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Economics of different nitrogen sources (organic and inorganic) in *kharif* pearl millet (*Pennisetum glaucum* L.)

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Abstract
Among the response of different source of nitrogen, treatment T_{10}(25% RDN through VC + 75 % N through Urea + Azotobactor) recorded maximum plant height (277.17cm), plant dry weight (105.30g), tillers plant^{-1}(3.40), crop growth rate (2.74 g m^{-2} day^{-1}), relative growth rate (0.04 g g^{-1} day^{-1}), ear plant^{-1} (3.57), length of ear (31.85), no. of grains ear^{-1} (3433.33), test weight (8.39 g), grain yield (4.97 t ha^{-1}), straw yield(12.99 t ha^{-1}), protein content (13.03%) and harvest index (27.67%).Whereas the lowest value in terms of plant height (246.33cm), dry weight (98.83g),number of grains (2803.33 ear^{-1}) grain yield (2.51 t ha^{-1}) and stover yield (9.30 t ha^{-1}) was observed in the treatment T_3*i.e.*,(100% RDN through VC). Further, number of tillers (2.03 plant^{-1}),crop growth rate (2.29 g m^{-2} day^{-1}), relative growth rate (0.03 g g^{-1} day^{-1}), number of ear (2.33 plant^{-1}), length of ear(26.07cm), test weight (7.15g), protein content (9.15%), harvest index (21.06%) was recorded in the treatment T_1(100 % RDN through Urea). The highest gross return (₹ 85620.00 ha^{-1}), net return (₹ 59522.00 ha^{-1}) and benefit cost ratio (2.28) were registered in treatmentT_{10} (25% RDN through VC + 75 % N through Urea + *Azotobactor*), However, the lowest of value (₹ 49900.00 ha^{-1}), (₹ 5884.00 ha^{-1}) and (0.13) respectively in the treatment T_3 (100 % RDN through VC).

Keywords: Kharif pearl millet, organic, nitrogen resources, plant height, grain yield and straw yield

Introduction
Pearl millet (*Pennisetum glaucum* L.) is largely grown for grain and fodder purpose under those situations where other crops generally fail. Pearl milletas a food crop is limited to the developing countries in Asia, and particularly in Africa and ranked sixth in the world followed by rice, wheat, maize, barley and sorghum (Anonymous, 2010-11). The important pearl millet growing countries are India, China, Nigeria, Pakistan, Sudan, Egypt, Arabia, and Russia. It is estimated that over 95% of pearl millet production is used as food, the reminder being divided between animal and poultry feed (7%), other uses (seed, bakery products, snacks, etc.) and waste. Pearl milletis used in flat breads (roti) or mixed up to 25% with wheat flour for use in yeast breads. In India, pearl milletis popularly known as *Bajra*, and it is the fourth most important cereal crop after rice, wheat and sorghum. It has the greatest potential among all the millets. The major producing states are Rajasthan (46%), Maharashtra (19%), Gujarat (11%), Uttar Pradesh (8%) and Haryana (6%), (Sonawane *et al*., 2010) [9]. Nutrient management system refers to combined application of all nutrient source *viz*. Vermicompost, use of Biofertilizer *(Azotobactor*) and inorganic fertilizer (urea). The combined effect of organic and inorganic source of nutrient help in maintaining yield stability through correction of nutrients deficiencies, enhancing their efficiency and providing favourable soil physiological condition (Behera *et al.*, 2007) [2]. Biofertilizers play an important role in increasing the availability of native and applied nutrients and productivity in sustainable manner. *Azotobacter* is a free-living nitrogen fixing bacteria. It has been reported to fix about 20 kg N ha^{-1} per year in a field of non legume crop and also secretes some growth promoting substances (Kumawat and Jat 2005) [5].

Materials and Method
Field experiment was conducted during *kharif* season 2015 at Crop Research Farm, Sam Higginbottom Institute of Agriculture, Technology & Sciences (Deemed-to-be-University) Allahabad. The experimental site is located at 250 57 N latitude, 870 19 E longitude and at an altitude of above mean sea level. The soil of the experimental area was sandy loam with moderately alkaline pH; low in organic carbon (0.32%) and available N (188.30 kg ha-1), available P (34.50 kg ha-1) and available K (87.00 kg ha-1) during *kharif* 2015 respectively.

The experiment was laid out in Randomized Block Design (RBD) with two organic and inorganic sources of nitrogen with ten treatments combination on a plot size of 4 x 3 m^2. Before sowing, line was formed in the field as the spacing in treatments. Pearl millet was sown in line and covered with the soil. Pearl millet seeds were hand dibbled. The total quantity of nitrogen, phosphorus and potassium as per treatment in the form of two split application are applied, one at basal and the second application at top dressing.

All the agronomic practices were carried out uniformly to raised the crop. For taking data on yield and yield components on pearl millet five plants were selected randomly in each plot. Cost of cultivation, gross return, net return and benefit cost ratio was worked out to evaluate the economics of each treatment, based on the existing market prices of inputs and output. The Cost of Cultivation (ha-1) for each treatment was work out separately, on the following basis:

The Gross return (ha-1) from each treatment was calculated by

Gross return (ha-1) = Income from grain + income from Stover

Net return (ha-1):- The net profit from each treatment was calculated separately, by using the following formula

Net return = Gross return (ha-1) – Cost of cultivation (ha-1)

Benefit cost ratio

The benefit cost ratio was calculated using the following formula

$$\text{Benefit cost ratio} = \frac{\text{Gross return (ha-1)}}{\text{Total cost of cultivation (ha-1)}}$$

Results and Discussion

Observations regarding the response of organic and inorganic sources of nitrogen on economics of pearl milletare given in table (1 to 2).

