

## Effect of Farm Yard Manure and Higher Plant Population on Yield and Water Use Efficiency in Pearlmillet-Wheat Cropping System

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### Abstract

A field experiment was conducted during 2005-06 and 2006-07 to study the response of pearlmillet *Pennisetum glaucum* (L.)—wheat *Triticum aestivum* (L.) cropping system to farmyard manure and increased seed rate. Incorporation of 10 tonnes/ha farmyard manure in pearlmillet increased grain yield of both pearlmillet and wheat, evapotranspiration and water use efficiency over recommended package to both crops. Incorporation of farmyard manure in pearlmillet along with 30% higher seed rate to pearlmillet and wheat increased grain yield, evapotranspiration and water use efficiency over both recommended packages alone or with 10 tonnes farmyard manure to pearlmillet.

**Key words :** Cropping system, Pearlmillet-wheat, Farmyard manure, Evapotranspiration, Water use efficiency.

In recent years, the productivity level of various field crops is stagnating and in some situations even declining with the application of recommended dose of fertilizers. The persons concerned with agriculture in any form are serious to increase the stagnant or declined yield to higher level to meet out national requirement. The decline in crop productivity and soil health can be sustained through the use of organic sources of nutrients in field crops. Organic sources alone cannot meet the nutritional requirement of various cropping systems due to low nutrient status and limited availability in the country. The use of leguminous inter crops and integrated nutrient management holds great promise in increasing crop productivity besides maintaining soil health and environment (1). Better soil conditions viz. improvement in porosity, water holding capacity, soil aeration, bulk density, balanced soil nutrients status created with the application of farmyard manure may hold more plant population and enhance system productivity. The work on this aspect has been mainly carried out on single crop while a systematic effort to evaluate the effect of integrated nutrient management / leguminous inter crops on specific cropping system is lacking. Therefore, a field experiment was conducted to investigate the ef-

fect of integrated nutrient management/leguminous inter crops and higher plant population on pearlmillet *Pennisetum glaucum* (L.)—wheat *Triticum aestivum* (L.) cropping system during 2005-06 and 2006-07.

### Methods

The field experiment was conducted in two consecutive seasons of 2005-06 and 2006-07 at Research Farm of CCS Haryana Agricultural University, Hisar, India located at latitude 29° 10' N, longitude 75° 46' E and altitude 215.2 m. The weather data prevailed at Hisar during 2005-06 and 2006-07 are presented in Table 1. The soil of the experimental field was slightly alkaline (pH 7.8), low in organic carbon (0.29%) and sandy loam in texture. Pearl millet and wheat crops were grown in rotation during *kharif* and *rabi* season on the experimental field. The experiment under study consisted of four treatments, viz. T<sub>1</sub>-recommended fertilizer and package for both crops, T<sub>2</sub>-T<sub>1</sub> + 10 tonnes/ha farmyard manure to pearlmillet, T<sub>3</sub>-T<sub>2</sub> + 30% higher seed rate in both crops and T<sub>4</sub>-T<sub>1</sub> + intercropping of cluster bean in paired rows of pearlmillet in place of sole crop of pearlmillet. The experiment was laid out in four stripes and sampling was done from five loca-

**Table 1.** Weather data for pearl millet-wheat cropping system in 2005-06 and 2006-07.

Month	Rainfall (mm)		No. of rainy days		Temperature (C)				Mean humidity (%)	
	2005-06	2006-07	2005-06	2006-07	Maximum	Minimum	Maximum	Minimum	2005-06	2006-07
					2005-06		2006-07			
Jul	195.9	91.3	8	8	37.6	24.0	40.9	24.1	76.0	73.5
Aug	9.4	7.9	3	2	38.6	23.5	38.0	22.5	67.5	70.0
Sep	181.3	69.8	8	3	38.9	20.4	36.4	17.5	76.0	69.5
Oct	—	0.0	0	0	34.9	10.5	37.0	13.4	58.0	59.5
Nov	3.2	0.0	1	0	32.0	5.0	34.0	3.4	58.0	71.0
Dec	—	6.0	0	3	25.6	0.2	26.2	1.3	58.0	70.5
Jan	0.0	0.0	0	0	26.4	-3.5	27.8	-0.5	67.0	68.5
Feb	0.0	75.3	0	3	31.7	5.1	27.9	4.5	72.0	84.0
Mar	27.2	44.3	3	3	32.6	6.5	36.2	6.5	70.5	67.5
Apr	0.0	2.0	0	1	42.2	13.0	42.7	10.7	47.5	44.5

