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Utilization of Parthenium and water hyacinth as a bio-nutrient source in rice crop

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ABSTRACT

A field experiment was carried out at Rajendra Agricultural University, Pusa, Samastipur, Bihar during *kharif* seasons from 2004 to 2006 to assess the weed utility as a bio-nutrient source in rice cultivation. The results revealed that among organic sources, the use of water hyacinth (2.5 t/ha) FYM (5 t/ha) recorded the maximum growth, yield attributes and grain and straw yields of rice which was closely followed by water hyacinth (2.5 t/ha) + vermicompost (1 t/ha), Parthenium (2.5 t/ha) + vermicompost (1 t/ha), *Parthenium* (2.5 t/ha) + FYM (5 t/ha) and water hyacinth (2.5 t/ha) + poultry manure (1 t/ha). The maximum net return (Rs 11148/ha) and benefit: cost ratio (1.61:1) were also recorded by water hyacinth (2.5 t/ha) + FYM (5 t/ha). The highest available N (185.67 kg/ha), available P (26.38 kg/ha) and exchangeable K (525.6 kg/ha) were recorded by water hyacinth (2.5 t/ha) + FYM (5 t/ha). Water hyacinth or Parthenium either alone or in combination with other organic sources had a better utility as a bio-nutrient source. Among the inorganic levels, application of 100%, recommonded dose of fertilizer (RDF) produced significantly higher grain and straw yields as compared to other nutrient levels. Application of full dose of recommended NPK recorded significantly higher net return (Rs 10974 /ha) over 50% RDF which was closely followed by 75% RDF. Full dose of recommended NPK application had significant and beneficial effect on rice grain yield and improved the soil NPK status. The interaction effects between organic sources and inorganic levels were found to be non-significant.

Key words : Weed utility, Rice Productivity, Soil fertility, FYM, Vermicompost, Poultry manure

Improvement of soil fertility and crop productivity by the use of organic manure is a well known fact. Day-to-day increase in fertilizer cost, growing ecological concern and conservation of energy have created awareness for use of organics as a source of nutrients and also in integrated nutrient management system for sustainable production of rice. Continuous use of chemical fertilizers in rice adversely affects its sustainability (Singh *et al*. 1999). Sustainable rice productivity can be achieved through integrated nutrient management practices, comprising various sources *viz.,* chemical fertilizer, farm yard manure (FYM) and green-leaf. Organic manures play vital role in sustaining higher productivity in intensive agriculture and irrigated rice in particular. Organic manures not only act as the source of nutrients, but also modify soil-physical behaviour as well as increase the efficiency of applied nutrients. Nitrogenous fertilizers applied with organic manures produced equivalent or even higher dry matter and N uptake than inorganic source alone (Khan *et al.* 1987). Green manuring may decrease the volatilization loss of ammonia (Santra *et al.* 1988). *Parthenium hysterophorus* and *Eichhornia crassipea* (water hyacinth) are obnoxious weeds. Parthenium is found in all types of land, whereas water hyacinth is found in low land rice field and also in other aquatic ecosystem of Bihar. Effective control of these weeds is a major problem which harbours labour cost and other inputs too. One alternative use of these weeds would be as a green manure. The availability of organic manures like compost and farm yard manure (FYM) is a major limiting factor in their use. In recent years, with rapid increase in the number of poultry farms, substantial amounts of poultry waste is produced in north Bihar area. Due to its rapid mineralization, it was recognized as a valuable source of plant nutrients for crop plants (Sims 1987). Keeping the above facts in view, an experiment was conducted to study the utility of Parthenium and water hyacinth as a bio-nutrient source in rice cultivation.

