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Growth, yield and economics of pearlmillet (*Pennisetum glaucum* L.) under custard apple (*Annona squamosa* L.) influenced by land configuration practices

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Abstract
A field experiment was conducted at Agronomy Research Farm of Rajiv Gandhi South Campus Banaras Hindu University, Barkachha, Mirzapur Utter Pradesh, during *kharif* season of 2017-18, to study the Growth, yield and economics of pearlmillet (*Pennisetum glaucum* L.) under custard apple (*Annona squamosa* L.) are influenced by land configuration practices on a sandy clay loam soil at Agronomy Research Farm, Institute of Agricultural Sciences, RGSC, Mirzapur, UP, India. The investigation was carried out in a simple randomized design with 3 replications. The treatment comprised of 10 land configuration practices (T_1 - Flat bed line sowing, T_2 - Furrow sowing, T_3 - Ridge bed sowing, T_4 - Flat bed broadcasting, T_5 - Dibbling sowing method, T_6 - Spade sowing method T_7 - Broad bed and furrow (BBF) sowing method, T_8 - Raised bed sowing method, T_9 - Ridge two side sowing method and T_{10} - Traditional sowing method). Furrow sowing was significantly superior over other land configuration practices in terms of growth parameter, yield attributes and yield as well as economics of crop cultivation.

Keywords: Pearlmillet, land configuration, growth and yield, economics

Introduction
Pearlmillet is a major warm season coarse grain cereal grown on 26 million ha in semi - arid tropical environments of Asia and Africa. India is the largest producer of pearlmillet, both in term of area (7.12 million ha) and production (8.06 million tonne), with an average productivity of 1132 kg ha^{-1}. As compared to the early 1980s, pearlmillet area in India declined by 26 per cent during 2015-16. The major pearlmillet growing states in India are Rajasthan, UP, Haryana, Gujarat and Maharashtra. It is cultivated in the sandy, infertile soil and droughty environments where no other cereal crop can survive. Even under these condition, pearlmillet yields 500-800 kg ha^{-1} of grain, (AICRPP-2017). Generally, pearlmillet production is affected by different factors *viz.* soil type, land configuration, sowing time, seed bed, varieties, spacing, and quality of water, judicious use of water as well as nutrients, weed, insect and disease management. Among them time of sowing and land configuration play a vital role for pearlmillet cultivation. The modification of surface configuration technology did not significant influenced on plant stand at 30 days after sowing (DAS) and harvest, and plant height at 30, 60 DAS and at harvest. Dry matter accumulation at 30, 60 DAS and at harvest, number of tiller $plant^{-1}$ were highly influenced by the modification in surface configuration as ridge and furrow (Parihar *et al*. 2012) [9]. Parihar *et al*. (2010) [10] reported that mustard sown on re-shaped ridge and furrow of preceding pearlmillet recorded higher plant height and yield attributes and yield over flat sowing in both the years of experiment. Sharma *et al.* (2014) reported that the crop growth characteristics i.e. plant height; dry matter accumulation, ear length and grain yield were significantly affected by different land configuration methods. Maximum plant height (197.43 cm) was recorded in ridge sowing, while the lowest plant height (176.73 cm) was recorded in broadcast method. As regards plant dry matter accumulation, and ear length, the trend of the results were similar to that noted in plant height. The results indicate that the treatments namely ridge bed patterns provided favorable environment, where water was used more efficiently, and resulted in better vegetative growth.

Material and method
The experiment was carried out at Agricultural Research Station (RGSC), Institute of Agricultural Sciences, Banaras Hindu University Barkachha Mirzapur Uttar Pradesh, during *kharif* 2017-18.

