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Pest and Disease Tolerance in Rice *cv Pusa Basmati* as Related to Different Locally Available Organic Manures Grown in New Alluvail Region of West Bengal, India

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Abstract: Field experiments were carried out to evaluate relative efficacy of organic manures in improving productivity, pest tolerance of rice in lateritic soil. Three commercial manures viz., Processed Municipality Waste (PMW), Vermicompost (VC) and Oil Cake Pellets (OCP) were assessed in relation to Farmyard Manure (FYM) and with Chemical Fertilizer (CF). Among the organic manures tested, FYM produced maximum grain yield. Maximum tolerance to pests and pathogens in terms of per cent affected hills/panicles was observed when manured with VC followed by FYM. Chemical fertilizer showed significantly higher per cent affected hills and plants compared to all other organic manures. Among the commercial manures, PMW emerged as a potential alternative to FYM and VC.

Key words: Alluvail soil, rice, organic manures, grain yield, resistance

INTRODUCTION

Unbalanced nutrient supply to crop often results in lush sappy growth that makes the crop more susceptible to pests and diseases (Magdoff and van Es, 2000). The increase in the incidence of insect-pests and disease-pathogens is responsible for increase in the use of toxic pesticides almost by leaps and bounds. Chemical pesticides often affect species other than the target pests, particularly their predators. Thus the natural checks and balances surrounding a pest may get reduced, leading to the need for use of greater amount of pesticide in subsequent years. Inspite of using over 100,000 tons of insecticides, pre-harvest losses today are as high as 15%, while 30 years ago these losses were 7.5% with a consumption of only 4000 tons of pesticides (Raza, 2010). This “vicious spiral” is exacerbated by the ability of the pest to become resistant to pesticides. This means that, over a period of time, more and more of a pesticide would be required to achieve the same level of control.

Increased use of pesticides has increased the risk of finding their toxic residues in human diet. In India, average dietary intake of pesticide residues has been estimated to be 362.5 mg/day/person (vegetarian) and 356.3 mg/day/person (non-vegetarian). Most of the pesticide residues are known to affect the central nervous system, respiratory system and gastro-intestinal system of human being. Besides posing health hazard due to toxic residues in the food, it may also have commercial risk in export markets, since such produce with high toxic residues are not likely to be accepted.

The outcome of neglecting the importance of soil organic matter in crop production and prolonged overuse of soluble agro-chemicals on lowering land productivity, increased crop infestation of pests and diseases, human health hazards and pollution of the environment are becoming increasingly evident (Huber and Graham, 1999). It is now considered that restricted use of chemicals and inclusion of organic materials could be the alternative to come out of 'vicious spiral' of agrochemical menace (Rao, 1996). Mineral nutrients may either increase or decrease the resistance or the tolerance of the plants to pathogens and pests. Ramesh *et al*. (2005) concluded that organic crops have been shown to be more tolerant as well as resistant to insect attacks and organic rice is reported to have thicker cell wall and lower levels of free amino acid than conventional rice.

In view of the above, the present investigation was undertaken to assess the influence of different locally available organic manures on resistance and tolerance to attack by insect-pests and disease-pathogens in rice .

MATERIALS AND METHODS

The experiment with rice (*Oryza sativa* L.) variety Pusa Basamati was conducted during the spring in the year 2005 and 2006 in a farmers plot in new alluvial region of West Bengal, India ($pH_{(H2O)}$ 5.6, organic C 3.9 g kg^{-1}, contained 16% clay, 24% silt and 7.3 ppm P (Bray 1). The rice crop was grown during wet season (June-October). Treatments comprised of a total of seven nutrient sources which include (a) three commercial manures varying in nutritional quality, (b) farmyard manure (FYM)