MATERIALS AND METHODS

A field experiment was conducted at the research farm of Rajendra Agricultural University, Pusa, Bihar, during *kharif* seasons from 2004 to 2006. The soil of the experimental field was sandy loam in texture having 0.48% organic carbon, alkaline in reaction (pH 8.1) with electrical conductivity (EC) 0.49 milli mhos/cm, medium in available nitrogen (283 kg/ha), phosphorus (23 kg/ha) and rich in potassium (147 kg/ha). The experiment was laid out in split plot design with ten organic manure combinations [T_1*:* Parthenium (5 t/ha), T_2: Water hyacinth

(5 t/ha), T_3: Parthenium (2.5 t/ha) + water hyacinth (2.5 t/ha), T_4: Parthenium (2.5 t/ha) + farm yard manure (FYM) (5 t/ha), T_5: Water hyacinth (2.5 t/ha) + FYM (5 t/ha), T_6: Parthenium (2.5 t/ha) + poultry manure (1 t/ha), T_7: Water hyacinth (2.5 t/ha) + poultry manure (1 t/ha), T_8: Parthenium (2.5 t/ha) + vermicompost (1 t/ha), T_9 : Water hyacinth (2.5 t/ha) + vermicompost (1 t/ha), T_{10}: No organic manure as main plots and three levels of NPK (50, 75 and 100% recommended dose of NPK i.e. 80 kg N + 40 kg P + 20 kg K/ha) as sub plots. Each treatment was replicated thrice. The NPK contents of Parthenium, water hyacinth, poultry manure, FYM and vermicompost on dry weight basis were, 1.62, 1.54, 0.74; 1.92, 1.57, 0.82; 1.54, 1.50, 1.85; 1.41, 0.55, 1.75 and 1.36, 0.56, 1.14%, respectively. All organics were applied to the puddled soil and was incorporated manually 20 days before transplanting. Twenty two days old seedlings of rice cultivar *'Rajshree'* were transplanted at a spacing of 20 x 10 cm. Entire P and K along with 50% of N were applied at the time of transplanting and remaining 50% N was applied in two equal splits at 30 and 55 days after transplanting coinciding with active tillering and panicle initiation stages, respectively. The economics was worked out based on the prevalent local market price. At the end of third year, soil samples from 0 to 20 cm depth were collected and analyzed for available N, P and K.

RESULTS AND DISCUSSION

Performance of rice crop

Application of water hyacinth (2.5 t/ha) + FYM (5 t/ha) recorded the maximum grain yield of 5030 kg/ha which was significantly superior to no organic manure and alone application of Parthenium (5 t/ha) and water hyacinth (5 t/ha) and closely followed by water hyacinth (2.5 t/ha) + vermicompost (1 t/ha), Parthenium (2.5 t/ha) + vermicompost (1 t/ha), Parthenium (2.5 t/ha) + FYM (5 t/ha), water hyacinth (2.5 t/ha) + poultry manure (1 t/ha) and Parthenium (2.5 t/ha) + poultry manure (1 t/ha) (Table 1). Similar trends were also recorded with respect to growth and yield attributes of rice. Increase in grain yield in the present study may be attributed to yield attributes like number of panicles/m^2, number of grains per panicle, 1000-grain weight. Similarly, yield increase in rice with the application of poultry manure and farm yard manure was also reported by Prasad (1999). The superiority of farm yard manure and poultry manure along with Parthenium and water hyacinth is due to the release of aliphatic and aromatic hydroxy acids, humates and lignins (Ram Singh *et al.* 1985). Farm yard manure acts as nutrient reservoir and upon decomposition produces organic acids, thereby adsorbed ions are releasing slowly for the entire growth leading to higher yields (Nimje and Seth 1988). The increased grain yield with vermicompost along with

Table 1. Effect of different organic manures and graded levels of NPK on growth, yield attributes and yield of rice (pooled data of three years)

