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EFFECT OF CROP GEOMETRY AND DRIP IRRIGATION LEVELS ON PEARL MILLET (*PENNISETUM GLAUCUM*)

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SUMMARY

A field experiment was conducted during **kharif** 2012 at Niche Area Excellence Farm, S. K. Rajasthan Agricultural University, Bikaner to study the effect of crop geometry and drip irrigation levels on pearl millet (*Pennisetum glaucum*). The treatments consisted of three drip irrigation schedules viz., 40, 60 and 80 per cent ETc, three crop geometry viz., normal sowing in 60 cm drip line spacing, paired row sowing at 120 cm drip line spacing and normal sowing at 120 cm drip line spacing and a control with surface irrigation in normal sowing. The experiment was conducted in randomized block design and replicated thrice. The study indicated that there was increase in yield attributes, seed, straw and biological yield with increase in irrigation levels from 40 to 80 per cent ETc and 60 and 80 per cent ETc gave at par yield but superior to surface irrigation. The study further revealed that highest water use efficiency was recorded with drip irrigated crop as compared to surface irrigated crop. Crop geometry also significantly influenced the seed yield, straw yield, biological yield and water use efficiency. Highest seed yield, straw yield, biological yield and water use efficiency were recorded with normal sown crop at 60 cm drip line spacing which was at par with paired row sown crop at 120 cm drip line spacing.

Key words : Drip irrigation, crop geometry, pearl millet, seed yield, water use efficiency

Pearl millet is an important coarse grain cereal generally grown as rainfed crop on marginal lands under low input management conditions. It is adapted to drought and poor soil fertility, but responds well to good management and higher fertility levels. It is generally cultivated in area where rainfall ranges from 150 to 600 mm. It is a dual purpose crop. Its grain is used for human consumption and its fodder as cattle feed. Rajasthan ranks first in area (46 lakh ha) and production (28 lakh tonnes) and constitutes about 50 per cent area and 42 per cent production of pearl millet in the country. Average productivity of pearl millet in Rajasthan is 400 kg/ha. Rajasthan, particularly western region, comes under hyper arid zone with very scarce water resource and scanty and erratic rainfall. The arid climate is quite extreme with temperature as high as near about 49° C and lowest as low as 0°C. Thus, production of any crop is very meagre in this climatic condition. However, by maintaining adequate moisture content (nearer to field capacity), crops can be grown. Drip irrigation maintains moisture content at near about field capacity on one hand and eliminates water losses on the other hand. Thus, drip system would be the most effective tool in increasing yield as well as water use efficiency in even close growing crop (GaoYang *et al.*, 2010). Further, drip irrigation proved to be effective in improving yield and water use efficiency compared to level-basin irrigation method even under condition of deficit water (Wang Jian Dong *et al.*, 2013). However, modifying crop geometry and using wider spacing between two drip lines can make pearl millet growing under drip system economically feasible. Change of crop geometry brings about the change in growth and yield of wheat under drip system (Ahmad *et al.*, 2009; Kato and Osawa, 2013).

MATERIALS AND METHODS

A field experiment was conducted on pear millet during **kharif** season of 2012 at Niche area excellence farm, S. K. Rajasthan Agricultural University, Bikaner situated in arid western hyper arid zone of Rajasthan. The soil was sandy loam in nature, having field capacity 6.60 per cent, PWP 1.92 per cent, bulk density 1.52 g/

cc, pH (1 : 2) 8.3 and electrical conductivity (1 : 2) 0.2 dS/m. The soil was very low in organic matter (0.13%) and medium in available P (32.6 kg/ha) and high in available K (352 kg/ha). The experiment was laid out in randomized block design with three replications. The treatments consisted of three irrigation levels (40, 60 and 80% ETc), three crop geometry levels (normal sowing in 60 cm drip line spacing, normal sowing in 120 cm drip line spacing and paired row sowing in 120 cm drip line spacing) and control (surface irrigation). The total irrigation water provided was 261.48, 292.31 and 323.15 mm at 40, 60 and 80 per cent ETc, respectively (Table 1). Rainfall received during the crop growing season was 174.8 mm. Ground water was below 10 m throughout the growth period. Pearl millet variety RHB 173 was sown using seed rate of 4 kg/ha as per crop geometry on July 15, 2012 and harvested on October 17, 2012. All the cultural operations were carried out as per recommendations.

