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Effects of Fertilizers and Pesticides on Growth and Yield of Rice

M. T. Haq, M. A. Sattar, M. M. Hossain and M. M. Hasan
Department of Soil Science, Bangladesh Agricultural University,
Mymensingh-2202, Bangladesh

Abstract: An experiment was conducted to study the effect of fertilizers and pesticides on the growth and yield of BRRI Dhan 30 rice. There were twelve treatments T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9, T_{10}, T_{11} and T_{12}. The rates of different fertilizers were 90 kg N from urea, 50 kg P_2O_5 from TSP, 40 kg K_2O from MP, 10 kg S from gypsum, 4 kg Zn/ha from $ZnSO_4.H_2O$. The recommended doses of diazinon (Di) and sodium arsenite pesticides as 1680 and 500 ml/ha, respectively were used in the experiment. All the treatments significantly increased the grain and straw yields of BRRI Dhan 30 rice over control except T_{12} which showed a decreasing trend. The combined application of N, P, K, S, Zn and Di produced the highest grain yield (4773 kg/ha) which was 47.31% increase over control. On the other hand, single application of As decreased the yield (3088 kg/ha) by 4.69% over control.

Key words : Fertilizers, pesticides, crop yield

Introduction

Bangladesh is an agro-based country where around 32% of her total gross domestic product (GDP) comes from agriculture (BBS, 1998). Agriculture in Bangladesh is characterized by intensive crop production, mainly rice. The crop covered an area of about 10712.55 thousand hectares producing 23066.00 thousand tons of rice with an average yield of 2.15 t/ha (Monthly Statistical Bulletin, Bangladesh, November, 2000). Never the less, the yield of rice is low in Bangladesh compared to 5-6 t/ha in China, Japan and Korea. There are several factors behind it, of them, depletion of organic matter, imbalance use of fertilizer, high doses of pesticide, intensive cropping without inclusion of legume crops in rotation, use of modern varieties, nutrient leaching with monsoon rain, lack of knowledge of new inputs and techniques etc. So, production of rice can be increased by balanced fertilizers, replenishment of soil organic matter, crop rotation with legumes, changing of cropping pattern, optimum doses of pesticides and advanced management practices etc.

The deficiency of primary elements like N,P,K of Bangladesh soils but thereafter, S and Zn are also deficiency with N, P,K observed (Islam *et al*. 1986; Hoque and Jahiruddin, 1994). Now each crop has recommended dose of N,P, K, S and Zn fertilizers in Bangladesh. Although Bangladesh is a small country having an area of 147570.00 sq.km. There exists a natural variation in soil condition. So, developed technology of fertilizers are need to be adapted to each situation.

Pesticides have been used to some extent since ancient times. The Chinese used arsenic in 900 A.D. to control garden insects. Arsenic is a harmful trace element. Arsenic problem of soil and water in this country is increasing day by day. Today Bangladesh face severe arsenic hazards is drinking water but in future it may arise in food grain too.

Pesticide were applied to rice crops increased the yields significantly (Moletti *et al.*, 1993). In Europe, Japan and USA, crop production has been greatly increased by proper used of pesticides. Crop yield significantly increased with minor to normal uses of pesticides. Application of furadan and mocap pesticides on Ratna rice at Kalyani, WB, India, increased the yield significantly. The yield of rice was highest (3.8 t/ha) with application of furadan at 1 kg/ha (Das, 1997). Sattar (1998) handled 4-5 experiments covering on impacts of pesticides on crop yields (rice, wheat, groundnut etc.) where crop yield significantly increased with minor to normal uses of pesticides. Bangladesh is a rice growing country where 50-60 pesticides are used (Sattar, 1998a). In using pesticides, the benefits must be weighed against their effects on human health biological interactions, with non-target species, pesticide resistance and alterations to and/or accumulation of pesticide in the environment. In order to minimize the risks associated with the use of pesticides Young (1987) advocated a better understanding of pesticide pharmacology and toxicology, pests and pest management and potential hazards associated with pesticide use. In Bangladesh very limited work has been concerning the effects of pesticides in yield and/or quality of crops. Therefore, the present study was undertaken to know the effects of fertilizers and pesticides on growth and yield of rice.

