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Effect of integrated nitrogen management and bio-fertilizer in *Kharif* pearl millet (*Pennisetum glaucum* L.)

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ABSTRACT : A field experiment was carried out during *Kharif* season of 2009 to study the effect of integrated nitrogen management through vermicompost, urea and *Azotobacter* on yield and economic of pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz]. The result revealed that application of 100 per cent RDN (75% through urea and 25% through vermicompost) significantly increased the growth, yield attributing characters and yield of pearl millet however, it was at par with 100 per cent RDN through urea. Inoculation of seed with *Azotobacter* also resulted significantly higher plant height at time of harvest, yield attributing characters and yield. Interaction effect between nitrogen management and bio-fertilizer was found significant in case of grain and straw yield. Application of 100 per cent RDN through 75 per cent urea and 25 per cent vermicompost along with seed treatment with *Azotobacter* recorded higher grain and straw yield however, the straw yield was at par with that of treatment 100 per cent RDN through urea with *Azotobacter* inoculation. Same treatment recorded higher net return and benefit : cost ratio.

Key **W**ords : Pearl millet, Bio-fertilizer, Integrated nitrogen management

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Pearl millet [*Pennisetum glaucum* (L.) R. Br.], the world's hardiest warm season cereal crop (Reddy *et al.,* 2012). Globally it ranks sixth after rice, wheat, maize, barley and sorghum in terms of area (Khairwal *et al.,* 2007) and share 42 per cent of total world production (*Ramesh et al.,* 2006). Pearl millet is an indispensable arid and semi arid crop of India (Ramesh *et al.,* 2006) cultivated as dual purpose (food and feed) crop in over 8.3 m ha ranking fourth among total cereals (Yadav *et al*., 2011).

Pearl millet is one of the most important dry land crops. It is very exhaustive crop and require higher dose of nitrogen fertilizers. Nitrogen is the major nutrient required by pearl millet and has shown variable growth and yield response to N application (Gascho *et al.,* 1995). Generally, pearl millet has been known for growing under low N management (Gascho *et al.,* 1995) but, several studies showed that N application can increase millet production efficiency (Singh *et al*., 2010). The higher prices of fertilizers and low supply of nitrogenous fertilizers necessities the application of organic manure and bio fertilizer. The nitrogen requirement of the crop is large and to meet only through organic manure and biofertilizer which are not possible. Integrated nitrogen management is good concept which aims at efficient and judicious use in an integrated manner so as to get maximum economic yield. An integrated nitrogen management could also provide a viable option for sustainable crop production without degrading the natural resources base the soil and that too, on long term basis. The present investigation was, therefore, planned to study the effect of integration of vermicompost, urea and *Azotobacter* on yield and economic of pearl millet.

RESEARCH PROCEDURE

The field experiment was conducted at Agronomy Instructional Farm, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the *Kharif* - 2009. The

treatments comprised of seven levels of nitrogen management *i.e.* N_1: 100 per cent RDN (through urea), N_2: 100 per cent RDN (50% through urea + 50% through vermicompost), N_3: 100 per cent RDN (75% through urea + 25% through vermicompost), N_4: 75 per cent RDN (50% through urea + 50% through vermicompost), N_5: 75 per cent RDN (75% through urea + 25% through vermicompost), N_6: 50 per cent RDN (50% through urea + 50% through vermicompost) and N_7: 50 per cent RDN (75% through urea + 25% through vermicompost) and two levels of bio-fertilizer *i.e.* B_1: No inoculation and B_2: *Azotobacter* inoculation, replicated thrice in Randomized Block Design with factorial concept.

Pearl millet seed was treated with *Azotobacter* @ 30 g kg^{-1} of seed as per treatments. The soil was loamy sand having low in organic carbon (0.26 %) and available nitrogen (158 kg ha^{-1}), medium in available phosphorus (50.4 kg ha^{-1}) and potash (156.2 kg ha^{-1}) with 7.5 pH. A common dose of FYM @ 10 t ha^{-1} was applied uniformly and mixed in cultivated soil. The crop was fertilized with 80 kg N and 40 kg P_2O_5 ha^{-1} as per treatments in manually opened furrows at 45 cm distance. Nitrogen was applied through urea and vermicompost as per treatments. Half nitrogen in the form of urea was applied at the time of sowing and remaining half N was top-dressed in at 30 DAS. Vermicompost was applied as basal as per treatments. Pearl millet hybrid (variety - GHB 558) was sown on July 5th, 2009 and crop was harvested on October 3rd, 2009. Total rainfall of 379.8 mm was received in 16 rainy days during the cropping period. It's distribution was uneven in the season. Therefore, one life saving irrigation was given to crop on September 4th, 2009. One hand weeding and two interculturing were carried out during crop season for weed management. The observations were recorded on growth and yield determinates and yields of pearl millet at harvest. The economics of different treatments was worked out in terms of net returns ha^{-1} and B:C (benefit cost) ratio.