tions in each strip. The farmyard manure was incorporated thoroughly four weeks before pearl millet sowing. The recommended fertilizer dose applied during both the years to pearl millet and wheat was 125 kg N + 62.5 kg P<sub>2</sub>O<sub>5</sub>/ha and 150 kg N, 60 kg P<sub>2</sub>O<sub>5</sub>/ha, respectively. Standard agronomic operations and plant protection measures were followed according to local recommendations. During *kharif* season, pearl millet variety HHB 67 was sown on 15 and 5 July, respectively during 2005-06 and 2006-07. Wheat variety PBW 343 was sown on 21 and 22 November in 2005-06 and 2006-07, respectively during *rabi* season. Pearl millet was harvested on 30 and 20 September while wheat on 14 and 20 April, during first and second year of experimentation.

Soil moisture was determined gravimetrically at sowing, before and after each irrigation and at harvest. Soil samples were taken from 0—15, 15—30, 30—45, 45—60, 60—75 and 75—90 cm depths with a post-hole auger. Soil water depletion was calculated for each layer for the periods between successive soil

samplings. Total evapotranspiration was calculated from the soil water content measurements combined with rainfall and irrigation. Water-use efficiency was expressed as the ratio of kilograms of wheat equivalent yield to mm water used for individual crops.

## Results and Discussion

### Crop Productivity

The incorporation of 10 tonnes/ha farmyard manure to pearl millet along with recommended fertilizers and 30% higher seed rate to both crops increased pearl millet and wheat yield during both the years of experimentation (2).

Pearl millet and wheat grain yield increased with the incorporation of 10t/ha FYM to pearl millet along with recommended fertilizers as compared to recommended package and practices during both the years (Table 2). The incorporation of farmyard manure along with recommended dose of fertilizers increases soil nitrogen, phosphorus, potassium, enriches the

**Table 2.** Effect of different treatments on grain yield (kg/ha) in pearl millet-wheat cropping system. T<sub>1</sub>-recommended fertilizer and package for both crops; T<sub>2</sub>-T<sub>1</sub> + 10 tonnes/ha farmyard manure to pearl millet; T<sub>3</sub>-T<sub>2</sub> + 30% higher seed rate to both crops and T<sub>4</sub>-T<sub>1</sub> + intercropping of cluster bean in paired rows of pearl millet in place of sole crop of pearl millet. \*Cluster bean yield converted to pearl millet equivalent.

Treatments	Pearl millet	2005-06		Wheat equivalent yield		2006-07		Wheat equivalent yield		Mean of two years	
		Wheat	Wheat	Pearl millet	Pearl millet	Wheat	Wheat	Pearl millet	Wheat	Wheat equivalent yield	
T <sub>1</sub>	3162	4296	6249	3240	4985	6986	3201	4641	6618		
T <sub>2</sub>	3356	4469	6540	3449	5280	7410	3403	4875	6975		
T <sub>3</sub>	3466	4567	6708	3578	5420	7630	3522	4994	7169		
T <sub>4</sub>	3574*	4327	6534	3687	5075	7352	3630	4701	6943		

**Table 3.** Effect of different treatments on evapotranspiration and water use efficiency in pearl millet-wheat cropping system. T<sub>1</sub>-recommended fertilizer and package for both crops; T<sub>2</sub>-T<sub>1</sub> + 10 tonnes/ha farmyard manure to pearl millet; T<sub>3</sub>-T<sub>2</sub> + 30% higher seed rate to both crops and T<sub>4</sub>-T<sub>1</sub> + intercropping of cluster bean in paired rows of pearl millet in place of sole crop of pearl millet.