Materials and Methods

An experiment was conducted at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during aman season of 2000 to study the effects of fertilizers and pesticides on growth and yield of BRRI Dhan 30 rice. The experiment field was opened on July 27, 2000 and continued until December 02, 2000. There were 12 treatments T_1 (control), T_2 (N, P, K), T_3 (N, P, K, S), T_4 (N, P, K, S, Zn), T_5 (N, P, K + Di), T_8 (N, P, K + As), T_9 (N, P, K, S + As), T_{10} (N, P, K, S, Zn + As), T_{11} (Di) and T_{12} (As) and the experiment was laid out in a randomized complete block design with 3 replications. The rates of different fertilizers were 90 kg N from urea, 50 kg $P_2 0_5$ from TSP, 40 recommended doses of diazinon (Di) and sodium arsenite (As) pesticides as 1680 ml/ha and 5000 ml/ha, respectively were used in this experiment. The treatments were randomly distributed to the plots in each block. There were 36(12 × 3) unit plots, each plot measuring 4 × 2 m^2. The plot to plot distance was 0.5 m and block to block distance was 1.0 m. The bunds around individual plots were significantly strong to control water movement between the plots. A drain of 1m with was provided around the whole experiment plot and between the blocks. During the grain period of the crop, all necessary cares (application of fertilizers, pesticides, irrigation, weeding etc.) were done for ensuring and maintaining the normal growth and development of the crop. The physical and chemical properties of the soils are reported in Table 1.

Collection of data: a) The plant height was measured from the ground level to the top of the panicle. From each plot plants of 10 hills were measured and averaged b) Panicle length: in ten selected hills per plot were recorded in cm and averaged. c): Ten hills were selected at random from each plot and total number of tillers/hill were calculated. The number of effective tillers/hill were also calculated. d): Each panicle were selected and the filled and unfilled grains/panicle were counted and averaged.

e) Thousand grains were selected from each plot and the weight of grains were recorded in gm after sundering in an electrical balance. f) : Grain and straw obtained from each plot were dried and weighed carefully. The yields were expressed as kg/ha on 14%

Table 1: Physical and chemical characteristics of the field soils

Physical characteristics		Chemical characteristics		
Constituent	Value	Constituent	Unit	Value
Particle size distribution		CEC	Meq/100 g soil	17.17
Sand(%)	14.44	PH	-	6.80
Silt (%)	73.40	Organic carbon	%	1.52
Clay(%)	12.16	Organic matter	%	2.62
Textural class	Silt loam	Total N	%	0.11
		Available P	ppm	8.86
		Exchangeable K	Meq/100 g soil	0.12
		Available S	ppm	16.00

moisture basis. All treatments significantly increased the grain and straw yields of BRRI Dhan 30 rice over control (5-47%) except T_{12} 0.5%).

Results and Discussion

Growth parameters of rice

Plant height: Plant height of BRRI Dhan 30 rice was significantly affected by the selected treatments. The height of plant varied from 106.5 cm in T_{12} to 121.8 cm in T_7 (Table 2). The highest plant height (121.8 cm) found in T_7 treatment which was statistically identical to all other treatments except T_1, T_{11} and T_{12}. Fertilizers and diazinon together showed better performance in increasing the plant height. Table 2 also showed that plant height increased with the combined application of fertilizers and diazinon. Plant height decreased with single application of arsenic. Awan *et al.* (1984) reported that the application of different levels of nitrogen on rice increased plant height significantly. Juan *et al.* (1996) reported that increasing the level of arsenic decreased plant height.

Tillers/hill: The tillers/hill was significantly influenced by the treatments. The number of tillers/hill due to different treatments varied from 7.66 to 14.33 and the minimum number was obtained in T_{12} treatments (Table 2). The treatments T_7 produced the highest number of tillers/hill (14.33) which was statistically identical to T_3, T_4 and T_6 treatments. The obtained effect of fertilizers and diazinon was more in producing the number of tillers/hill as compared to combined application of fertilizers + arsenic and single application of arsenic. Yuying and Li (1999) observed that the application of S increased the number of tillers. Varshney (1988) reported that the application of zinc increased the number of tillers. Uddin *et al.* (1998) reported that half of recommended doses of pesticides application increased the number of tillers but high doses decreased.