RESULTS AND DISCUSSION

Irrigation Levels

Increasing irrigation levels from 40 to 80 per cent ETc under drip increased plant height, dry matter

TABLE 1
Month-wise irrigation events and irrigation water applied (mm)

Month	No. of irrigation events	40% ETc	60% ETc	80% ETc
July (15-31)	2	5.28	7.92	10.56
August (5 days)	5	24.08	36.11	48.15
Sept. (20 days)	10	27.52	41.28	55.04
Oct. (10 days)	5	4.80	7.20	9.60
Total	22	61.68	92.51	123.35
Irrigation after sowing	1	25.00	25.00	25.00
Rainfall	-	174.80	174.80	174.80
Total	-	261.48	292.31	323.15

TABLE 2
Effect of drip irrigation levels and drip line spacing on yield attributes of pearl millet

Treatment	Height (cm)	No. of tillers	Ear length (cm)	Test weight (g)	Dry matter accumulation (g/ plant)		
					30 DAS	55 DAS	80 DAS
Irrigation levels							
40% ETc	159.22	2.84	28.33	10.5	2.74	14.41	91.22
60% ETc	201.11	5.70	33.33	12.6	3.80	32.51	203.22
80% ETc	207.22	5.76	34.77	12.8	4.10	34.00	204.88
S. Em±	1.65	0.08	0.46	0.07	0.07	0.76	1.43
C. D. (P=0.05)	7.49	0.38	2.09	NS	0.33	3.45	6.52
Crop geometry							
60 cm drip line (60 cm row spacing)	196.88	4.92	33.44	12.4	3.81	27.87	169.22
120 cm paired row (45 x 75 cm)	189.44	4.77	31.66	12.3	3.61	27.16	165.55
120 cm drip line (60 cm spacing)	181.22	4.61	31.33	12.2	3.22	25.87	164.55
S. Em±	1.65	0.08	0.46	0.07	0.07	0.76	1.43
C. D. (P=0.05)	7.49	2.96	29.66	NS	3.36	16.06	97.33
Surface irrigation (60 cm row spacing)	160.00	0.38	2.09	10.2	3.27	15.90	95.67
S. Em±	1.59	0.08	0.45	0.06	0.05	0.71	1.41
C. D. (P=0.05)	7.49	0.24	1.31	NS	0.22	2.12	4.11

NS–Not Significant.

accumulation and yield attributes viz., ear length, number of tillers and test weight (Table 2). Increased plant height and yield attributes with increasing irrigation levels through drip irrigation, thus enhanced grain, straw and biological yield of pearl millet and highest grain (25.06 q/ha), straw (112.61 q/ha) and biological yield (137.67 q/ha) was recorded at 80 per cent ETc. However, drip irrigation at 60 per cent ETc also gave at par seed, straw and biological yield with 80 per cent ETc (Table 3). This finding is in confirmation with that of Godara *et al*. (2013), who reported maximum plant height, dry matter of plant, seed and biological yield of fennel recorded with full ETc under drip irrigation.

Drip irrigation levels from 40 to 80 per cent ETc saved water by 93.32 to 31.65 mm over surface irrigation which used 354.8 mm water. Hence, increased yield coupled with less water use in drip irrigation and recorded higher water use efficiency (WUE) of 4.92, 8.35 and 7.98 kg/ha/mm at 40, 60 and 80 per cent ETc, respectively, against 3.53 kg/ha/mm in surface irrigation. Kharrou *et al*. (2011) reported that drip irrigation applied to wheat was more efficient and saved 20 per cent of water in comparison to surface irrigation. Rajbir Singh *et al*. (2009) also reported that water use efficiency was highest under drip irrigation as compared to surface irrigation. Lower water use efficiency in surface irrigation (absolute control) may be due to loss of irrigation water from sandy loam soil through deep percolation which resulted in higher water use but lowered grain yield.

Crop Geometry

The study of crop geometry levels indicated that plant height, dry matter accumulation and yield attributes viz., number of tillers and ear length increased in normal sown crop at 60 cm drip line spacing, which was at par with paired row sown crop at 120 cm drip line spacing (Table 2). Increased plant height and yield attributes with normal sown crop at 60 cm drip line spacing, thus, enhanced grain, straw and biological yield of pearl millet and highest grain (21.73 q/ha), straw (99.60 q/ha) and biological yield (121.33 q/ha) was recorded at normal sown crop at 60 cm drip line spacing. However, paired row sown crop at 120 cm drip line spacing also gave at par grain, straw and biological yield with normal sown crop at 60 cm drip line spacing (Table 3). Proper crop geometry facilitates sufficient interception of sunlight and satisfactory absorption of nutrients and water from the soil due to proper development of root system (Annadurai *et al*., 2009).

Among different crop geometries the total 'water use' was same. However, the water use efficiency in different geometries showed significant variation (Table 3). Highest water use efficiency was recorded with normal sown crop at 60 cm drip line spacing (7.60 kg/ha/mm). It may be due to increased evaporation with increased row spacing and increased transpiration with decreased row spacing. Thus, the narrow row spaced crop reduced soil evaporation, which

TABLE 3
Effect of drip irrigation levels and crop geometry on yield, water use and water use efficiency of pearl millet