Soil was sandy clay loam, organic carbon (0.39%), pH - 5.5, electrical conductivity (0.30 dsm^{-1}), and available nitrogen (194.67 kg ha^{-1}), available P (16.76 kg ha^{-1}), available K (183.25 kg ha^{-1}). In Vindhya region growing millets crop (pearlmillet) with custard apple, are more suitable under the agri-horti system. The experiment laid out in Simple random block design with 10 treatment and three replication of land practices *viz*. T_1 - Flat bed line sowing, T_2 - Furrow sowing method, T_3 - Ridge bed sowing method, T_4 - Flat bed broadcasting, T_5 - Dibbling sowing method, T_6 - Spade sowing method T_7 - BBF sowing method, T_8 - Raised bed sowing method, T_9 - Ridge two side sowing method and T_{10} - Traditional sowing method. Pearlmillet variety "Kaveri Super Boss" was sown on 5th August 2017-18 by the spade and *kudali* with seed rate of 5.0 kg ha^{-1} and harvested on 4th November of 2017-18. Half dose of nitrogen and full dose of phosphorus and potash were applied as basal dressing and remaining dose of nitrogen as top dressing after first irrigation. Other cultural practices such as weeding, thinning, and gap filling etc. were applied after 22 DAS of sowing of pearlmillet crop. The crop was fully raised as rainfed crop. The five plants in each plot were randomly selected and tagged and were subsequently used for recording growth parameters (at 30, 60 DAS and at harvest) and yield attributes by adopting standard procedures. The crop from net plots after discarding border area plants was harvested and used for recording grain, straw and biological yield. To workout the economics of the treatments, the cost of inputs involved in crop and output price were used as per local market and accordingly cost of cultivation, gross returns, net returns and B:C ratio were calculated. Data obtain from pearlmillet crop was statistically analyzed by using the F - test as per the procedure given by Gomez and Gomez (1984), CD at P = 0.05 were used to determine the significance differences between average data of treatment.

Result and Discussion

Effect of various land configuration practices on growth and development of pearlmillet

The crop growth characteristics *i.e.* plant height; dry matter accumulation, no. of tiller $plant^{-1}$, no. of leaves and ear length were significantly affected by different treatments. Maximum plant height (214.73 cm) was recorded in furrow sowing, while the lowest plant height (173.19 cm) was recorded in flat bed broadcast [Table -1]. As regards plant dry matter accumulation, No. of tiller $plant^{-1}$, and ear length, the trend of the results were similar to that noted in plant height. This might be due to maintenance of proper air moisture regimes under furrow sowing which might have improved the drainage resulting in good supply of required moisture, available nutrients, soil aeration, soil environment and better growth and development. Our results are in agreement with the research findings of Verma *et al.* (2017), Deshmukh *et al.* (2016), Kanvar *et al.* (2017) Parihar *et al*. (2012) [9] and Om *et al.* (2013) [11].

Effect of various land configuration practices on yield and yield attributes of pearlmillet

The yield attributes and yield significantly influenced by various land configuration practices. The higher values of these characters *viz;* length of panicle (23.60 cm), girth of panicle (9.34 cm), no. of grains $panicle^{-1}$ (1786.13), test weight (11.41 g), grain yield (17.73 q ha^{-1}) and straw yield (51.10 q ha^{-1}) were recorded under furrow sowing method (T_2), higher yield attributes and yield with furrow sowing method of land configuration was due to it is facilitate aeration and proper water supply and better root growth but the difference with other treatments are not found significant [Table - 2]. Our results are in agreement with the research findings of Kantwa *et al*. (2006), Parihar *et al.* (2010) [10], Verma *et al*. (2017), Kuotsu *et al*. (2014) [8] and Om *et al.* (2013) [11].

Economics

The land configuration practices, furrow sowing recorded maximum gross income (□ 78923.50 ha^{-1}), net return (□ 58968.9 ha^{-1}) and benefit: cost ratio (2.96 ha^{-1}) followed by ridge bed sowing and BBF sowing recorded grass income (□ 77292.50 ha^{-1}, □ 76630.50 ha^{-1}), net return (□ 57337.9 ha^{-1}, □ 56675.9 ha^{-1}) and benefit: cast ratio (2.87, 2.84) respectively, minimum gross income (□ 75301.50 ha^{-1}), net return (□ 55546.9 ha^{-1}) and benefit: cost ratio (2.81) were recorded with flatbed broadcasting. Our findings in conformity with the findings of Deshmukh *et al.* (2013), Verma *et al.* (2018) [14], Parihar *et al.* (2009) and Sharma *et al.* (2016).

