (2009) also reported that planting geometry showed significant effect on tillering of wheat but no improvement in grain yield. Higher

Table 1 : Effect of drip irrigation, crop geometry and bioregulator on plant height and yield attributes of wheat

Treatments	Plant height at harvest (cm)	Ear length (cm)	Effective tiller/ m length	Grain / panicle	Test weight (g)
Irrigation level					
60% ETc	96.8	9.1	68.5	38.4	38.67
80% ETc	110.5	10.0	78.1	42.1	39.86
100% ETc	112.4	10.5	79.3	42.8	40.26
Control (Surface irrigation)	95.6	9.0	69.8	38.8	37.54
S.E. ±	0.04	0.02	0.05	0.03	0.05
C.D. (P=0.05)	0.12	0.06	0.15	0.09	0.15
Crop geometry					
Paired rows : 4 rows at 22 cm spacing (drip lines at 120 cm spacing)	107.4	9.6	79.9	42.3	40.08
Normal sowing at 22 cm spacing (60 cm drip line spacing)	105.6	10.1	70.7	39.9	39.10
S.E. ±	0.03	0.01	0.04	0.02	0.04
C.D. (P=0.05)	0.10	0.03	0.12	0.06	0.12
Bioregulator thiourea					
Water spray	105.7	9.8	74.9	41.2	39.06
500 ppm spray at vegetative and flowering stages	106.3	9.9	75.7	41.0	40.12
S.E. ±	0.03	0.01	0.04	0.02	0.05
C.D. (P=0.05)	0.10	0.03	0.12	0.06	0.15

Table 2 : Plant height and dry matter accumulation at different stages of growth of wheat

Treatments	Dry matter accumulation (g/m length)				Plant height (cm)		
	30DAS	60DAS	90 DAS	120 DAS	30 DAS	75 DAS	120 DAS
Irrigation level							
60% ETc	36.4	52.6	114.7	165.3	48.0	70.4	96.4
80% ETc	55.9	80.4	179.5	255.8	53.5	80.5	108.2
100% ETc	60.5	86.8	192.3	271.6	54.0	81.2	109.3
Control (Surface irrigation)	38.5	53.5	115.8	166.8	39.1	61.1	94.3
S.E. ±	1.2	1.3	1.5	1.4	0.8	0.9	1.0
C.D. (P=0.05)	3.4	3.7	4.2	4.1	2.3	2.6	2.9
Crop geometry							
Paired rows : 4 rows at 22 cm spacing (drip lines at 120 cm spacing)	51.0	78.9	180.8	260.5	53.2	82.0	108.6
Normal sowing at 22 cm spacing (60 cm drip line spacing)	50.9	67.6	143.5	201.3	50.5	74.7	100.7
S.E. ±	1.1	1.2	1.2	1.2	0.7	0.8	0.9
C.D. (P=0.05)	NS	3.4	3.5	3.5	2.1	2.4	2.6
Bioregulator thiourea							
Water spray	50.7	73.5	161.4	228.5	51.5	77.6	103.8
500 ppm spray at vegetative and flowering stages	51.1	74.0	162.9	233.3	52.2	79.0	105.5
S.E. ±	1.1	1.2	1.2	1.2	0.7	0.8	0.9
C.D. (P=0.05)	NS	1.4	NS	3.5	NS	NS	2.6

NS= Non-significant

Table 3 : Effect of drip irrigation, plant geometry and bio-regulators on wheat

Treatments	Grain yield (q/ha)	Biological yield (q/ha)	Harvest index (%)	Water use (mm)	WUE (kg/ha-mm)
Irrigation level					
60% ETc	36.73	89.29	41.13	201.18	18.26
80% ETc	52.04	115.74	44.96	294.92	17.64
100% ETc	53.36	121.33	43.97	368.65	14.47
Control (Surface irrigation)	35.82	100.95	35.48	370.00	9.68
S.E. ±	0.47	0.86			
C.D. (P=0.05)	1.46	2.65			
Crop geometry					
Paired rows : 4 rows at 22 cm spacing (drip lines at 120 cm	41.10	95.28	43.13	288.25	14.26
spacing)	53.65	122.29	43.86	288.25	18.61
Normal sowing at 22 cm spacing (60 cm drip line spacing)					
S.E. ±	0.38	0.70			
C.D. (P=0.05)	1.19	2.16			
Bioregulator thiourea					
Water spray	46.01	107.55	42.78	288.25	15.96
500 ppm spray at vegetative and flowering stages	48.74	110.02	44.30	288.25	16.91
S.E. ±	0.38	0.70			
C.D. (P=0.05)	1.19	2.16			
Irrigation and spacing interaction					
60% ETc + 60 cm drip line spacing	37.70	96.65	48.04	201.18	18.74
60% ETc + 120 cm drip line spacing	35.75	81.93	40.72	201.18	17.77
80% ETc + 60 cm drip line spacing	60.75	128.03	43.41	294.92	20.60
80% ETc + 120 cm drip line spacing	43.32	103.45	35.07	294.92	14.68
100% ETc + 60 cm drip line spacing	62.49	142.20	38.57	368.65	16.95
100%ETc + 120 cm drip line spacing	44.22	100.47	27.25	368.65	12.00
S.E. ±	0.67	1.21			
C.D. (P=0.05)	2.06	3.75			

grain yield was recorded 53.65 q/ha in normal planting as compared to 41.10 q/ha in paired row. Higher biological yield which was reported 122.29 q/ha in normal planting as compared to 95.28 q/ha. Higher water use efficiency was also reported 18.61 kg/ha-mm in normal planting as compared to 14.26 kg/ha-mm in paired row planting.

Bio-regulator :

Foliar spray of thiourea at vegetative and flowering stages recorded higher plant height and yield attributes *viz.*, ear length, effective tiller per meter length, grain per panicle and test weight than control (Table 1). Higher yield attributes in turn improved grain yield, biological yield and harvest index. Higher grain yield (48.47 q/ha) of wheat was recorded with 500 ppm spray as compared to water spray-control (46.01q/ha) (Table 3). Dayanand *et al.* (2013) also reported that application of thiourea at the rate of 0.05 per cent recorded 5.7 per cent higher grain yield over control. Higher biological yield (110.02q/ha) was recorded with the spray of thiourea as compared to control-water spray (107.55q/ha). Similarly higher harvest index (44.30 %) was recorded with the spray of thiourea as compared to control-water spray (42.78 %). Thiourea (500ppm) significantly increased grain yield, straw yield and harvest index as compared to water spray (Singh *et al.*, 2013).

Irrigation and crop geometry interaction :

Irrigation × crop geometry interaction was found significant statistically. The study indicated that 60cm drip line spacing with 60 per cent, 80 per cent and 100 per cent ETc levels gave yield of wheat 37.70, 60.75 and 62.49 q/ha, respectively. Whereas, 120 cm drip line spacing with 60 per cent, 80 per cent and 100 per cent ETc levels gave yield of wheat 35.75, 43.32 and 44.22 q/ha, respectively. Irrigation at 60 per cent ETc and drip line spacing of 120 cm and 60 cm gave at par yield. However, at higher level of irrigation *i.e.* 80

and 100 per cent ETc 60cm drip line spacing gave higher grain yield (Table 3).

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