Treatment	Grain yield (q/ha)	Biological yield (q/ha)	Straw yield (q/ha)	Harvest index (%)	Water use (mm)	WUE (kg/ha-mm)
Irrigation levels						
40% ETc	13.20	80.11	66.91	16.48	261.48	4.92
60% ETc	23.81	132.84	109.03	17.92	292.31	8.35
80% ETc	25.06	137.67	112.61	18.20	323.15	7.98
S. Em±	0.31	1.40	1.09	-	-	-
C. D. (P=0.05)	1.40	6.35	4.95	-	-	-
Crop geometry						
60 cm drip line (60 cm row spacing)	21.73	121.33	99.60	17.91	292.31	7.60
120 cm paired row (45 x 75 cm)	20.32	118.84	98.52	17.10	292.31	7.10
120 cm drip line (60 cm spacing)	20.01	110.44	90.43	18.12	292.31	6.87
S. Em±	0.31	1.40	1.09	-	-	-
C. D. (P=0.05)	1.40	6.35	4.95	-	-	-
Surface irrigation (60 cm row spacing)	12.40	85.00	72.60	14.59	354.8	3.53
S. Em±	0.40	1.78	1.41	6.57	-	-
C. D. (P=0.05)	1.24	5.45	4.35	19.75	-	-

in turn recorded improved water use efficiency (Chen Su Yin *et al*., 2010).

Interaction Effect of Crop Geometry and Drip Irrigation

Irrigation x crop geometry interaction was found significant statistically. The study indicated that 60 cm drip line spacing with 40, 60 and 80 per cent ETc levels gave yield of pearl millet 15.5, 25.13 and 26.06 q/ha, respectively. However, paired row sown crop at 120 cm drip line spacing with 60 and 80 per cent ETc levels pearl millet gave 24.50 and 25.80 q/ha grain yield, respectively, which was at par with normal sown crop at 60 cm drip line spacing at 60 and 80 per cent ETc. It is, thus, concluded that under the interaction of 80 per cent ETc+60 cm drip line spacing gave maximum yield (26.06 q/ha) as compared to other interaction effects (Table 4). This is confirmatory with Tekale *et al.* (1999), who reported that interaction effect of irrigation scheduling at 0.8 ETc with normal planting by drip method increased the yield of cotton significantly over the rest combinations.

TABLE 4
Interaction effect of irrigation levels and drip spacing on grain yield (q/ha) of pearl millet

Crop geometry/ irrigation level	60 cm drip line (60 cm row spacing)	120 cm paired row (45 x 75 cm)	120 cm drip line (60 cm spacing)
40% ETc	15.50	12.00	11.16
60% ETc	25.13	24.50	23.60
80% ETc	26.06	25.80	25.56
S. Em±	0.54	C. D. (P=0.05)	2.46

REFERENCES

Ahmad, Z. I., Ansar Muhammad, Iqbal Muhammad, and N. M. Minhas. 2009 : Effect of different planting geometry and wheat straw mulch on performance of wheat under rainfed conditions of pothowar. *Pak. J. Agric. Res.*, **22** : 112-115.

Annadurai, Naveen Puppala, Sangu Angadi, and P. Masilamani. 2009 : Agronomic management for peanut production. *Agric. Rev.*, **30** (No. 4).

Chen Su Yin, Zhang Xi Ying, Sun Hong Yong, Ren Tu Sheng, and Wang Yan Mei. 2010 : Effect of winter wheat row spacing on evaporation, grain yield and water use efficiency. *Agric. Water Manage*., **97** : 1126-1132.

Gao Yang, Ren Zhi Bin, Duan Rui Ping, Zhuang Wei Min, Huang Jian Guo, and Wang Rong Dong. 2010 : Planting technique for spring wheat with saving water, high yield and high efficiency under drip irrigation system. *Xinjiang Agric. Sci.*, **47** : 281-284.

Godara, S. R., I. M. Verma, J. K. Gaur, Bairwa Suresh, and P. K. Yadav. 2013 : Effect of different levels of drip irrigation along with various fertigation levels on growth, yield and water use efficiency in fennel (*Foeniculum vulgare* Mill.). *Asian J. Hort.*, **8** : 758-762.

Kato, Y., and M. Osawa. 2013 : Manipulation of the availability of assimilates for kernel growth in wheat in Japan : Effects of crop thinning and planting geometry. *European J. Agron.*, **49** : 74-82.

Kharrou, M. H., S. Er-Raki, A. Chehbouni, B. Duchemin, V. Simonneaux, M. Le Page, L. Ouzine, and L. Jarlan. 2011 : Water use efficiency and yield of winter wheat under different irrigation regimes in a semi-arid region. *Agric. Sci.*, **2** : 273-282.

Rajbir Singh, Satyendra Kumar, D. D. Nangare, and M. S. Meena. 2009 : Drip irrigation and black polyethylene mulch influence on growth, yield and water use efficiency of tomato. *African J. Agric. Res.*, **4** : 1427-1430.

Tekale, D. D., R. K. Patil, M. R. More, R. G. Nadre, and V. G. Vaishnav. 1999 : Yield response of cotton cv. NHH-44 to varying depths of irrigation through drip under differential planting geometry. *J. Soils and Crops*, **9** : 174-177.

Wang Jian Dong, Gong Shihong, Xu Di, Yu Yingduo, and Zhao Yuefen. 2013 : Impact of drip and level-basin irrigation on growth and yield of winter wheat in the North China Plain. *Irrigation Sci.*, **31** : 1025-1037.