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Influence of organic and inorganic nutrient source on growth, growth indices and yield of pearl millet

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Abstract
A field experiment was conducted at Agronomy Research Area, CCSHAU, Hisar during *Kharif* 2016 with the objective to study the influence of organic and inorganic nutrient source on growth, growth indices and yield of pearl millet. The experiment was conducted in split plot design with three replications. In the main plot there were manurial treatment *viz.* control, biomix, vermicompost @ 2.5 t ha^{-1} and vermicompost @ 2.5 t ha^{-1} + biomix and nitrogen levels *viz.* 70, 80, 90 and 100 per cent RDN were kept under subplot. The growth parameters *viz*. plant height, LAI, total number of tillers $plant^{-1}$, leaf area $plant^{-1}$, and grain, stover yield differed significantly among different treatments. Among the manurial treatments, significantly higher tiller conservation index was recorded over control, but it was at par with biomix and vermicompost @ 2.5 t ha^{-1}. Among different nitrogen levels the differences in the TCI was found non-significant.

Keywords: Influence of organic, inorganic nutrient, growth indices and pearl millet

Introduction
Pearl millet [*Pennisetum glaucum* (L.) R. Br. Emend. Stuntz] commonly known as *Bajra,* play a dominant role in integrated agricultural and animal husbandry economy of the drier region of the country. It is grown under the environmental conditions with limited and erratic rainfall, high temperature and poor soil condition with low nutrient levels too harsh for other cereals crops. (Renu *et al*. 2017) [9]. Today, it is getting more attention due to increasing evidence of less seasonal rainfall, terminal heat, frequent occurrence of extreme weather events coupled with scanty water resources (Singh *et al.*, 2013) [12]. To meet the ever growing food demand with limited resources, we need to increase the productivity by adopting better agronomic practices and efficient fertilization The chemical fertilizers are quite expensive and the small and marginal farmers are unable to use these fertilizers in required quantity (Patil *et al.* 2014). Current trends in agriculture are focused on reduction in the use of inorganic fertilizers compelling the search for alternatives (Hameeda *et al.* 2006) [2]. Biofertilizers play an important role in increasing the availability of native and applied nutrient and productivity in sustainable manner (Rinku *et al.* 2014) [11]. Vermicompost has been advocated as a good source of organic manure along with inorganic sources for use in integrated nutrient management practices in field crops (Roy and Singh, 2006) [12]. Vermicompost is a rich mixture of macro and micro plant nutrients. It also increases microbial availability of phosphorus and nitrogen and improves microbial action in the soil. Integration of inorganic fertilizer with organic source of nutrients is able to maintain soil fertility and sustained crop productivity. The present investigation was, therefore, planned to study the effect organic and inorganic source on growth and growth indices of pearlmillet under semiarid environment.

Materials and Methods
A field experiment was conducted during Kharif season 2016 at Agronomy Research Area, Chaudhary Charan Singh Haryana Agricultural University, Hisar to study Influence of organic and inorganic source on growth and growth indices of pearlmillet. The experiment was laid outin split plot design with three replications. In the main plot manurial treatment *viz.* control, biomix, vermicompost @ 2.5 t ha^{-1} and vermicompost @ 2.5 t ha^{-1} + biomix and in sub plot nitrogen levels *viz.* 70, 80, 90 and 100 per cent RDN were kept. The soil was sandy loam in texture, slightly alkaline in reaction, low in organic carbon and nitrogen, medium in available phosphorus and potassium (Table1).

The pearlmillet hybrid 'HHB 223' was sown at a spacing of 45 cm at about 2.0 cm depth by using 5 kg seed ha^{-1}. The seed pertaining to inoculated plots was treated with *biomix* culture, as per treatment. Full dose of phosphorus and half nitrogen, as per treatments, were applied at the time of sowing and remaining half of the nitrogen was top dressed in two splits, one after thinning and gap filling, and another at the time of ear head formation stage.

Prevailing weather conditions: During experimentation period, the prevailing weather conditions are described in the graph. A total rainfall of 340 mm was received during the crop season bifurcated as 244.8, 80.4 and 2.8 mm during July, August and September month, respectively. the mean weekly maximum and minimum temperature ranged from 32.7 to 36.1ºC and 23.5 to 26.9ºC, respectively. The weekly mean relative humidity ranged from 84.9 to 95.3 per cent in morning and 48.7 to 78.2 per cent in evening hours. The range values for wind speed, sunshine hours and pan evaporation were 3.1 to 6.9 km h^{-1}, 4.8 to 9.7 h day^{-1} and 3.5 to 6.1 mm day^{-1}, respectively. (Table 2).

