International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(5): 1813-1816

Received: 19-07-2019
Accepted: 21-08-2019

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Influence of land configurations and integrated nutrient management on growth and growth attribute of pearl millet (*Pennisetum glaucum* L.) under rainfed conditions

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Abstract
An experiment entitled "Influence of land configurations and integrated nutrient management on pearl millet (*Pennisetum glaucum* L.) under rainfed conditions" was conducted during *kharif* season of the year 2016 at Bajra Research Scheme Farm, College of Agriculture, Dhule (Maharashtra).
The experiment was laid out in split plot design with three replications. There were twelve treatment combinations. Three treatments of land configurations *viz*., flat bed, ridges and furrow and broad bed furrow assigned in main plots and four treatments of nutrient management *viz*., RDF (60:30:30 kg NPK ha^{-1}), RDF + 5 t FYM ha^{-1}, 50% RDF + 50% RDN through FYM and 100% RDN through FYM in sub plots. In general, the close scrutiny of the data revealed that, at harvest growth attributes like maximum plant population, plant height, number of functional leaves, leaf area, dry matter and total numbers of tillers per plant were found to be superior in broad bed furrow and were on par with ridges and furrow.

Keywords: Land configurations, integrated nutrient management, growth attribute, *Pennisetum glaucum* L.

Introduction
The main aim of this research to enhanced the sustainable crop production under rainfed condition. Pearl millet (*Pennisetum glaucum* L.) is the world's hardiest warm season cereal crop. It is considered to be a poor man's food as it provides staple food for the poor in a short period. Pearl millet grain is nutritionally better than many cereals as it is a good source of protein having higher digestibility (12.1%), fats (5%), and high levels of iron, zinc and insoluble dietary fibers and is the major source of dietary carbohydrates (69.1%) in the human diet. Its stover is an important component of livestock ration during the dry period of the year. Its stalk is used as fuel and for packing of fruits (Khairwal and Rai, 2006) [6].
Although pearl millet can respond to good moisture availability during its growth, it is nevertheless one of the toughest, drought tolerant crops available and has a distinct advantage over competing crops in the regions where there is scanty and erratic rainfall and high temperatures (Reddy *et al*., 2013) [22].
For getting a sustainable crop production system under rained condition, the conservation of rain water and its efficient recycling are imperative. The rainwater can be carried out either through tillage or land surface management practices like raised and sunken bed, ridge and furrow developed for Vertisols, broad bed and furrow (BBF) system is very promising in controlling surface runoff, reducing the soil loss through erosion and increasing infiltration (Pathak *et al.*, 1985 [18]; Singh *et al.*, 1999) [26].
Land configuration increases water use efficiency as reported by Chiroma *et al.* (2008) [2] and also increases availability of nutrients to crops. Land configuration decides the effectiveness of the crop management practices regarding application of nutrient, irrigation, weed management, *etc.* Different techniques of land configuration showed remarkable influence on crop growth. Significant differences in plant height, leaf area index, dry matter accumulation and number of effective tillers per plant at different growth stages of crop was observed due to the effect of various methods of land configuration. Proper land configuration to the climatic conditions of the region *viz.*, heavy rainfall area or drought prone areas or area with salinity hazards will act as management practice to the crop. In medium black soil, land configuration can play a vital role by providing easy and uniform germination as well as good growth and development of plants. The superiority of ridges and furrow system could be ascribed to proper drainage of

excess water coupled with adequate aeration at the time of heavy rainfall. Parihar *et al*. (2009) [16] reported that ridges and furrow sowing method improved grain as well as stover yield of pearl millet over the flat bed method.

Materials and Methods

This experiment was carried out during the *kharif* season of the year 2016 at Bajra Research Scheme Farm, College of Agriculture, Dhule (M.S.)

The experiment involving hybrid 'Aadishakti (DHBH 9071)' was laid out in split-plot design replicated thrice, comprising three land configuration (L_1-flat bed, L_2- ridges and furrow and L_3- broad bed furrow) as a main plot and four nutrient management levels (N_1- DF (60:30:30 kg NPK ha^{-1}, N_2-RDF + 5 t FYM ha^{-1}, N_3-50% RDF + 50% RDN through FYM and N_4-100% RDN through FYM as a sub-plots. Seeds treated with *Azospirillum* and PSB each @ 25 g kg^{-1} common to all treatments. The total rainfall receiving during crop growing period of *Kharif* 2016 was 334.6 mm in 24 rainy days.

The soil of experimental field was clayey in texture. The soil responds well to manuring and irrigation. The soil having bulk density 1.36 Mg m^{-3} and porosity 48.67%. The pH of soil was 7.8 having low in available nitrogen (156.25 kg ha^{-1}), medium in available phosphorus (15.78 kg ha^{-1}) and very high in available potassium (382.13 kg ha^{-1}).