Grain yield (t ha-1)

The result revealed that there was significant difference between different treatments and maximum grain yield found (4.97) with treatment T_{10} (25 % through VC + 75 % N through Urea + *Azotobactor*), while minimum grain yield (2.51) was observed in treatment T_3 (100 % RDN through Urea), However T_9 (25 % RDN through VC +75 % N through Urea), T_8 (50 % RDN through VC +50 % N through Urea + *Azotobactor*), were found statistically at par with T_{10}(25 % through VC + 75 % N through Urea + *Azotobactor*). Choudhary *et al*., (2007) [4].

Straw yield (t ha-1)

The result revealed that there was significant difference between different treatments and Maximum Stover yield(t ha^{-1}) was found (12.99) with treatment T_{10}(25 % through VC + 75 % N through Urea + *Azotobactor*), while minimum Stover yield(9.30) was observed in treatment T_3(100 % RDN through VC), However T_9 (25 % RDN through VC +75 % N through Urea)was found statistically at par with T_{10}(25 % through VC + 75 % N through Urea + *Azotobactor*). Rathor *et al*., (2008) [7] and Chellamuthu *et al*. (2004) [3].

Table 1: Variable cost and Cost of cultivation of each treatments.

	Treatments	Fixed cost	Variable cost	Total cost
T_1	100 % RDN through Urea	14016.00	5897.21	19913.21
T_2	100 % RDN through Urea + Azotobactor	14016.00	5942.21	19958.21
T_3	100 % RDN through VC	14016.00	30000.00	44016.00
T_4	100 % RDN through VC + Azotobactor	14016.00	30045.00	44061.00
T_5	75 % RDN through VC + 25 % N through Urea	14016.00	24041.80	38057.80
T_6	75% RDN through VC + 25 % N through Urea +Azotobactor	14016.00	24086.80	38102.80
T_7	50 % RDN through VC + 50 % N through Urea	14016.00	18172.58	32188.58
T_8	50 % RDN through VC + 50 % N through Urea+ Azotobactor	14016.00	18217.58	32233.58
T_9	25 % RDN through VC + 75 % N through Urea	14016.00	12036.41	26052.41
T_{10}	25 % RDN through VC + 75 % N through Urea+ Azotobactor	14016.00	12081.41	26097.41
	Urea= 6 ₹ kg^{-1}, SSP=8₹ kg^{-1},MOP= 17.8₹kg^{-1}			
	Azotobactor=100₹ kg^{-1},Vermicompost= 5 ₹ kg^{-1},			

Table 2: Mean grain yield and straw yield grain and straw return and gross return.

	Treatments	Yield (t ha^{-1})		Return (₹ ha^{-1})		Gross return (₹ ha^{-1})
		Grain yield	Straw yield	Grain	Straw	
T_1	100 % RDN through Urea	3.14	11.39	37680.00	22780.00	60460.00
T_2	100 % RDN through Urea +Azotobactor	3.29	11.51	39480.00	23020.00	62500.00
T_3	100 % RDN through VC	2.51	9.30	30120.00	19780.00	49900.00
T_4	100 % RDN through VC + Azotobactor	2.68	9.33	33600.00	19980.00	53580.00
T_5	75 % RDN through VC + 25 % N through Urea	3.04	10.15	36480.00	20280.00	56760.00
T_6	75% RDN through VC + 25 % N through Urea +Azotobactor	3.11	10.59	37320.00	20520.00	57840.00
T_7	50 % RDN through VC + 50 % N through Urea	3.77	11.01	45240.00	22200.00	67440.00
T_8	50 % RDN through VC + 50 % N through Urea+ Azotobactor	4.68	11.32	56160.00	22680.00	78840.00
T_9	25 % RDN through VC + 75 % N through Urea	4.72	12.67	56640.00	25340.00	81980.00
T_{10}	25 % RDN through VC + 75 % N through Urea+ Azotobactor	4.97	12.99	59640.00	25980.00	85620.00
	Sales rate of grain=12.00₹ kg^{-1}					
	Sales rate of straw=2.00₹ kg^{-1}					

Cost of cultivation

Maximum cost of cultivation (44061.00) was recorded in treatment T4(100 % RDN through VC + Azotobactor), whereas the lowest value 19913.21 ha-^{1}in T4 (100 % RDN through Urea). Singh *et al*., (2003) [8] and Malik *et al*., (1990) [6].

Gross return: Maximum gross return (85620.00 ha-1) was recorded in treatment T10 (25 % through VC + 75 % N through Urea + Azotobacter), which was the lowest value 49900.0 ha-1in T3 (100 % RDN through VC).

Net return: Maximum net return (59522.00 ha-1) was recorded in treatment T10 (25 % through VC + 75 % N through Urea + Azotobacter), whereas the lowest value 5884.00 ha-1in T3 (100 % RDN through VC).

Benefit cost ratio: Maximum benefit cost ratio (2:28) was recorded in treatment T10 (25 % through VC + 75 % N through Urea + Azotobacter), whereas the lowest value 0:13 in T3 (100 % RDN through VC).

This study has showed that integrated use of inorganic along with organic manure resulted in maximum returns per rupees invested on production inputs. The result suggested that application of recommended dose of NPK along with organic manure was important for improving productivity, grain quality and profitability of pearl millet.

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