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Cow urine spray and integrated nutrient management of rice on productivity and energy-use under temperate valley conditions

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ABSTRACT

Cow urine as a nutrient source to rice crop was evaluated in field experiments conducted during rainy (*kharif*) seasons of 2008 and 2009 at the Agronomy Research Field, Shalimar, Srinagar. The maximum plant height, effective tillers/hill, filled grains/panicle, grain yield and straw yield were noticed with application of 15 tonnes FYM + 120:60:30 kg N:P_2O_5:K_2O/ha, which was significantly superior to rest of the treatments except plant height and straw yield, which were at par with 15 tonnes FYM + 60:60:30 kg N:P_2O_5:K_2O/ha in 2008 and plant height with 15 tonnes FYM + 60:60:30 kg N:P_2O_5:K_2O/ha and 15 tonnes FYM /ha in 2009. The maximum uptake of N, P and K was recorded with application of 15 tonnes FYM + 120:60:30 kg N:P_2O_5:K_2O/ha than rest other treatments during both the years. In case of fresh cow urine and *Neemuch mutka khad*, three spray of both shows significantly higher N, P and K uptake and grain yield in comparison to two sprays. However, *Neemuch mutka khad* recorded higher uptake than fresh cow urine. The application of FYM with inorganic fertilizer significantly improved final N, P and K status of soil. Integrated use of 15 tonnes FYM + 120:60:30 kg N:P_2O_5:K_2O/ha recorded maximum net returns (₹ 20 650/ha) and net energy output (189 386.1 MJ/ha). However, B:C ratio (0.61), energy output : input ratio (26.61) and energy use efficiency (0.85 kg grains/MJ) and (2.06 kg dry matter/MJ) were computed higher under control (no nutrient application). Minimum B:C ratio was observed under application of FYM alone than rest other treatments during both the years. Three spray of fresh cow urine and *Neemuch mutka khad* were shown superiority over two spray in terms of B:C ratio, energy output : input ratio and energy-use efficiency.

Keywords: Cow urine, Economics, Energetics, Nutrient balance, Nutrient management, Rice

Cow urine is a rich source of nitrogen and potassium which usually drains out as waste material from farmer household. This nutrient source is available to farmers, free of cost in their own house. It is organic in nature, eco-friendly if used in crops without any adverse effect on ecosystem and human health. Livestock excreta has two portions That is solid dung urine; the compounds in urine – urea, uric acid, soluble phosphates, and potassium salts – are ready for nutrition of plants are require slight changes, whereas, solid dung needs to be decomposed before availability of nutrients to the plant. Further organic nutrient spray (cow urine) can be sprayed at critical growth stage of crop to overcome the problem of the slow release nutrients of organic sources affecting crop growth. Therefore, to utilize the natural source of available nutrients as cow urine needs to be studies under existing temperate condition of Kashmir.

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MATERIALS AND METHODS

Field experiment was conducted in rainy (*kharif*) season of 2008 and 2009 at the Agronomy Research Field, Shalimar, Srinagar (J&K) at 34°08´ N, 74°52´ E and at a height of 1 600 m above mean sea level. The soil was silty clay loam in texture, neutral reaction (*p*H 6.9) and high in organic carbon (1.0%). The available soil N, P and K were 380, 15.2 and 140 kg/ha respectively. The total rainfall received during crop growth period was 221.1 mm (21 rainy days) and 177.8 mm (15 rainy days) in 2008 and 2009 respectively. The maximum temperature ranged between 34 °C (July) to 13.5 °C (September) in 2008 and 35.5 °C (Aug.) to 18 °C (June) in 2009. The minimum temperature ranged between 21.2 °C (Aug.) to 6.5 °C (September) in 2008 and 21.5 °C (Aug.) to 7 °C (June) in 2009. The experiment was laid out in split-plot design with four nutrient management of T_1 : No manure and fertilizer application (control), T_2 : 15 tonnes FYM /ha, T_3 : 15 tonnes FYM + 120:60:30 kg N:P_2O_5:K_2O/ha (50% N applied as top dressing in two equal splits), T_4 : 15 tonnes FYM + 60:60:30 kg N:P_2O_5:K_2O/ha (whole N applied as basal), in main plot and four treatments in sub-plot treated as