Observations and methods of analysis: The observations regarding population, various growth characters and growth indices were recorded as:

1. **Plant population:** The number of plants per metre row length was counted from three randomly selected rows in each plot at 20 DAS and at maturity and their average was calculated and converted as 000 ha^{-1}.
2. **Plant height:** The plant height (cm) of three tagged plants from each plot was measured from base of the plant to the growing point of main shoot at 20, 40, 60 days after sowing (DAS) and at maturity of pearl millet crop
3. **Total tillers per plant:** Tillers were counted in each plot for three tagged plants. Total number of tillers thus recorded were divided by three and average number of tillers per plant were calculated at 40, 60 DAS and at maturity.
4. **Leaf area per plant:** The leaf area of the leaf blade of plant taken for dry matter accumulation was measured by LI- 3000 Area Meter (LICOR Ltd. Nebraska, U.S.A.) before putting for drying in an oven at 20, 40, 60 DAS.
5. **Leaf area index (LAI):** The leaf area index (LAI) is the ratio between leaf area to ground area (Watson, 1952). It was computed by using following formula:

$$LAI = \frac{\text{Leaf area}}{\text{land area}}$$

6. **Tiller conservation index (TCI):** The tiller conservation index was calculated by dividing the number of effective tillers per plant with total number of tillers per plant and multiplying by 100.

$$TCI\ (\%) = \frac{\text{Number of effective tillers per plant}}{\text{Total number of tillers per plant}} \times 100$$

7. **Crop growth rate** (CGR): The crop growth rate (g/m2/day) was calculated for 0-20, 20-40, 40-60 DAS and at 61 DAS- harvest stage by using formula given by Watson (1952) as given below:

$$CGR = \frac{W2-W1}{(t2-t1)\,S}$$

Where, W_1 and W_2 are plant dry weight (g) at time t_1 and t_2, respectively.
S is the land area or plant geometry over which dry matter was recorded.

8. **Relative growth rate:** The relative growth rate (mg/g/day) indicates rate of growth per unit dry matter. The RGR was calculated for the period 0-20, 20-40, 40-60 DAS and 60 DAS - maturity stage by using the following formula given by Blackman (1969);

$$RGR = \frac{\ln W2 - \ln W1}{t2-t1}$$

W1 and W2 are plant dry weights at time t1 and t2, respectively

9. **Yield**: Grain yield: The dried earheads of pearl millet from each plot were threshed to record grain yield per plot, which was converted to grain yield per hectare (q ha^{-1}). The pearl millet stover after separating the earhead at harvest was left in the plots for sun drying. After proper drying, it was weighed to record the stover yield per plot and converted into stover yield (q ha^{-1}).

Results and Discussion

The results revealed that neither the manure nor the nitrogen levels application had any significant variation in the plant population recorded at 20 DAS and at maturity. Combined application of biomix and vermicompost @ 2.5 t ha^{-1} significantly improved growth of pearl millet in terms of plant height, number of tillers and leaf area per plant. Similarly, growth characters increase significantly with increasing level of nitrogen up to 100 per cent RDN which did not differ significantly with 90 per cent RDN. However, the lowest values of these characters were recorded in treatment where 70 per cent RDN was applied. The tiller conservation index (TCI) values varied from 90.4 to 94.7 per cent among the treatments. Among the manurial treatments, it was maximum with biomix + vermicompost @ 2.5 t ha-1 (94.3 %) and was at par with biomix (92.0 %) and vermicompost @ 2.5 t ha-1 (93.8 %) and differs significantly over control. Among different nitrogen levels the differences in the TCI was found non-significant but the highest value was recorded with the 100 per cent RDN (Table 3 & Fig 1). Application of organic manures such as vermicompost improves the physical condition of soil, provide complimentary environment for micro organisms. The plant growth is a function of cell division and cell enlargement, which depends upon availability of nutrient, especially nitrogen. Adequate supply of this nutrient element to crop has important role in the synthesis of carbohydrates, protein and lipids by the plants. The role of nitrogen in synthesizing the protoplasm and other body building materials of plant are well documented. The increase in auxin supply with higher level of nitrogen brought about increase in tillers per plant. Similar results were reported by Sinha *et al.* (2011) and Rathore (2006) [7]. The growth indices viz. LAI, CGR and RGR were improved as the fertility levels increased either by manurial or nitrogen doses.. LAI was maximum at 40 DAS and CGR and RGR was found maximum between 20-40 and thereafter decreasing trend was observed. In the manurial treatment, grain yield was found maximum with the treatment biomix + vermicompost @ 2.5 t ha^{-1} (30.3 q ha^{-1}) followed by vermicompost @ 2.5 t ha^{-1} (27.1 q ha^{-1}) and differ significantly. Also, with the increase in the nitrogen level grain yield was maximum with 100 per cent RDN (29.0 q ha^{-1}) but did not differ significantly with 90 per