Effective tillers/hill: The treatment T_7 gave the highest number of effective tillers/hill (13.00), which was statistically similar to T_4 (11.00), T_5 (11.00) and T_6 (11.67) treatments (Table 2). The treatment T_{12} produced lowest number of effective tillers/hill (7.00) than those of other treatments. Fertilizers + diazinon produced better effective tillers than that of fertilizers + arsenic and fertilizers treated plots. It was observed that effective tillers was positively correlated with tillers/hill (Fig. 1). Balakrishnan and Natarajaratnam (1986) reported that the application of 25 kg $ZnSO_4$/ha with N,P and K on rice increased the effective tillers/hill. Barnas *et al.* (1986) reported that the similar results.

Panicle length: The treatment T_7 produced longest/highest panicle length of 25.00 cm which was statistically identical to T_6 (24.00 cm) treatment. The lowest panicle length of 19.47 cm was recorded in the T_{12} treatment which was significantly different from all other treatments (Table 3). The panicle length was positively correlated with grains/panicle (Fig. 2). Azad *et al.* (1995) noted that the panicle length increased with the increasing levels of nitrogenous fertilizer Varshney (1988) reported that application of zinc increased the panicle length.

Grains/panicle: The numbers of grain/panicle was significantly influenced by the treatments. The number of grain/panicle ranged from 101.8 to 129.7 (Table 3). The treatment T_6 produced the highest number of grains/panicle (129.7) which was statistically similar to those of T_4, T_5, T_7 and T_9. The treatment T_{12} (101.8) had the lowest number of grain/panicle. The treatment T_1, T_2, T_8 and T_{11} also increased the number of grain/panicle over T_{12}. In general, diazinon treated plots showed slightly better performance than that of arsenic. Halder *et al.* (2000) also showed that number of grain/panicle increasing trend with increasing N-rates.

Filled grains/panicle: The number of filled grains/panicle varied from 84.80 to 110.2 (Table 3). All the treatments increased the number of filled grains/panicle except T_1, T_{11} and T_{12}. The treatment T_7 give the highest number of filled grains/panicle (110.2), which was statistically identical to the treatments T_3, T_4, T_5, T_6 and T_{10}. The treatment T_2 (102.5) and T_8 (102.2) also produced significantly higher number of filled grains/panicle over T_1 (85.50), T_{11} (86.50) and T_{12} (84.80) treatments.

The diazinon was more effective in producing filled grains/panicle compared to As. Mondal *et al.* (1987) found that the increasing rate of N and/or K_2O from 40 to 160 Kg/ha increased percentage of filled grain Babikar (1986) observed that number of filled and unfilled grains/panicle was significantly affected by rice cultivars and $ZnSO_4$ rate.

1000-grain weight: The data (Table 4) showed that the 1000-grain weight of BRRI Dhan 30 rice was not significantly influenced by the different treatments although some variations existed between in treatments. The highest and lowest 1000-grain weight were obtained in treatments T_7 and T_{12} respectively which different by 1.40 g only. Mondal *et al.* (1987) found that the increasing rate of N and/or K_2O from 40 to 160 kg/ha increased percentage of filled grain and 1000-grain weight. Varshney (1988) reported that application of zinc increased panicle length and 1000-grain weight. Khalil (1996) showed that single effect of different pesticides had pronounced effect on the growth, yield and yield contributing characters of two varieties of transplanted aman rice.