RESEARCH ANALYSIS AND REASONING

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads :

Effect of nitrogen management :

It is evident from the data presented in Table 1 that all the

Table 1 : Effect of nitrogen management and bio fertilizer on growth, yield attributes and yields of pearl millet

Treatments	Plant height (cm)	No. of total tillers $plant^{-1}$	No. of effective tillers $plant^{-1}$	Length of ear head (cm)	Girth of ear head (cm)	Grain yield $plant^{-1}$ (g)	Test weight (g)	Yield (kg ha^{-1})	
								Grain	Straw
Nitrogen management (N)									
N_1 : 100% RDN (through urea)	165.37	4.83	1.87	19.47	5.84	14.67	7.04	1808	3542
N_2 : 100% RDN (50% through urea + 50% through vermicompost)	161.03	4.33	1.57	17.77	5.20	13.96	5.29	1483	2919
N_3 : 100% RDN (75% through urea +25% through vermicompost)	171.87	4.77	1.93	19.70	6.16	15.00	7.40	1986	3760
N_4 : 75 % RDN (50% through urea +50% through vermicompost)	150.43	4.17	1.37	16.50	4.75	12.70	4.99	1231	2402
N_5 : 75 % RDN (75% through urea +25% through vermicompost)	154.73	4.20	1.43	16.87	4.85	12.75	5.45	1282	2517
N_6 : 50 % RDN (50% through urea +50% through vermicompost)	146.93	4.00	1.27	16.17	4.36	10.95	5.07	926	1666
N_7 : 50 % RDN (75% through urea +25% through vermicompost)	149.30	4.03	1.37	16.23	4.54	11.18	5.22	937	1768
S.E. ±	3.39	0.16	0.07	0.64	0.19	0.34	0.29	62	137
C.D. (P=0.05)	9.86	0.46	0.21	1.90	0.57	0.99	0.85	179	399
Biofertilizer (B)									
B_1: No inoculation	153.72	4.24	1.47	16.94	4.93	12.494	5.536	1268	2402
B_2: Azotobactor inoculation	160.47	4.43	1.62	18.11	5.27	13.567	6.025	1491	2905
S.E. ±	1.81	0.08	0.04	0.34	0.10	0.18	0.16	33	73
C.D. (P=0.05)	5.27	NS	0.11	1.00	0.30	0.53	0.46	96	213
C.V. %	5.29	8.93	11.60	9.00	9.36	6.41	12.40	10.96	12.66
Interaction N × B	NS	NS	NS	NS	NS	NS	NS	S	S

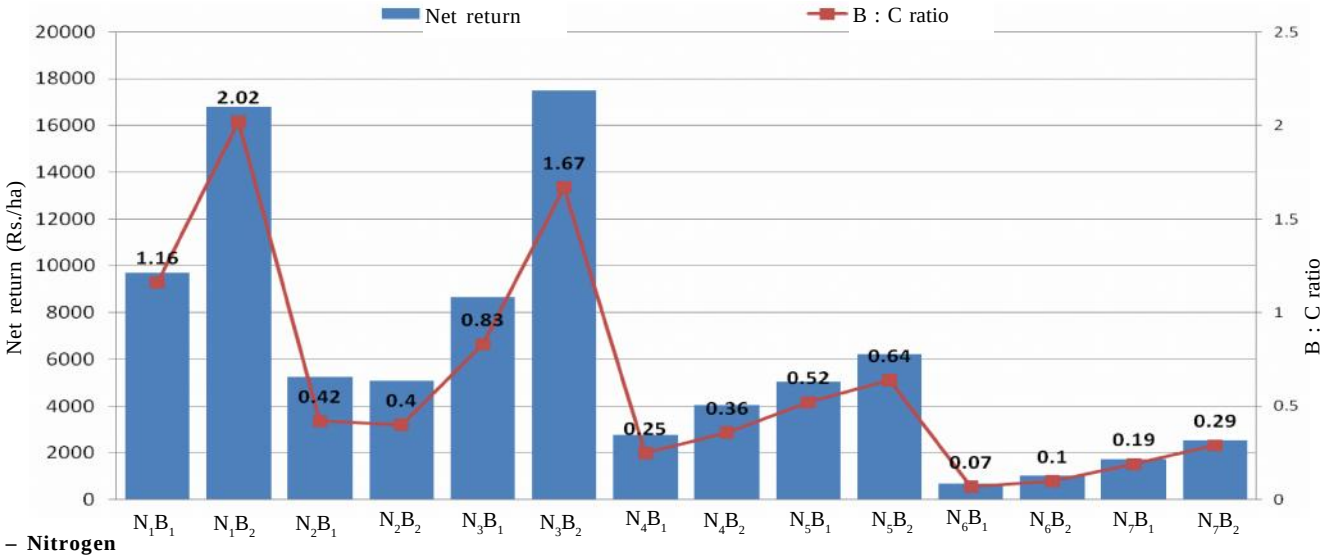
NS=Non-significant, S=Significant

growth, yield attributes and yields differed significantly due to nitrogen management treatments under the present study. The higher plant height at harvest of pearl millet (171.87 cm), number of effective tillers per plant (1.93), length of ear head (19.70 cm), girth of ear head (6.16 cm), grain yield per plant (15.0 g), test weight (7.40 g), grain (1986 kg ha^{-1}) and straw (3760 kg ha^{-1}) yields at the time of harvest were recorded with the application of 100 per cent RDN (75% through urea + 25% through vermicompost). This treatment was found superior to rest of all the treatments except 100 per cent RDN through urea, whereas the higher number of total tillers per plant (4.83) at the time of harvest was recorded in the treatment of 100 per cent RDN through urea. It was at par with the application of 100 per cent RDN through urea (75%) and vermicompost (25%).