Treatment	Plant height (cm)	Dry matter production (g/hill)	Leaf area index	No. of panicles/ hill	Panicle length (cm)	No. of grains/ panicle	1000-grain weight (g)	Grain yield (kg/ha)	Straw yield (q/ha)	Harvest index
Organic manures										
Parthenium (5 t/ha)	78.1	124.3	3.7	9.0	16.3	105.3	20.6	4159	63.68	39.50
Watar hyacinth (5 t/ha)	78.6	121.4	3.8	9.2	16.9	108.9	20.8	4011	62.49	39.09
Parthenium (2.5 t/ha) + watar hyacinth (2.5 t/ha)	78.4	130.5	3.8	10.1	17.2	113.4	21.1	4426	65.36	40.38
Parthenium (2.5 t/ha) + FYM (5 t/ha)	78.9	133.7	3.9	10.6	18.1	116.5	21.5	4623	72.57	38.91
Watar hyacinth (2.5 t/ha) + FYM (5 t/ha)	79.5	138.4	4.1	10.9	19.9	118.7	22.8	5030	78.49	39.09
Parthenium (2.5 t/ha) + poultry manure (1 t/ha)	77.1	129.5	3.7	9.3	16.4	109.2	20.6	4467	64.89	40.77
Watar hyacinth (2.5 t/ha) + poultry manure (1 t/ha)	77.4	131.3	3.7	9.7	16.8	111.5	20.9	4589	68.53	40.11
Parthenium (2.5 t/ha) + vermicompost (1 t/ha)	78.3	132.5	3.3	9.3	17.7	114.5	22.8	4758	73.15	39.41
Watar hyacinth (2.5 t/ha) + vermicompost (1 t/ha)	78.6	135.4	3.8	9.5	18.5	116.9	23.5	4885	75.51	39.28
No organic manure	74.2	87.5	2.9	7.0	14.6	86.0	18.1	3519	51.32	40.68
LSD (P=0.05)	1.2	2.3	0.3	1.3	1.8	9.2	0.9	608	2.80	0.08
NPK levels										
50% NPK	76.8	98.7	3.1	7.1	15.1	96.7	18.5	4448	68.12	39.50
75% NPK	77.5	117.5	3.8	8.4	18.6	110.8	21.8	5048	77.53	39.43
100% NPK	81.2	139.8	4.4	10.2	20.5	122.5	23.6	5258	80.45	39.82
LSD (P=0.05)	2.3	2.8	0.4	0.9	1.1	10.7	0.76	209	3.5	NS

either Parthenium or water hyacinth may be attributed to significantly higher yield attributes due to increased availability of nutrients from vermicompost, presence of beneficial microflora such as nitrogen fixers (Lee 1992), phosphate solubilizers, VAM fungi, *etc.* (Harini Kumar *et al*. 1991) and due to the presence of biologically active metabolites like gibberellins, cytokinins, auxins and group B vitamins (Tomati *et al.* 1991). Application of 100% NPK recorded significantly superior grain yield (5258 kg/ha) than application of 50% (4448 kg/ha) and 75% NPK (5048 kg/ha). The increase in yield with 100% recommended dose of fertilizer (RDF) over 50% RDF and 75% RDF is to the extent of 18.21 and 4.16%, respectively. This indicates that rice responds to higher levels of NPK, which might be due to favorable climatic and soil condition during the crop growth that made the crop to respond for higher level of fertilizer (NPK). Similar observation was also made by Setty and Channabasavanna (1990).

Economics

Application of water hyacinth (2.5 t/ha) + FYM (5 t/ha) recorded significantly higher net return (Rs 11149/ha) over rest of the organic sources. The highest benefit: cost ratio (1.61:1) was recorded by water hyacinth (2.5 t/ha) + FYM (5 t/ha) which was closely followed by water hyacinth (2.5 t/ha) + poultry manure (1 t/ha), Parthenium (2.5 t/ha) + poultry manure (1 t/ha) and Parthenium (2.5 t/ha) + water hyacinth (2.5 t/ha). Among the NPK levels the highest gross return (Rs 30174/ha) and net return (Rs. 10974/ha) were recorded with 100 percent recommended dose of NPK. However, the benefit: cost ratio was found to be non-significant among the NPK levels (Table 2).