Grain and straw yield of rice

Grain yield: The grain yield responded significantly to different treatments. The grain yield varied from 3088 to 4773 kg/ha (Table 4). The highest grain yield was achieved in the treatment T_7 which was statistically identical to T_4, T_5 and T_6. The lowest grain yield was noted in the treatment T_{12} (3088 kg/ha) which was statistically similar to T_1 and T_{11} treatments. The treatment T_7 produced 47.31% higher and T_{12} treatment produced 4.69% lower grain yield over control. The grain yield was positively correlated with straw yield (Fig. 3). It was observed that yield increased due to combined application of fertilizers only (Fig. 4) and fertilizers and diazinon (Fig. 5) but observed due to combined

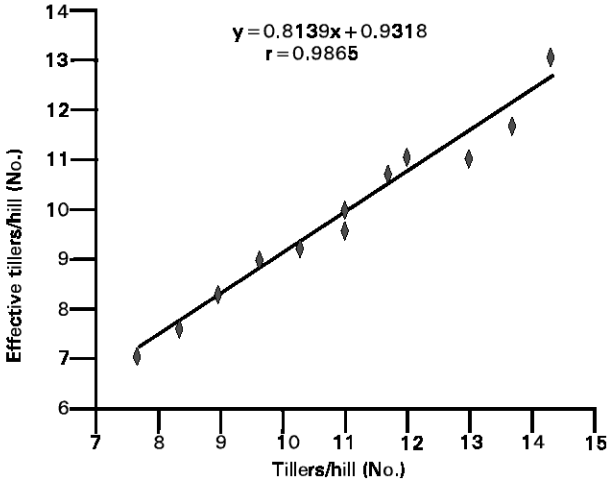

Fig. 1: Relationship between tillers/hill and effective tillers/hill

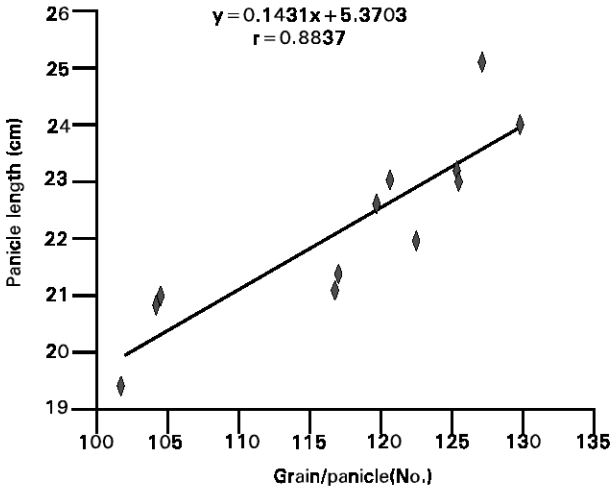

Fig. 2: Relationship between panicle length and grains/panicle

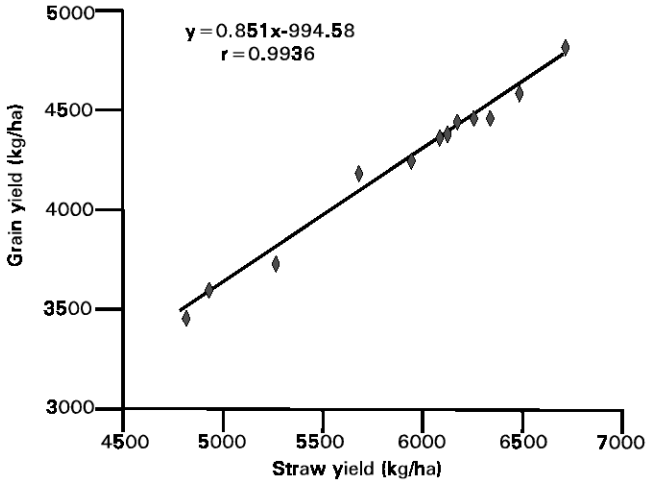

Fig. 3: Relationship between grain yield and straw yield

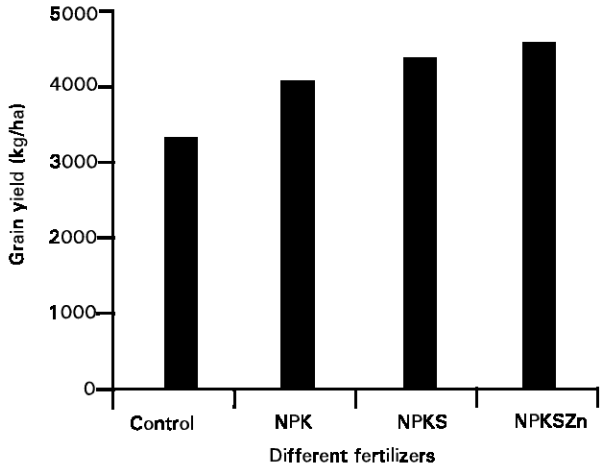