S_1 : fresh cow urine three sprays @ 100 lit./ha each, S_2 : fresh cow urine two sprays @ 100 lit./ha each, S_3 : *Neemuch mutka khad* three sprays @ 100 lit./ha each, and S_4 : *Neemuch mutka khad* two sprays @ 100 lit./ha each. FYM was incorporated at the time of field preparation as per treatment. Fresh cow urine collected from cow shed and *Neemuch mutka khad* (prepared by fermentation of 15 lit. fresh cow urine + 15 kg cowdung + 250 g jaggery or gur + 15 lit. water for one week in earthen pot then filtered) were applied as foliar spray. Before spraying fresh cow urine and *Neemuch mutka khad* were properly filtered and diluted with five times by volume with fresh and clean water to make appropriate volume to cover whole area evenly. Three sprays were performed at maximum tillering, panicle initiation and flowering and two sprays were performed at maximum tillering and flowering stage of the crop. The composition of FYM on oven dry basis, i e dry matter, N, P and K content was 55, 0.5, 0.2 and 0.5% respectively. Cow urine contains 1.21% N, slight P and 1.35% K. The rice variety Jhelum was transplanted with a spacing of 20 cm × 15 cm on 15 June in 2008 and 13 June in 2009. The concentrations of various nutrients in plant and soil were estimated by standard methods. Relative economics was worked out as per the prevailing market prices of the inputs and produce. The price of rice grain and straw per quintal were ₹ 800 and 130 during 2008 and ₹ 850 and 135 during 2009, respectively. Price of FYM was ₹ 100/q during both the year. Production efficiency was calculated by dividing grain yield by 112 days (rice crop duration after transplanting). Energy input and output was calculated using energy equivalents as suggested by Devasanapathy *et al.* (2009). Energy-use efficiency (kg grain/MJ and kg dry matter/MJ) was calculated by dividing grain yield (kg) by total input energy (MJ) and total dry matter produce (kg) by total input energy (MJ).

RESULTS AND DISCUSSION

Plant growth and yield

The plant height, yield attributes and yield of rice varied significantly due to nutritional management (Table 1). The maximum plant height, effective tillers/hill, filled grains/panicle, grain yield and straw yield were noticed with application of 15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$/ha, which was significantly superior to rest of the treatments except plant height and straw yield, which were at par with 15 tonnes FYM + 60:60:30 kg $N:P_2O_5:K_2O$/ha in 2008 and plant height with 15 tonnes FYM + 60:60:30 kg $N:P_2O_5:K_2O$/ha and 15 tonnes FYM/ha in 2009. Such increase in plant height, yield attributes and yield might be due to supply of higher nutrients through inorganic fertilizers easily available to plants adequately providing congenial growth which improve the metabolic activity and photosynthesis efficiently and finally improve the dry matter production in sink. There

Table 1 Plant height, yield attributes and yields of rice as influenced by integrated nutrient management and spray of cow urine and *Neemuch matka khad*