Results and Discussion

Effect of land configurations Growth Characters

Plant population

The initial and final plant population at harvest was not significantly influenced due to different land configurations. At harvest, maximum plant population (1,41,015) was recorded in the broad bed furrow than of other land configurations. Minimum plant population (1,39,300) was recorded in the flat bed.

Plant height (cm)

The plant height at harvest was found significantly maximum in broad bed furrow (216.12 cm) but it was at par with ridges and furrow (211.33 cm). Both these treatments were significantly superior over flat bed. This might be due to higher soil moisture retention and helps in maintaining favorable moisture condition for relatively longer duration. Similar effects of land configuration have also been reported by Ugale *et al*. (1995) [28], Selvaraju *et al.* (1999) [24], Kumar (2008) [10], Shaikh *et al.* (2010) [25] and Parihar *et al*. (2012) [17].

Number of functional leaves plant^{-1}

At 70 days after sowing and at harvest, sowing in broad bed furrow registered maximum number of functional leaves plant^{-1} (14.58 and 8.25, respectively) and it was remained at par with ridges and furrow. Significantly minimum number of functional leaves plant^{-1} was observed in flat bed.

In broad bed furrow, more availability of soil moisture might have increased the number of functional leaves plant^{-1} and reached maximum at 56 days after sowing and thereafter decreased due to senescence. These results are in conformity with the findings of Selvaraju *et al.* (1999) [24], Kumar (2008) [10], Shaikh *et al.* (2010) [25], Mandal *et al.* (2013) [14], Deshmukh *et al.* (2013) [3].

Mean leaf area plant^{-1}

At 70 days after sowing leaf area plant^{-1} was significantly the highest (14.70 dm^2) in broad bed furrow followed by ridges and furrow as compared to flatbed land configurations.

At harvest, the leaf area plant^{-1} in broad bed furrow was significantly higher (7.51 dm^2) to those found in the rest of land configurations but it was remained at par with sowing in ridges and furrow (7.19).

Higher availability of moisture and nutrients with BBF resulted in the higher uptake of nutrients which might have accelerated the leaf dry matter production. Nitrogen being constituent of proteins, enzymes and chlorophyll and phosphorus being the constituent of phosphor nucleotides helps in cell division and expansion might have helped to achieve higher leaf area per plant. These results are conformity with findings by Halepyati and Hosamani (1991) [4], Ugale *et al.* (1995) [28], Shaikh *et al*. (2010) [25], Mandal *et al.* (2012) [13], and Mahitha *et al*. (2014) [12]

Dry matter accumulation plant^{-1}(g)

At 70 days after sowing, dry matter accumulation plant^{-1} in broad bed furrow was significantly superior (106.95 g) over all the treatments but on par with ridges and furrow. Sowing in flat bed registered significantly the lowest dry matter accumulation plant^{-1} (91.10 g).

At harvest, dry matter accumulation plant^{-1} in broad bed furrow land configurations was maximum (125.92 g) and significantly higher than ridges and furrow (119.44 g) and followed by flatbed land configurations (107.32 g), however, it was at par with ridges and furrow (119.44 g).

The higher total dry matter production per plant with broad bed and furrow followed by ridges and furrow was due to higher soil moisture status at various growth stages of crop growth. Significantly higher total dry matter production per plant was due to higher dry matter accumulation in stem, leaves and reproductive parts with broad bed furrow followed by ridges and furrow at different growth stages of pearl millet. These results are in line with the findings of Kolekar *et al.* (1998) [9], Selvaraju (1999) [24], Patil and Sheelavantar (2000) [20], Nikam and Firake (2002) [15], Deshmukh *et al.* (2013) [3]

Total no of tillers plant^{-1}

At harvest number of total tillers plant^{-1}was at higher magnitude in broad bed furrow (3.42) which was at par with ridges and furrow (3.17) and significantly superior over flat bed. Similar results were also reported by Ugale *et al*. (1995) [28], Kumar *et al.* (2008) [10], Parihar *et al*. (2012) [17], Mahitha *et al*. (2014) [12] and Kanwar *et al.* (2015) [5]

Nutrient management

Plant population

The initial and final plant population at harvest was not significantly influenced due to different nutrient management treatments. At harvest, maximum plant population (1,41,289) was recorded in RDF + 5 t FYM ha^{-1}. Minimum plant population (1,39,552) was observed with 100% RDN through FYM.

Plant height (cm)

At harvest, the plant height in treatment of RDF + 5 t FYM ha^{-1} (216.44 cm) was the highest and it was significantly superior over rest of the treatments followed by 50% RDF + 5 t FYM ha^{-1}. Plant height was the lowest in treatment of 100% RDN through FYM ha^{-1} (205.07 cm).

The plants were significantly taller under application of RDF + 5 t FYM ha^{-1} and significantly dwarfed under 100% RDN through FYM ha^{-1}. This was attributed to adequate nutrient availability at critical growth stages of crop under proper and balanced nutrient management. Nitrogen promotes the vegetative growth thus, leading to significant increase in plant height. These results corroborate the findings of Singh *et al*. (2005) [27], Chaudhari and Gautam (2007) [1], Parihar *et al.* (2012) [17] and Reddy *et al.* (2016) [23].