cent RDN (28.0 q ha^{-1}, Table 3& 4). This increase in grain yield may be ascribed to better root growth and development, resulting in more nutrient uptake and higher dry matter accumulation per plant and its subsequent translocation to the developing panicle. Thus, balanced nutrition due to combined use of biomix, vermicompost and chemical fertilizers throughout the crop period probably resulted in better growth, enhanced yield attributes and finally yield. Under the manurial treatment highest stover yield was recorded with biomix + vermicompost @ 2.5 t ha^{-1} (71.4 q ha^{-1}) and lowest in control (56.4 q ha^{-1}) whereas under different nitrogen levels it was maximum with 100 per cent RDN (69.1 q ha^{-1}) and lowest with 70 per cent RDN (59.1 q ha^{-1}). This increase in the stover yield may be attributed to the increased plant height, leaf area and dry matter production.Similar results have also been reported by Rathore *et al*. (2004) [8].

Table 1: Physico-chemical properties of experimental field soil before sowing of pearl millet

Soil separates	Value	Method of determination
A. Mechanical composition (%)		
Sand	61.9	International Pipette Method (Piper, 1966)
Silt	19.4	
Clay	17.8	
B. Chemical composition of soil		
pH (1:2)	7.9	Glass electrode pH meter (Jackson, 1973)
EC (dS m^{-1} at 25ºC)	0.17	Conductivity bridge meter in 1:2 soil water suspension (Richards, 1954)
Organic carbon (%)	0.43	Walkley and Black's rapid titration method (Jackson, 1973)
C. Nutrient available		
Available N (kg ha^{-1})	133	Alkaline permanganate method (Subbiah and Asija, 1956)
Available P (kg ha^{-1})	18.3	Olsen's method (Olsen *et al*., 1954)
Available K (kg ha^{-1})	263	Flame photometric method (Richards, 1954)

Table 2: Mean weekly meteorological data recorded during crop season

Dates	Standard week	Temperature (°C)		Relative humidity (%)		Average wind speed (km/h)	Bright sunshine (h)	Pan evaporation (mm/day)	Rainfall (mm)
		Max.	Min.	Morning	Evening				
02-08 July	27	34.6	26.5	90.0	74.1	5.5	5.5	5.5	93.5
09-15 July	28	36.1	26.9	88.5	75.0	5.5	6.9	4.5	19.0
16-22 July	29	34.1	25.2	90.4	68.2	5.6	5.2	5.1	58.3
23-29 July	30	35.7	26.0	92.1	73.9	6.1	6.7	6.1	74.0
30-05 Aug	31	33.0	25.4	91.3	71.8	5.5	5.5	3.9	4.3
06-12 Aug	32	33.8	25.9	92.8	76.6	6.9	4.8	4.1	0.8
13-19 Aug	33	35.2	25.0	86.1	59.4	4.8	6.7	5.1	5.3
20-26 Aug	34	34.2	26.5	87.2	61.4	6.2	6.3	4.6	6.8
27-02 Sep	35	32.7	25.5	95.3	78.2	4.7	5.4	3.7	63.2
03-09 Sep	36	34.6	23.5	85.7	58.1	6.1	9.7	4.8	0
10-16 Sep	37	35.7	23.6	84.9	52.4	4.7	9.5	5.2	0
17-23 Sep	38	36.0	25.1	87.4	54.3	5.3	8.5	4.9	0
24-30 Sep	39	35.4	24.4	85.4	48.7	4.1	8.1	4.6	2.8
01-07 Oct	40	36.0	24.6	91.1	56.4	3.1	5.4	3.5	12.0
08-14 Oct	41	35.2	19.4	82.1	35.4	2.9	8.8	4.2	0

Table 3: Periodical change in crop growth yield attributes and tiller conservation index of pearl millet as influenced by different treatments