Table 1: Effect of various land configuration practices on growth and development of pearlmillet crop

Treatment	Plant height (cm)			Number of leaves $plant^{-1}$			Number of tiller $plant^{-1}$			Dry matter accumulation (g)		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
T_1	90.6	170.66	176.53	8.73	11.86	10.57	1.06	1.26	1.43	5.13	45.29	61.13
T_2	116.6	212	214.73	10.33	13.33	12.85	1.4	2.73	2.90	6.01	53.25	71.90
T_3	110.4	202.26	209.53	9.96	12.66	11.59	1.2	2.06	2.40	5.37	51.32	69.63
T_4	103.86	176.46	178.19	8.26	11	10.42	0.73	0.73	1.20	4.71	41.26	58.11
T_5	106.05	176.26	185.13	9.66	11.86	11.24	0.93	1.4	1.93	4.66	45.03	64.12
T_6	103.64	175.66	177.26	9.06	11.86	11.32	0.93	1.26	1.60	5.03	42.57	62.26
T_7	115.66	185.4	190.20	9.96	12.8	11.87	1.53	2.46	2.60	5.98	52.42	68.84
T_8	111.86	196.86	184.86	9.93	12.26	11.53	1.26	1.86	2.13	5.80	53.37	66.502
T_9	109.53	193.73	196.6	10.1	12.2	11.47	0.93	1.33	1.86	5.51	48.34	63.46
T_{10}	109.73	163.4	176.33	8.86	11.33	11.21	0.73	0.93	1.93	4.66	41.43	60.79
SEm ±	6.38	12.63	12.07	0.59	0.26	0.33	0.175	0.133	0.20	0.61	0.91	1.02
CD (*P =0.05*)	18.97	37.54	35.88	1.76	0.78	0.921	0.520	0.395	0.60	1.81	2.68	3.04

Table 2: Effect of various land configuration practices on yield of pearlmillet crop

Treatment	Length of panicle	Girth of panicle	No. of grain panicle^{-1}	Test weight	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
T_1	21.16	7.99	1589.68	10.29	15.99	45.75	61.74	25.01
T_2	23.60	9.34	1786.13	11.41	17.73	51.10	68.30	25.09
T_3	21.32	8.64	1760.82	11.15	16.30	48.39	64.90	25.20
T_4	19.65	7.14	1576.85	9.73	15.14	44.73	59.86	25.29
T_5	21.62	8.31	1648.76	10.69	16.95	46.90	63.85	26.55
T_6	20.73	8.18	1612.63	10.28	15.51	45.29	60.47	25.10
T_7	22.12	8.89	1778.56	11.29	16.24	47.81	64.05	25.35
T_8	22.94	8.48	1681.22	10.92	16.27	47.89	64.16	25.36
T_9	20.53	8.05	1632.43	10.31	15.82	45.98	61.80	25.59
T_{10}	19.69	7.54	1558.53	10.03	15.19	48.63	63.80	24.79
SEm $\pm$	9.28	0.19	43.72	0.089	0.33	0.96	1.23	0.17
CD (*P=0.05*)	27.59	0.56	133.42	0.265	0.98	2.64	3.68	0.53

Table 3: Effect of various land configuration practices on economic of pearlmillet under custard apple based agri-horti systems

Treatment	Cost of cultivation (□ ha^{-1})	Pearlmillet yield (□ ha^{-1})	Custard apple (fruit) (□ ha^{-1})	Total gross return (□ ha^{-1})	Net return (□ ha^{-1})	Benefit: cost ratio
T_1	19754.6	44773.00	31220	75993.00	56238.40	2.84
T_2	19954.6	47703.50	31220	78923.50	58968.90	2.96
T_3	19954.6	45410.50	31220	76630.50	56675.90	2.84
T_4	19954.6	44081.50	31220	75301.50	55546.90	2.81
T_5	20074.6	45668.00	31220	76888.00	56813.40	2.83
T_6	19954.6	45870.00	31220	77090.00	57135.40	2.85
T_7	19954.6	46072.50	31220	77292.50	57337.90	2.87
T_8	19954.6	45142.00	31220	76362.00	56407.40	2.82
T_9	19954.6	45630.00	31220	76850.00	56895.40	2.85
T_{10}	19754.6	44909.00	31220	76129.00	56374.4	2.84

Conclusion

It is concluded that furrow sowing method of land configuration practice were the best for enhancing growth of pearlmillet *viz.* [Plant height (214.35 cm), number of leaves plant^{-1} (12.25), number of tillers plant^{-1} (2.46), dry matter weight (106.62 g)], yield attributes [Panicle girth (10.55), panicle length (18.25), grain panical^{-1} (1260.25), test weight (12.39 g)], yield [grain yield (1824.27 kg ha^{-1}), straw yield (5761.62 kg ha^{-1})] and economics in terms of highest net returns (□ 52918 ha^{-1}), and B: C ratio (3.12)] was also observed in furrow sowing method.

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