Treatment	Plant height (cm)		Effective tillers/hill		Filled grains/panicle		1000-grain weight (g)		Grain yield (tonnes/ha)		Straw yield (tonnes/ha)	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Nutrient management												
No nutrients (control)	86.2	85.9	11.4	10.9	66.7	65.8	24.4	24.3	4.92	4.51	6.99	6.38
15 tonnes FYM /ha	88.6	89.3	11.3	11.0	67.6	66.9	24.5	24.3	5.42	5.58	7.69	6.82
15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$ /ha	92.0	92.5	13.7	13.0	77.9	77.1	24.8	24.6	7.25	6.67	9.35	7.71
15 tonnes FYM + 60:60:30 kg ($N:P_2O_5:K_2O$ /ha)	90.8	91.7	11.7	11.4	67.9	67.1	24.5	24.4	6.06	5.83	8.70	7.02
SEm ±	0.63	1.25	0.38	0.37	0.74	0.79	0.15	0.15	0.22	0.06	0.22	0.13
CD (*P*=0.05)	2.2	4.3	1.31	1.3	2.55	2.72	NS	NS	0.77	0.21	0.77	0.45
Cow urine spray												
Cow urine three sprays @ 100 lit./ha each	91.6	93.3	12.9	12.3	70.5	69.7	24.6	24.5	6.20	5.74	8.24	7.02
Cow urine two sprays @ 100 lit./ha each	86.8	86.4	10.6	10.1	66.6	65.9	24.1	24.0	5.50	5.08	7.75	6.61
Neemuch Mutka Khad three sprays @ 100 lit./ha each	91.3	91.7	13.4	12.8	74.5	73.6	24.9	24.7	6.40	6.28	8.82	7.39
Neemuch Mutka Khad two sprays @ 100 lit./ha each	87.8	88.2	11.3	11.1	68.6	67.8	24.5	24.5	5.55	5.49	7.91	6.91
SEm ±	1.3	0.74	0.52	0.62	0.67	1.48	0.24	0.30	0.21	0.11	0.16	0.15
CD (*P*=0.05)	3.8	2.2	1.52	1.8	1.95	4.32	NS	NS	0.62	0.33	0.46	0.45

was a progressive decline in plant height, yield attributes and yield due to reduction of nutrient application in treatments 15 tonnes FYM + 60:60:30 kg $N:P_2O_5:K_2O$/ha, 15 tonnes FYM/ha and control (no nutrient application). Similar results were obtained in rice–Indian mustard cropping sequence (Roul *et al.* 2006). The spray of fresh cow urine and *Neemuch mutka khad* recorded significant improvement in plant height, number of effective tillers, filled grains, grain yield and straw yield with three spray over two spray. However, response to plant height, number of effective tillers, filled grains, grain yield and straw yield fresh cow urine and *Neemuch mutka khad* were at par. Thousand grains weight was not influenced by nutrient management as well as spray of cow urine and *Neemuch mutka khad*.

Enhanced production efficiency was recorded with 15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$/ha and three sprays (Table 5) than others. Maximum production efficiency (62.1 kg grain/ha/day) were noticed with application of 15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$/ha and minimum was observed with control (no nutrient application). The next best treatment was 15 tonnes FYM + 60:60:30 kg $N:P_2O_5:K_2O$/ha which was higher than sole application of 15 tonnes/ha FYM and no nutrient application (control). With respect to cow urine spray higher production efficiency was recorded with three sprays of cow urine and *Neemuch mutka khad* as compared to two sprays. Nedunchezhyan (2010) also found that the production efficiency was increased with increase of nutrient levels.

Nutrient uptake and balance

Significant improvement in N uptake was observed when FYM was added in conjunction with inorganic fertilizers (Table 2). The maximum uptake of N was recorded with application of 15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$/ha than other treatments during both the years. In case of fresh cow urine and *Neemuch mutka khad*, three spray shows significantly higher N uptake in comparison to two spray of fresh cow urine and *Neemuch mutka khad* in both the year and three spray of fresh cow urine in 2009. The increased uptake was due to increased grain and straw yield in both the years. Similar findings are confirmed by (Tanwar *et al.* 2010). The application of FYM with inorganic fertilizer significantly improved final N status of soil. A net gain 37.7 and 13.7 kg/ha was recorded with application of 15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$/ha during 2008 and 2009, respectively. Whereas, net loss of 30.6 and 20.8 kg/ha were noted over initial status where nutrient was not applied during both the years (Table 2). The computed N balance was positive with application of 15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$/ha during both the years and with 15 tonnes

Table 2 Balance sheet of N (kg/ha) as influenced by integrated nutrient management and spray of cow urine and *Neemuch matka khad* in rice