Effect on soil NPK status

The highest soil available N was recorded under water hyacinth (2.5 t/ha) + FYM (5 t/ha) which was closely followed by water hyacinth (2.5 t/ha) + vermicompost (1 t/ha) and Parthenium (2.5 t/ha) + vermicompost (1 t/ha) and significantly superior over rest of the organic sources. The highest available P and exchangeable K were also recorded with water hyacinth (2.5 t/ha) + FYM (5 t/ha) which were at par with water hyacinth (2.5 t/ha) + vermicompost (1 t/ha), Parthenium (2.5 t/ha) + vermicompost (1 t/ha), Parthenium (2.5 t/ha) + FYM (5 t/ha), Parthenium (2.5 t/ha) + poultry manure (1 t/ha), Parthenium (2.5 t/ha) + poultry manure (1 t/ha), and Parthenium (2.5 t/ha) + water hyacinth (2.5 t/ha) (Table 3). NPK (100%) recorded significantly higher available N and P over 50 and 75% NPK however, maximum exchangeable K was recorded with 100% NPK which was

Table 2. Effect of different organic manures and graded levels of NPK on monetary returns of rice (pooled data of three years)

Treatment	Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	Benefit : cost ratio
Organic manures				
Parthenium (5 t/ha)	24330	16785	7545	1.45
Water hyacinth (5 t/ha)	23464	16541	6923	1.42
Parthenium (2.5 t/ha) + water hyacinth (2.5 t/ha)	25892	16967	8925	1.53
Parthenium (2.5 t/ha) + FYM (5 t/ha)	27044	18535	8509	1.46
Water hyacinth (2.5 t/ha) + FYM (5 t/ha)	29466	18317	11149	1.61
Parthenium (2.5 t/ha) + poultry manure (1 t/ha)	26132	16983	9149	1.54
Water hyacinth (2.5 t/ha) + poultry manure (1 t/ha)	26846	17115	9731	1.57
Parthenium (2.5 t/ha) + vermicompost (1 t/ha)	27834	18637	9197	1.49
Water hyacinth (2.5 t/ha) + vermicompost (1 t/ha)	28577	18965	9612	1.51
No organic manure	20586	15860	4726	1.30
LSD (P=0.05)	1625	-	1533	0.08
NPK levels				
50% NPK	26021	17530	8491	1.48
75% NPK	29113	18365	10748	1.61
100% NPK	30174	19200	10974	1.57
LSD (P=0.05)	1365	-	1765	NS

Table 3. Available soil N, P and K status in rice field as influenced by organic manures and graded levels of NPK (pooled data of three years)

Treatment	Available N (kg/ha)	Available P (kg/ha)	Exchangeable K (kg/ha)
Organic manures			
Parthenium (5 t/ha)	165.86	19.31	496.2
Water hyacinth (5 t/ha)	163.57	18.85	489.3
Parthenium (2.5 t/ha) + water hyacinth (2.5 t/ha)	167.45	20.87	505.8
Parthenium (2.5 t/ha) + FYM (5 t/ha)	174.56	23.72	511.2
Water hyacinth (2.5 t/ha) + FYM (5 t/ha)	185.67	26.38	525.6
Parthenium (2.5 t/ha) + poultry manure (1 t/ha)	169.67	21.35	507.5
Water hyacinth (2.5 t/ha) + poultry manure (1 t/ha)	171.85	22.79	509.8
Parthenium (2.5 t/ha) + vermicompost (1 t/ha)	178.75	24.63	512.3
Water hyacinth (2.5 t/ha) + vermicompost (1 t/ha)	181.89	25.26	518.7
No organic manure	146.56	16.75	458.32
LSD (P=0.05)	7.65	6.03	26.7
NPK levels			
50% NPK	158.58	18.87	474.6
75% NPK	172.45	22.35	503.8
100% NPK	182.75	25.75	515.5
LSD (P=0.05)	8.53	1.21	23.2

closely followed by 75% NPK and significantly superior over 50 % NPK.

Thus, the study revealed that water hyacinth and Parthenium either alone or in combination with other organic sources have a better utility as a bio-nutrient source and had significant beneficial effect on rice grain yield and improved the soil fertility. Similar results were also reported by Singh *et al*. 2000.

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