Number of functional leaves plant^{-1}

At harvest, the number of functional leaves were significantly higher under application of RDF + 5 t FYM ha $^{-1}$ (8.18) followed by 50% RDF + 50% RDN through FYM (7.84). The number of functional leaves plant^{-1} was significantly the lowest in treatment of 100% RDN through FYMha^{-1}. This might be due to increased availability of nutrients to plant initially through inorganic fertilizers and then by FYM matching to the need of crop throughout growing season. These results corroborate the finding of Kumar and Gautam (2004) [11], Patidar and Mali (2004) [19], Singh *et al*. (2005) [27], and Reddy *et al.* (2016) [23].

Mean leaf area plant^{-1}

At 70 days after sowing, significantly maximum leaf area plant^{-1} (14.94 dm^2) was observed due to application of RDF + 5 t FYM ha^{-1} followed by 50% RDF + 50% RDN through FYM. Minimum leaf area plant^{-1} recorded in 100% RDN through FYM. And at harvest, the leaf area plant^{-1} was significantly higher with the application of RDF + 5 t FYM ha^{-1} (7.67 dm^2) over rest of the nutrient management treatments.

The significantly higher leaf area was attributed to higher number of leaves per plant and dry matter accumulation in leaves. Increased photosynthetic area *i.e.* leaf area might be attributed to better uptake of nutrients. Thus, the leaf area plant^{-1} was increased under adequate nutrient supply of RDF + 5 t FYM ha^{-1} and significantly decreased with inadequate nutrient supply of 100% RDN through FYM at all the days of observations except 28 days after sowing. These results are in conformity with the findings of Kumar and Gautam (2004) [11], Patidar and Mali (2004) [19], Singh *et al*. (2005) [27], Chaudhari and Gautam (2007) [1], Parihar *et al.* (2012) [17] and Reddy *et al.* (2016) [23].

Dry matter accumulation plant^{-1}(g)

At harvest, maximum dry matter accumulation plant^{-1} was recorded due to application of RDF + 5 t FYM ha^{-1} (125.69 g) which was significantly higher over the application of 50% RDF + 50% RDN through FYM (119.48 g), 100% RDF (115.92 g). Significantly minimum dry matter accumulation plant^{-1} (109.14 g) was registered under 100% RDN through FYM.

The dry matter is the resultant of all growth parameters and higher in RDF + 5 t FYM ha^{-1} due to greater availability of most of the macro and micro nutrients in appropriate quantity and balanced proportion that led to higher uptake of the nutrients. These results are in conformity with the findings of Kumar and Gautam (2004) [11], Patidar and Mali (2004) [19], Chaudhari and Gautam (2007) [1], Khambalkar *et al.* (2012) [7], Parihar *et al.* (2012) [17], and Reddy *et al.* (2016) [23].

Total no of tillers plant^{-1}

The total number of tillers plant^{-1} was significantly more with application of RDF + 5 t FYM ha^{-1} followed by 50% RDF + 50% RDN through FYM. Significantly minimum number of total tillers plant^{-1} was recorded in application of 100% RDN through FYM. This might be due to application of fertilizer in combination with FYM which might have aided in higher root growth and development and enhanced the uptake and translocation of nutrients. These findings corroborate the results of Khan *et al.* (2000) [8], Rathore *et al.* (2006) [21], Chaudhari and Gautam (2007) [1] and Parihar *et al.* (2012) [17].

Table 1: Growth and growth attribute of pearl millet as influenced by land configurations and integrated nutrient management

Treatments	Plant population at harvest	No of functional leaves plant^{-1} at harvest	Plant height (cm)	Total Dry matter plant^{-1} (g)	No. of total tillers plant^{-1}	No. of effective tillers plant^{-1}
L: Land configurations						
L_1-Flat bed	139300	7.22	204.17	107.32	2.90	1.32
L_2-Ridges and furrow	140809	7.87	211.33	119.44	3.17	1.58
L_3-Broad bed furrow	141015	8.25	216.12	125.92	3.42	1.73
CD (P=0.05)	NS	0.52	6.74	11.94	0.28	0.18
N: Nutrient management						
N_1-RDF (60:30:30 kg NPK ha^{-1})	140192	7.67	208.62	115.92	3.04	1.49
N_2-RDF + 5 t FYM ha^{-1}	141289	8.18	216.44	125.69	3.49	1.76
N_3-50%RDF + 50% RDN through FYM	140466	7.84	212.02	119.48	3.27	1.58
N_4-100% RDN through FYM	139552	7.42	205.07	109.14	2.84	1.36
CD (P=0.05)	NS	0.31	4.31	5.29	0.21	0.15

RDF, Recommended dose of fertilizers, RDN, Recommended dose of nitrogen, FYM, Farm yard manure

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