Treatment	Initial available soil N status (a)		N added (b)		N uptake by crop (c)		Soil N status after crop harvest (d)		Actual gain/ loss over initial status (a-d)		N balance (a+b)-(c+d)	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Nutrient management												
No nutrients (control)	380	349.4	3.0	3.0	79.4	72.6	349.4	328.6	30.6	20.8	–45.8	–48.8
15 tonnes FYM /ha	380	390.5	78.0	78.0	100.9	98.1	390.5	406.9	–10.5	–16.4	66.6	63.5
15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$ /ha	380	417.7	198.0	198.0	155.1	136.1	417.7	431.4	–37.7	–13.7	5.2	48.2
15 tonnes FYM + 60:60:30 kg ($N:P_2O_5:K_2O$ /ha)	380	404.7	138.0	138.0	129.3	115.2	404.7	415.7	–24.7	–11	–16	11.8
SEm ±					3.5	1.1	2.1	2.8				
CD (P=0.05)					12.0	3.8	7.2	9.5				
Cow urine spray												
Cow urine three sprays @ 100 lit./ha each	380	385.3	104.9	104.9	120.5	107.4	385.3	391.4	–5.3	–6.1	–20.9	–8.6
Cow urine two sprays @ 100 lit./ha each	380	395.3	103.7	103.7	107.9	96.1	395.3	400.2	–15.3	–4.9	–19.5	2.7
Neemuch Mutka Khad three sprays @ 100 lit./ha each	380	386.7	104.9	104.9	126.3	115.9	386.7	390.8	–6.7	–4.1	–28.1	–15.1
Neemuch Mutka Khad two sprays @ 100 lit./ha each	380	395.0	103.7	103.7	110.0	102.7	395.0	400.3	–15	–5.3	–21.3	–4.3
SEm ±					3.2	2.0	3.7	3.1				
CD (P=0.05)					9.3	5.9	NS	NS				

FYM + 60:60:30 kg N:P_2O_5:K_2O/ha during 2009. While negative N balance was computed where nutrient was not applied or applied only 15 tonnes FYM. This negative N balance might be seen due to no addition of N or low addition of N.

The P uptake by crop increased significantly with application of FYM and FYM + inorganic fertilizers and maximum P was taken up by crop 8.12 and 6.98 kg/ha when applied 15 tonnes FYM + 120:60:30 kg N:P_2O_5:K_2O/ha during both the years respectively. The increased level of inorganic fertilizer along with FYM application increased the availability of P and its better absorption by the plant due to more root proliferation. In other hand spraying of *Nemuch mutka khad* at three times was recorded significantly higher P uptake than cow urine spray at three and two times and neemuch mutka khad spray at two times during both the years. This higher uptake of P might be recorded due to high grain and straw yield.

The P status of soil after harvest was observed higher over the initial status except under control (no nutrient application). The difference between two and three sprays of fresh cow urine and *Neemuch matka khad* was not significant with respect to soil P status after harvest of crop, because there was no addition of extra P in the soil. Maximum gain was recorded under application of 15 tonnes FYM + 120:60:30 kg N:P_2O_5:K_2O/ha during both the years. However, loss over initial status of P was found 2.3 and 1.7 kg/ha under control (no nutrient application), respectively during both the years (Table 3). Similar findings were reported by Tanwar *et al.*, 2010.

The K uptake was also found significantly higher with treatment 15 tonnes FYM + 120:60:30 kg N:P_2O_5:K_2O/ha than rest other treatments. The increased uptake might be due to higher grain and straw yield. In other hand soil K status after harvest of crop was significantly higher in treatment of 15 tonnes FYM + 120:60:30 kg N:P_2O_5:K_2O/ha which was at par with 15 tonnes FYM + 60:60:30 kg N:P_2O_5:K_2O/ha. While significantly lower K status was recorded in control plot (no nutrient application). 100% recommended dose of fertilizer NPK + FYM 10 tonnes/ha and 150% NPK application resulted in significantly higher uptake of NPK (Verma *et al.* 2006). The negative balance of K was observed due to release of K from its non exchangeable pool of the soil to meet the demand of crop. This result corroborate with Yadav *et al.* (2009).

Energetics

The maximum amount of energy input (19486.15 MJ/ha) was used in treatment 15 tonnes FYM + 120:60:30 kg N:P_2O_5:K_2O/ha (Table 5). This was due to the higher manure and fertilizer energy. The next higher amount of energy input was utilized by 15 tonnes FYM + 60:60:30 kg N:P_2O_5:K_2O/ha.