Treatment	Plant population (000 ha^{-1})		Effective tillers $plant^{-1}$ at maturity	Total tillers $plant^{-1}$			Tiller conservation index (%)	Leaf area $plant^{-1}$ (cm^2)			Leaf area index (LAI)		
	20 DAS	At maturity		40 DAS	60 DAS	At maturity		20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
Manure													
Control	174.1	169.8	2.6	4.3	3.3	2.9	90.4	531.3	1742.8	900.6	1.20	3.46	2.07
Biomix	174.5	170.9	3.0	4.5	3.5	3.2	92.0	539.2	1803.0	938.0	1.24	3.60	2.14
Vermicompost @ 2.5 t ha^{-1}	175.0	171.4	3.0	4.7	3.7	3.3	93.8	546.4	1821.9	980.0	1.25	3.88	2.24
Biomix + Vermicompost @ 2.5 t ha^{-1}	175.1	171.5	3.2	5.0	3.9	3.4	94.3	577.8	1862.3	1020.7	1.40	4.16	2.32
CD at 5%	NS	NS	0.3	0.5	0.15	0.3		7.3	23.8	19.3	0.07	0.24	0.13
Nitrogen level													
70% RDN	174.1	170.4	2.5	4.0	3.3	2.8	90.0	528.2	1736.2	902.6	1.15	3.45	2.01
80% RDN	174.6	170.8	2.9	4.5	3.5	3.1	92.0	544.0	1784.8	950.6	1.25	3.69	2.17
90% RDN	174.8	171.2	3.1	4.9	3.8	3.3	94.0	559.8	1850.5	985.2	1.35	3.88	2.27
100% RDN	175.2	171.3	3.3	5.1	3.9	3.5	94.7	562.6	1858.5	1000.8	1.36	4.04	2.31
CD at 5%	NS	NS	0.2	0.3	0.3	0.2	NS	7.0	15.8	19.1	0.08	0.20	0.11

Table 4: Periodical change in crop growth rate and relative growth rate of pearl millet as influenced by different treatments

Treatments	Crop growth rate (CGR, g $m^{-2}day^{-1}$)				Relative growth rate (RGR, mg $g^{-1}day^{-1}$)				Grain yield (q ha^{-1})	Stover Yield (q ha^{-1})
	0-20 DAS	20-40 DAS	40-60 DAS	60-Maturity	0-20 DAS	20-40 DAS	40-60 DAS	60-Maturity		
Manures										
Control	4.0	38.3	24.1	13.9	63.8	117.4	22.8	9.5	23.0	56.4
Biomix	4.6	42.9	26.8	15.7	70.1	117.0	22.6	9.7	25.6	62.7
Vermicompost @ 2.5 t ha^{-1}	4.7	44.4	29.8	16.1	71.2	117.9	23.9	9.3	27.1	67.4
Biomix + vermicompost @2.5 t ha^{-1}	5.6	46.5	30.0	18.0	80.8	111.2	26.0	9.4	30.3	71.4
CD at 5%	0.3	2.7	6.9	NS	3.4	4.7	NS	NS	1.3	3.7
Nitrogen levels										
70 % RDN	4.0	34.5	24.4	13.6	63.1	113.8	24.5	9.7	23.8	59.1
80 % RDN	4.6	42.0	28.7	15.4	70.1	116.4	24.0	9.3	26.2	64.9
90 % RDN	5.1	47.3	30.4	16.7	75.4	117.0	22.9	9.1	28.0	67.8
100 % RDN	5.2	48.4	33.0	18.1	77.4	116.3	23.9	9.5	29.0	69.1
CD at 5%	0.3	3.2	4.0	2.5	2.9	NS	NS	NS	1.2	1.8

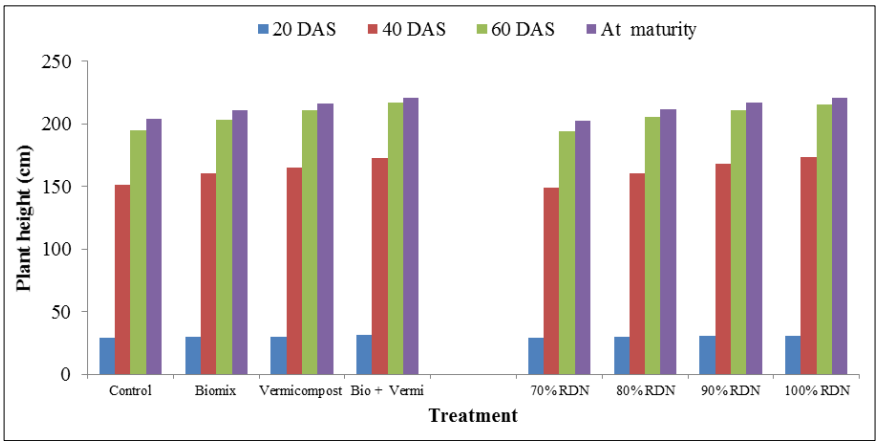

Fig 1: Effect of manures and nitrogen levels on plant height of pearl millet

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