Treat- ments	Evapotranspiration (mm)						Water use efficiency (kg/ha-mm)					
	2005-06			2006-07			2005-06			2006-07		
	<i>Kharif</i>	<i>Rabi</i>	Total	<i>Kharif</i>	<i>Rabi</i>	Total	<i>Kharif</i>	<i>Rabi</i>	Total	<i>Kharif</i>	<i>Rabi</i>	Total
T <sub>1</sub>	285.4	231.7	517.1	275.6	295.8	571.4	11.08	18.54	12.08	11.76	16.85	12.23
T <sub>2</sub>	296.3	238.4	534.7	289.3	304.1	593.4	11.33	18.74	12.23	11.92	17.36	12.49
T <sub>3</sub>	307.2	246.3	553.5	298.2	318.1	616.3	11.28	18.54	12.12	12.00	17.04	12.38
T <sub>4</sub>	287.3	233.2	520.5	281.4	297.1	578.5	12.44	18.55	12.55	13.10	17.04	12.11

physico-chemical properties, promotes root and shoot growth and thereby increases crop yields. These results agree with those of Srivastva et al. (3) and Kumar et al. (4).

The grain yield of both pearl millet and wheat increased markedly with the recommended fertilizers dose along with farmyard manure and 30% higher seed rate over application of recommended dose of fertilizers and recommended dose of fertilizers along with farmyard manure incorporation (Table 2). The mean wheat equivalent yield was highest (7169 kg/ha) with the application of 10 tonnes farmyard manure/ha along with recommended fertilizer and 30% higher seed rate to both crops. The wheat equivalent yield of 6,977 kg/ha was recorded with the application of farmyard manure along with recommended fertilizer dose; and 6,618 kg/ha with the application of recommended fertilizer dose alone. The incorporation of farmyard manure along with recommended fertilizer dose improved soil properties and thereby it was able to accommodate more healthy plants which finally resulted in higher crop yield (3, 5).

#### *Evapotranspiration*

In general, the seasonal evapotranspiration was higher in 2006-07 than in 2005-06. The application of farmyard manure increased the evapotranspiration of both pearl millet and wheat crops in 2005-06 and 2006-07 (Table 3). The application of 30% higher seed rate in pearl millet and wheat along with 10 tonnes farmyard manure/ha in pearl millet resulted in higher evapotranspiration in both the years (Table 3). Standard package and practices along with 10 tonnes farmyard manure/ha and 30% higher seed rate in pearl millet

and wheat resulted in evapotranspiration loss of 553.5 and 616.3 mm in 2005-06 and 2006-07, respectively (sum of both seasons). Application of higher dose of seed rate increased plant population which in turn increased root growth and leaf area and therefore increased the transpiration rate (1).

#### *Water Use Efficiency*

Water use efficiency (WUE) increased with the application of farmyard manure alone or farmyard manure along with 30% higher seed rate in both pearl millet and wheat crop (Table 3). Water use efficiency in recommended package, recommended package along with 10 tonnes farmyard manure/ha, recommended package and 10 tonnes farmyard manure/ha along with 30% higher seed rate in pearl millet and wheat, and clusterbean intercropped with pearl millet was 12.08, 12.23, 12.12 and 12.55 kg/ha-mm in 2005-06 and 12.23, 12.49, 12.38 and 12.11 kg/ha-mm in 2006-07, respectively. The application of farmyard manure resulted in higher water use efficiency because the application of farmyard manure increases grain yield. There was slight decline in water use efficiency due to incorporation of FYM 10t/ha along with 30% higher seed rate due probably to more increase in evapotranspiration as compared to grain yield (1). Saxena et al. (6) reported similar results. The intercropping of clusterbean with pearl millet recorded higher WUE due probably to higher wheat equivalent yield without any effect on evapotranspiration.

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