(c) farmyard manure+microbial culture (FYM+MC), (d) Chemical Fertilizer (CF) and (e) untreated control (UC). The commercial manures included Oil Cake Pellets (OCP), Vermicompost (VC) and Processed Municipality Waste (PMW) while the chemical fertilizers included urea, single super phosphate and muriate of potash. The microbial culture was commercially procured and these contained fast decomposing and other beneficial bacteria. Organic manures were applied at recommended N equivalent basis (80 kg N ha^{-1}) although P and K supplied by these manures differed depending upon their nutrient composition. FYM and commercial manures considerably vary in their physical and chemical properties. Total quantity of organic manure under different treatments were incorporated 15 days before transplanting/sowing while the others ¾th of inorganic fertilizer N was applied in three equal splits as top. The layout of the first experiment followed split plot design with three replications, where the main plots was allotted for two levels of pest control viz. No Pest Control (NPC) and Chemical Pest Control (CPC) and in sub plots, seven sources of nutrients were randomized.

Observations on pests, pathogens in rice was recorded. For taking observations, each plot was divided into four quadrants of 6 sq. m (3×2 m) each. From each quadrant, 10 hills\plants were randomly selected and thoroughly searched for pests and pathogens attack. The per cent hills/tillers/panicles/plants affected by individual insect-pests and disease-pathogens was then calculated by considering only those hills/tillers/panicles/plants affected or damaged of insect-pests and disease-pathogens above 10 % by individual insect-pests and disease pathogens.

RESULTS

Rhizoctonia solani was the major disease-pathogen observed and brown plant hopper (*Nilaparvata lugens*) and gundhi bug (*Leptocorisa acuta*) had been the major insect-pests attacking the rice crop. The observations recorded on crop-plants resistance to attack by pathogens and pests in terms of per cent affected hills and panicles for rice have been shown in Table 1. Data reveals that the per cent affected hills/panicles/plants were significantly lower when Chemical Pest Control (CPC) were undertaken as compared to No Pest Control (NPC) in both the years. Per cent affected hills/ panicles/plants varied among the nutrient sources. Significantly lower per cent affected hills/ panicles /plants were observed in untreated control than all other nutrient sources. Chemical fertilizer showed significantly higher per cent affected hills/panicles/plants compared to all organic nutrient sources used except OCP. The per cent affected hills/panicles by *Rhizoctonia solani*,

Table 1: Insect-pest and disease-pathogen damage in rice as influenced by pest control (PC), nutrient sources (NS) and their interaction (I)

	Pest Control (PC)								
	Sheath blight (% affected hills)			Hopper burn (% affected hills)			Gundhi bug (% affected panicles)		
Treatments	NPC	CPC	Mean	NPC	CPC	Mean	NPC	CPC	Mean
Nutrient Sources (NS) (2005)									
PMW	9.43	1.63	5.53	14.12	2.16	8.14	31.83	4.11	17.97
VC	4.67	0.65	2.66	7.17	1.54	4.36	23.56	2.53	13.05
OCP	22.10	4.07	13.09	28.43	4.87	16.65	50.07	6.18	28.13
FYM+MC	11.39	1.41	6.40	16.09	1.83	8.96	35.55	3.96	19.76
FYM	6.53	1.04	3.79	10.12	1.62	5.87	30.21	3.33	16.77
CF	17.62	3.63	10.63	24.66	4.14	14.40	47.38	4.92	26.15
UC	3.14	0.08	1.61	5.27	0.04	2.66	18.18	1.81	10.00
Mean	10.70	1.79		15.12	2.31		33.83	3.83	
	PC	NS	I	PC	NS	I	PC	NS	I
SEM ±	0.19	0.34	0.48	0.24	0.43	0.61	0.36	0.94	1.34
LSD (0.05)	1.16	0.99	1.40	1.46	1.26	1.78	2.19	2.74	3.90
Nutrient Sources (NS) (2006)									
PMW	8.76	1.57	5.17	15.86	2.54	9.20	29.73	3.41	16.57
VC	3.93	1.16	2.55	6.64	1.32	3.98	19.92	2.53	11.23
OCP	17.86	3.08	10.47	23.93	4.98	14.46	43.80	4.87	24.34
FYM+MC	9.21	1.49	5.35	17.40	1.93	9.67	31.74	3.48	17.61
FYM	7.40	1.24	4.32	12.67	1.44	7.06	24.86	2.94	13.90
CF	15.66	3.46	9.56	21.83	3.80	12.82	39.77	4.22	22.00
UC	1.87	0.06	0.97	3.82	0.06	1.94	15.52	1.67	8.60
Mean	9.24	1.72		14.59	2.30		29.33	3.30	
	PC	NS	I	PC	NS	I	PC	NS	I
SEM ±	0.16	0.29	0.41	0.21	0.38	0.56	0.34	0.89	1.26
LSD (0.05)	1.07	0.83	1.20	1.18	1.09	1.63	2.10	2.57	3.68