Table 3 Balance sheet of P (kg/ha) as influenced by integrated nutrient management and spray of cow urine and *Neemuch matka khad* in rice

Treatment	Initial soil P status (a)		P added (b)		P uptake by crop (c)		Soil P status after crop harvest (d)		Actual gain/ loss over initial status (a-d)		P balance (a+b)-(c+d)	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Nutrient management												
No Nutrients	15.2	12.9	0	0	2.86	2.61	12.9	11.2	2.3	1.7	–0.56	–0.91
15 tonnes FYM /ha	15.2	17.7	30.0	30.0	4.77	4.48	17.7	19.2	–2.5	–1.5	22.73	24.02
15 tonnes FYM + 120:60:30 kg N:P_2O_5:K_2O /ha	15.2	19.9	90.0	90.0	8.12	6.98	19.9	21.7	–4.7	–1.8	77.18	81.22
15 tonnes FYM + 60:60:30 kg (N:P_2O_5:K_2O /ha)	15.2	18.8	90.0	90.0	6.38	5.47	18.8	19.9	–3.6	–1.1	80.02	83.43
SEm ±					0.15	0.06	0.13	0.39				
CD (*P*=0.05)					0.52	0.2	0.46	1.34				
Cow urine spray												
Cow urine three sprays @ 100 lit./ha each	15.2	18.0	52.5	52.5	5.71	4.95	18.0	18.2	–2.8	–0.2	43.99	47.35
Cow urine two sprays @ 100 lit./ha each	15.2	18.1	52.5	52.5	5.12	4.47	18.1	18.2	–2.9	–0.1	44.48	47.93
Neemuch Mutka Khad three sprays @ 100 lit./ha each	15.2	18.1	52.5	52.5	6.04	5.36	18.1	17.8	–2.9	0.3	43.56	47.44
Neemuch Mutka Khad two sprays @ 100 lit./ha each	15.2	18.1	52.5	52.5	5.26	4.77	18.1	17.9	–2.9	0.2	44.34	47.93
SEm ±					0.13	0.10	0.13	0.27				
CD (*P*=0.05)				0.39	0.29		NS	NS				

Table 4 Balance sheet of K (kg/ha) as influenced by integrated nutrient management and spray of cow urine and *Neemuch matka khad* in rice

Treatment	Initial soil K status (a)		K added (b)		K uptake by crop (c)		Soil K status after crop harvest (d)		Actual gain/ loss over initial status (a-d)		K balance (a+b)-(c+d)	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Nutrient management												
No Nutrients	140	124.0	3.4	3.4	234.4	214.2	124.0	115.7	16	8.3	–215	–202.5
15 tonnes FYM /ha	140	148.0	78.4	78.4	294.5	262.8	148.0	156.9	–8	–8.9	–224.1	–193.3
15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$ /ha	140	167.0	108.4	108.4	394.6	326.9	167.0	176.5	–27	–9.5	–313.2	–228
15 tonnes FYM + 60:60:30 kg ($N:P_2O_5:K_2O$ /ha)	140	159.0	108.4	108.4	350.6	284.6	159.0	165.8	–19	–6.8	–261.2	–183
SEm ±					8.2	4.57	5.03	4.0				
CD (P=0.05)					28.3	15.8	17.4	13.8				
Cow urine spray												
Cow urine three sprays @ 100 lit./ha each	140	147.5	75.3	75.3	326.0	277.4	147.5	152.2	–7.5	–4.7	–258.2	–206.8
Cow urine two sprays @ 100 lit./ha each	140	148.6	74.0	74.0	296.2	252.7	148.6	153.3	–8.6	–4.7	–230.8	–183.4
Neemuch Mutka Khad three sprays @ 100 lit./ha each	140	149.1	75.3	75.3	348.8	293.7	149.1	154.6	–9.1	–5.5	–282.6	–223.9
Neemuch Mutka Khad two sprays @ 100 lit./ha each	140	152.8	74.0	74.0	303.0	264.7	152.8	154.8	–12.8	–2	–241.8	–192.7
SEm ±					6.1	5.95	3.61	4.5				
CD (P=0.05)					17.8	17.4	NS	NS				