The increase in grain and straw yields of pearl millet was due to increase in growth and yield attributes which were enhanced with the application of higher rate of inorganic nitrogenous fertilizer with vermicompost. Vermicompost contains more number of nitrogen fixing, phosphate solubilizing and other beneficial microbes, vitamins, hormones and enzymes etc. which have batter effect of yield attribute due to better root proliferous. The relative findings were also reported by Patel and Patel (2002) and Guggari *et al*. (2007).

Effect of bio-fertilizer :

Seed treatment with *Azotobacter* significantly improved higher yield attributes *viz*., plant height (160.47cm), number of



– Nitrogen

N_1: 100 % RDN (through Urea), N_2: 100 % RDN (50% through Urea + 50% through vermi compost), N_3 : 100 % RDN (75% through Urea + 25% through vermicompost), N_4 : 75 % RDN (50% through Urea + 50% through vermicompost), N_5 : 75 % RDN (75% through Urea + 25% through vermicompost), N_6 : 50 % RDN (50% through Urea + 50% through vermicompost) and N_7 : 50 % RDN (75% through Urea + 25% through vermicompost)

– Biofertilizer

B_1 : No biofertilizer and B_2 : *Azotobacter*.

Fig. 1 : Economics of pearl millet as influenced by iteraction of nitrogen and biofertilizer

Table 2 : Grain and straw yields of pearl millet as influenced by N x B interaction

Nitrogen management (N)	Bio-fertilizer (B)			
	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})	
	B_1	B_2	B_1	B_2
N_1	1534	2087	2811	4273
N_2	1496	1471	2904	2935
N_3	1601	2370	3124	4396
N_4	1178	1284	2300	2503
N_5	1235	1330	2411	2623
N_6	924	935	1590	1742
N_7	907	966	1678	1865
S.E. ±	87		194	
C.D. (P=0.05)	254		564	

effective tiller per plant (1.62), length of ear head (18.11cm), girth of ear head (5.27cm), grain yield per plant (13.57g), test weight (6.03g), grain (1491 kg ha^{-1}) and straw (2905 kg ha^{-1}) yields with *Azotobacter* inoculation, whereas number of total tillers per plant was found non- significant (Table 1).

The better response of crop to biofertilizer might be attributed to increased nitrogen availability by fixing appreciable amount of molecular nitrogen and made available for plant growth and to synthesis growth promoting enzyme like indole acetic acid (IAA), gibberellins, vitamins and also altered the microbial balance in the rhizosphere and producing metaboliter that stimulates plant development. The result of grain and straw yields with the use of biofertilizers is in accordance with the finding of Raghuwanshi *et al.* (1997) and Bhaghchand and Gautam (2000).

Interaction effect :

Interaction effect between nitrogen management and bio fertilizer was found significant in case of grain and straw yields. Application of 100 per cent RDN (75 % through urea and 25% through vermicompost) along with seed treatment of *Azotobacter* recorded significant higher grain (2370 kg ha^{-1}) and straw (4396 kg ha^{-1}) yields (Table 2), however, the straw yield was at par with that of 100 per cent RDN through urea and *Azotobacter* inoculation. The magnitude of increase in grain yield under treatment N_3B_2 was 161 per cent over lower application of nitrogen N_7B_1 and in straw 176 per cent yield increase in N_3B_2 over treatment N_6B_1. These results are similar to the findings of those reported by Satyajeet and Yadav (2006) and Patil and Sheta (2008).

Economics :

Net return (Rs. 17481 ha^{-1}) and benefit : cost ratio (1.67) were recorded higher under the treatment combination of 100 per cent RDN (75% through urea and 25% through vermicompost) along with *Azotobacter* inoculation (Fig. 1). The above result indicated that nitrogen should be managed with 60 kg N ha^{-1} through urea and 20 kg ha^{-1} through vermicompost along with seed treatment of *Azotobacter* for obtaining higher production point of view. The results are in agreement by Choudhary and Gautam (2007).

Conclusion :

In view of the results obtained from the investigation, it is concluded that the most appropriate nutrient management strategy for getting higher yields and net return, the pearl millet crop should be fertilized with 80 kg N ha^{-1} through urea along with seed inoculation of *Azotobacter*, with this a recommended dose of FYM @ 10 t ha^{-1} should be applied uniformly.

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