Table 2: Average Grain yield of rice as influenced by pest control (PC), nutrient sources (NS) and their interaction (I)

Treatments	Grain yield (mg ha^{-1}) NPC	CPC	Mean
Nutrient Sources (NS)			
PMW	3.14	4.31	3.72
VC	3.36	3.72	3.54
OCP	2.45	3.81	3.13
FYM+MC	3.55	4.63	4.09
FYM	3.95	4.43	4.19
CF	2.50	3.77	3.13
UC	1.80	2.20	2.00
Mean	2.96	3.84	
	PC	NS	I
SEM ±	0.07	0.14	0.18
LSD (0.05)	0.43	0.40	0.52

brown plant hopper and gundhi bug were significantly lower in FYM than commercial manures tested except VC and FYM+MC. The second year also followed similar general trend.

Interaction effect of nutrient sources and pest control significantly influenced the per cent affected hills, panicles and plants due to incident pests and pathogens in Table 1. In general, a significantly lower per cent of affected hills (1.72-2.31%) and panicles (3.30-3.83%) were observed in all treatments with different nutrient sources under CPC as against NPC. The per cent affected hills/panicles by *Rhizoctonia solani*, brown plant hopper and gundhi bug in rice were significantly lower in the FYM treatment under NPC compared to treatment of commercial organic manures except VC. The general trend was similar in both the years. It was observed from (Table 1) that nutrient sources such as OCP and CF had profound interactive influence while FYM+MC and PCW had an average interactive effect with pest control measure on the per cent affected plants.

In general grain yield of rice significantly increased over the period of time. FYM attained significantly maximum yield followed by combination of FYM and MC (Table 2). A significantly minimum yield was recorded in control plots. Grain yield was significantly influenced by pest control measures. Significantly higher grain yield was recorded in CPC compared to NPC. Grain yield recorded in UC was lowest and significantly inferior to other nutrient sources. Although grain yield in CF was lower than in all commercial manures, statistically they were not different. Among the commercial organic sources (PMW, VC and OCP), only PCW was significantly superior compared to CF, while others were at par. FYM treatment was responsible for significantly higher yield compared to commercial nutrient sources and at par with FYM+MC. Interaction effect of pest control and nutrient sources significantly influenced grain yield. All commercial manures, except OCP showed statistically higher yield compared to CF where pest control measures were not undertaken .However under CPC, the grain yield obtained with application of FYM was significantly higher than treatments with all commercial manure except PCW, which was comparable. On comparing FYM and FYM+MC, under NPC grain yield in FYM was superior to FYM+MC. The grain yield recorded in certain nutrient sources such as OCP and CF showed profound interactive influence with pest control measures, while FYM+MC and PMW showed moderate interactive. However in FYM, VC and UC the variation in fruit yield between NPC and CPC was small and statistically not different.