Table 5 Productivity efficiency, economics and total energy input and output (MJ/ha) of rice as integrated nutrient management and spray of cow urine and *Neemuch matka khad*

Treatment	Production efficiency kg grain/ ha/day	Cost cultivation (₹)	Net returns (₹)	B:C ratio	Energy input (MJ/ha)	Total energy output (MJ/ha)	Net energy output (MJ/ha)	Output: inout ratio	Energy-use efficiency	
									Kg grain/ MJ	Kg total dry matter/ MJ
Energy-use efficiency										
Nutrient management	42.1	29 734	17 950	0.61	5 537.17	152 886.8	147 349.6	26.61	0.85	2.06
No nutrients (Control) 15 tonnes FYM/ha	49.1	44 734	10 250	0.23	11 311.87	171 506.7	160 194.8	14.16	0.49	1.13
15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$ /ha	62.1	47 955	20 650	0.43	19 486.15	208 872.3	189 386.1	9.72	0.36	0.79
15 tonnes FYM + 60:60:30 kg ($N:P_2O_5:K_2O$/ha)	53.1	47 097	12 350	0.26	15 826.63	185 696.3	169 869.7	10.73	0.38	0.87
Cow urine spray										
Cow urine three sprays @ 100 lit./ha each	53.3	42 255	17 038	0.43	12 980.8	183 159.6	170 178.8	13.11	0.46	1.05
Cow urine two sprays @ 100 lit./ha each	47.2	41 955	11 121	0.29	12 874.98	167 478.5	154 603.5	12.01	0.41	0.97
Neemuch Mutka Khad three sprays @ 100 lit./ha each	56.6	42 915	20 114	0.50	13 250.97	194 529.9	181 278.9	13.68	0.48	1.09
Neemuch Mutka Khad two sprays @ 100 lit./ha each	49.3	42 395	12 942	0.33	13 055.09	173 793.9	160 738.8	12.31	0.43	0.99

In respect of cow urine spray, three spray utilized higher energy than two spray. The application of 15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$/ha produced higher gross and net energy output compared to other treatments. However, energy output : input ratio, energy-use efficiency in terms of kg grain/MJ and kg dry matter/MJ of all the treatments revealed that the control (no nutrient application) recorded maximum energy output : input ratio (26.61), energy-use efficiency of kg grain/MJ (0.85) and kg dry matter/MJ (2.06) than all other treatment (Table 5). This might be due to lower utilization of energy input in control (no nutrient application) than other treatment. However, three sprays were shown superiority over two spray of *Neemuch mutka khad* and cow urine.

Economics

Integrated use of 15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$/ha recorded maximum net return (₹ 20 650/ha) (Table 5). Sharma *et al*. (2007) also reported that by integration of FYM and Azotobacter with N productivity and monetary returns of wheat can be increased by maintaining or improving soil fertility. The application of 15 tonnes FYM + 60:60:30 kg $N:P_2O_5:K_2O$/ha was the next best treatment. The lowest net return was obtained with control due to lower grain yield. However, B:C ratio was computed higher under control (no nutrient application) 0.61, followed by treatment of 15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$/ha 0.43. Minimum B:C ratio (0.23) was observed under application of 15 tonnes/ha FYM alone than rest other treatments. High B:C ratio in control plot might be due to lower cost of cultivation than other treatment. The cultivation costs were abruptly increased in other treatment mainly due to higher cost of FYM. With respect of *Neemuch mutka khad* and cow urine spray, three sprays recorded higher net return and B:C ratio in comparison to two sprays.

It is concluded that the 15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$/ha and spray of fresh cow urine and *Neemuch mutka khad* improve our soil health along with sustainable productivity of rice under temperate condition. Thus the application of 15 tonnes FYM + 120:60:30 kg $N:P_2O_5:K_2O$/ha along with three spray of *Neemuch mutka khad* or fresh cow urine in rice was found suitable, and recommended under temperate valley condition.

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