Fig. 4: The effect of fertilizes on grain yield of BRRI Dhan 30 rice

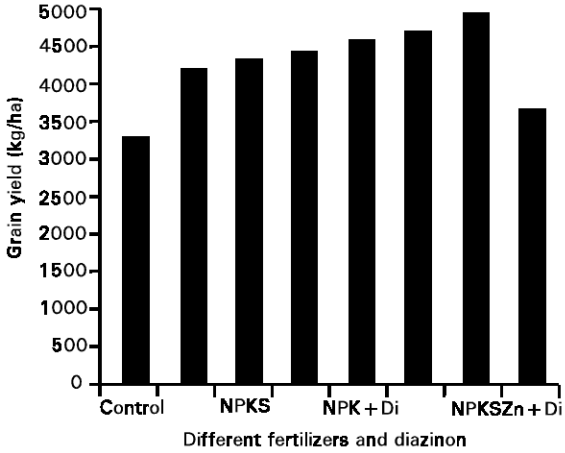

Fig. 5: The effect of fertilizer and diazinon on grain yield of BRRI Dhan 30 rice

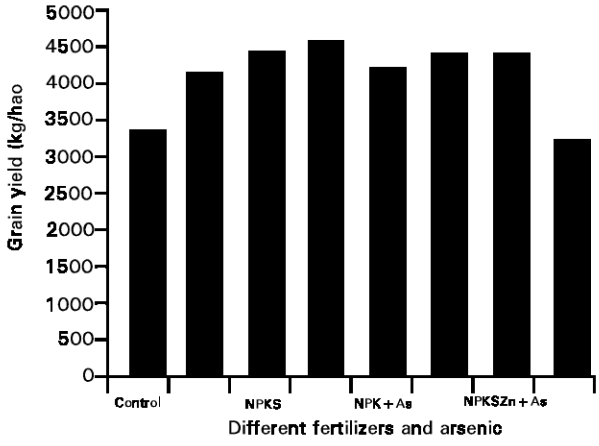

Fig. 6: The effect of fertilizer and arsenic on grain yield of BRRI Dhan 30 rice

Table 2: Effect of fertilizers and pesticides on plant height, tillers/hill and effective tillers/hill of BRRI Dhan 30 rice

Treatment	Plant height	Tillers/hill (no.)	Effective tillers/hill (no.)
T_1 (control)	108.3cd	8.33fg	7.66ef
T_2 (N,P,K)	114.7a-d	10.33c-g	9.33c-e
T_3 (N,P,K,S)	116.6a-c	11.67a-e	10.67bc
T_4 (N,P,K,S,Zn)	118.8ab	12.00a-d	11.00a-c
T_5 (N,P,K + Di)	120.3a	13.00a-c	11.00a-c
T_6 (N,P,K,S + Di)	121.5a	13.67ab	11.67ab
T_7 (N,P,K,S,Zn + Di)	121.8a	14.33a	13.00a
T_8 (N,P,K + As)	112.8a-d	9.64d-g	9.00c-f
T_9 (N,P,K,S + As)	115.4a-d	11.00b-f	9.66b-e
T_{10} (N,P,K,S,Zn + As)	117.7ab	11.00b-f	10.00b-d
T_{11} (Di)	110.0b-d	9.00e-g	8.33d-f
T_{12} (As)	106.5d	7.66g	7.00f
LSD (5%)	8.25	2.44	2.03
CV (%)	4.22	13.15	12.16

Figure(s) in column having common letter(s) did not differ significantly at 5% level of significance.