DISCUSSION

The percentage of affected hills/panicles in rice caused by pathogens and pests attack have been lower in treatment with FYM compared to treatments with CF and commercial manures except VC, under conditions where pest control measures were not adopted. The percentage affected hills/panicles in rice ranged from 8 to 31 (average of two years) following treatment with different nutrient sources. However, FYM treatment has been responsible for maximum tolerance to attack by pests and pathogens since grain yield has been highest when pest control measures have not been adopted Table 2. The extent of tolerance in terms of increase in grain yield of rice in treatment with FYM against treatments with commercial manures and CF ranged from 14 to 58% (average of two years). In fact the grain yield recorded in different treatments has not been always proportional to the amount of hills/panicles that have been affected. From this, it would be tempting to infer that nutrient source having favorable influence on crop resistance may not have similar influence on its tolerance to attack by pathogens and pests as has been similarly reported by Huber (1980). The absence of significant correlation between per cent affected hills/panicles and rice yield tables below confirms such an interpretation.

A balanced nutrient supply that ensures optimal plant growth has also been considered by some author as optimal for plant resistance (Marschner, 1988). As regards tolerance, a general pattern has been described (Huber, 1980, 1989; Graham, 1983) in which plants suffering from mineral nutrient deficiency have lower tolerance to pathogens and pests, which can be increased by supplying the deficient nutrient. Such a relationship is expected because vigorously growing plants usually have a higher capacity to compensate, for example, for losses of photosynthates or damage to leaf and root surface area due to infection or feeding by pests etc. (Marschner, 1988).

Table 3: Correlation of N, P and K content of plant with pathogen/pest damaged hills/panicles at different growth stages in rice as influenced by the use of different nutrient sources

Nutrient content	Sheath blight 2005	Sheath blight 2006	Hopper burn 2005	Hopper burn 2006	Gundhi bug 2005	Gundhi bug 2006
30 DAT						
N	0.61	0.55	0.64	0.64	0.70	0.59
P	0.31	-0.02	0.32	0.15	0.41	0.08
K	-0.35	-0.23	-0.31	-0.15	-0.21	-0.16
60 DAT						
N	-0.12	-0.27	0.07	0.34	0.05	0.29
P	0.03	0.10	0.06	0.26	0.17	0.18
K	-0.42	-0.29	-0.39	-0.16	-0.29	-0.22
90 DAT						
N	0.23	0.19	0.28	0.29	0.38	0.24
P	0.18	0.29	0.21	0.08	0.31	0.38
K	-0.33	-0.20	-0.30	-0.44	-0.19	-0.14

The substance known to influence pest activity are wide ranging and include amino acids, sugars, enzymes, phenols, alkaloids etc. (Palaniappan and Annadurai, 1999). When nutrients are made available to the crop-plants in required quantity and proportion, these may aid formation of such substances that impart resistance to disease-pathogens and insect-pests.

It has been reported that submerged conditions in rice growing provides favorable influence on nutrient balance (Ghildayal, 1973) which can be a reason for lower variation among the manures in respect of per cent affected hills/panicles . Further, it has also been observed that individual plant content of N, P and K has less bearing on crop resistance to pathogens and pests than their proportion in the plant (Table 3). Altieri and Nicolls, (2003), Varughese and Padmakumari (1993) and Mathews *et al.* (1996) have also pointed out towards such a relationship. The absence of significant correlation table below between individual N, P and K content and corresponding per cent affected hills/panicles confirm such a notion.

Young and rapidly growing plants are more likely to suffer attack by pests than old and slow growing plants. Therefore, often positive correlation between nitrogen and pest attack has been reported (Marschner, 1988). The continuous, balanced and sample supply of both major and minor elements resulted not only in better resistance but also higher tolerance to pathogens and pests in rice following application of FYM besides recouping soil health (Raikar *et al*., 2009). Nutrient sufficiency may provide a general form of resistance to biotic attack by maintaining a high level of inhibitory compounds in tissue or quick response to invasion by a pathogen.

The intricate relationship of the plant nutritional status with plant pathogens, the abiotic environment and organisms in the environment is dynamic and genetically controlled , the severity of most diseases and insect attack is mediated through physiological and biochemical processes and can be greatly decreased by proper nutrient management. Knowledge of the relationship of plant nutrition to disease provides a basis for reducing disease severity in intense as well as integrated crop production systems. Among the commercial manures, PMW emerged as a potential alternative to FYM.

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