Table 3: Effect of fertilizers and pesticides on panicle length, grains/panicle and filled grains/panicle of BRRI Dhan 30 rice

Treatment	Panicle length (cm)	Grains/panicle (no.)	Filled grains/panicle (no.)
T_1 (control)	20.90e	104.3d	85.50d
T_2 (N,P,K)	21.40de	117.0c	102.5bc
T_3 (N,P,K,S)	22.64b-d	119.6bc	109.3ab
T_4 (N,P,K,S,Zn)	23.17bc	125.3ab	105.3a-c
T_5 (N,P,K + Di)	23.07bc	125.3ab	108.3a-c
T_6 (N,P,K,S + Di)	24.00ab	129.7a	109.2ab
T_7 (N,P,K,S,Zn + Di)	25.00a	126.9ab	110.2a
T_8 (N,P,K + As)	21.17e	116.9c	102.2bc
T_9 (N,P,K,S + As)	22.00c-e	122.5a-c	101.5c
T_{10} (N,P,K,S,Zn + As)	23.03bc	120.7bc	103.5a-c
T_{11} (Di)	21.03e	104.5d	86.50b
T_{12} (As)	19.47f	101.8d	84.80b
LSD (5%)	1.31	7.26	6.41
CV (%)	3.49	3.64	3.76

Figure(s) in column having common letter(s) did not differ significantly at 5% level of significance.

Table 4: Effect of fertilizers and pesticides on 1000-grain weight, grain and straw yield of BRRI Dhan 30 rice

Treatment	1000-grain weight (gm)	Grain yield (kg/ha)	% increase or decrease over control	Straw yield (kg/ha)	% increase or decrease over control
T_1 (control)	20.80	3240c	-	4957ef	-
T_2 (N,P,K)	21.30	4070b	+25.61	5970cd	+20.43
T_3 (N,P,K,S)	21.23	4212b	+30.00	6140bc	+23.86
T_4 (N,P,K,S,Zn)	21.10	4321ab	+33.36	6260bc	+26.28
T_5 (N,P,K + Di)	21.20	4380ab	+35.18	6350abc	+28.10
T_6 (N,P,K,S + Di)	21.60	4480ab	+38.27	6490ab	+30.92
T_7 (N,P,K,S,Zn + Di)	22.10	4773a	+47.31	6710a	+35.36
T_8 (N,P,K + As)	21.20	4000b	+23.45	5690d	+14.78
T_9 (N,P,K,S + As)	21.40	4190b	+29.32	6110bc	+23.26
T_{10} (N,P,K,S,Zn + As)	20.90	4270b	+31.79	6190bc	+24.87
T_{11} (Di)	21.50	3405c	+5.09	5270e	+6.31
T_{12} (As)	20.70	3088c	-4.69	4800f	-3.16
LSD (5%)	NS	430.5	-	365	-
CV (%)	3.12	6.30	-	3.65	-

Figure(s) in column having common letter(s) did not differ significantly at 5% level of significance.

application of fertilizers and arsenic (Fig. 6). Diazinon alone or in combination with fertilizers showed better performance than that of arsenic either alone or in combination with fertilizers. Miah and Eunus (1978) reported that the application of increased doses of N,P and K tended to produce increased grain yield. Hossain *et al.* (1987) and Khanda and Dixit (1996) reported that application of S, Zn and N significantly increased the grain yield of rice. Solaiman (1995) reported that the combined application of fertilizers and pesticides significantly increased the grain and straw yield of rice over the control.

Straw yield: The straw yield of BRRI Dhan 30 rice was also affected significantly by various treatments under study. The yield ranged from 4800 to 6710 kg/ha (Table 4) treatment T_7 produced the highest straw yield (6710 kg/ha) due to combined application of fertilizers and diazinon which was statistically similar to T_5 and T_6. The lowest straw yield was obtained in the treatment T_{12} (4800 kg/ha). Again, treatments, T_3, T_4, T_5, T_6, T_9 and T_{10} were statistically similar to each other for this character. Table 3 showed that the treatment T_7 produced 35.36% higher and T_{12} gave 3.16% lower straw yield over control. Hossain *et al.* (1989) reported that S application significantly increased the straw yield of rice.

From the study it can be concluded that application of N, P, K, S, Zn fertilizers increased the grain and straw yields of BRRI Dhan 30 rice. The combined application of diazinon organophosphorus pesticide (recommended dose) and fertilizers were more beneficial. Arsenic alone and in combination with fertilizers showed

detrimental effects on the growth and yield of BRRI Dhan 30 rice.

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