



EFFECTS OF ORGANIC FARMING ON SOIL PROPERTIES AND GROWTH OF RED AMARANTH

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Abstract: This study endeavors to determine the extent of influence of organic farming on soil properties and growth and yield of Red amaranth. It also compares between conventional and organic farming on Sonatola soil series of Non-calcareous, Dark Grey under the Old Brahmaputra Floodplain (AEZ 9) during Rabi season from January to February 2008. Treatments used for the experiments were no fertilizer, cow-dung, poultry manure, synthetic fertilizer, cow-dung in combination with synthetic fertilizer and poultry manure in combination with synthetic fertilizer. From laboratory experiment it was found that except control site all types of treatments showed a significant positive effect on soil moisture, organic carbon, total N, available P and exchangeable K. Cow-dung and poultry manure treated plots conserve maximum amount of soil moisture, available P and exchangeable K. For soil organic carbon, poultry manure showed the best performance. Poultry manure in combination with synthetic fertilizer showed the best performance for total N content of soil. For improving soil properties and maintaining good soil quality poultry manure was the best and cowdung was better than conventional farming. Organic manure and its combination with synthetic fertilizer showed the best performance for plant height and shoot length. The highest yield and leaf area index were found with poultry manure alone and in combination with synthetic fertilizer treated plots. For growth and yield of Red Amaranth, poultry manure alone and in combination with synthetic fertilizer were superior to conventional farming.

Keywords: Organic farming, conventional farming, soil properties, growth, red amaranth.

Introduction

Organic farming is the utilization of organic manures to practice crop production and maintaining good soil health. It has the twin objectives of the system being sustainable and environmentally sensitive (Magar, 2004). Fertilizers are essential part of modern farming, with about 50% of the world production being attributed to fertilizer use. Nevertheless, it is true that fertilizers may be responsible for soil degradation. Intensive use of chemical fertilizers can jeopardize the conservation of soil and invites some new problems, which may create potential health hazards (Pradhan, 1992). Fertility status of soil declines tremendously unless the adequate quantities of nutrients are added to soil (Mongia and Gangwar, 1991). In Bangladesh organic matter status of soil is in so critical position having low contents usually less than 2% (Bhuiyan, 1994) where around 2.5 to 3.0 percent is desirable for satisfactory crop production (Smith and Hughes, 2002). Conversion from commercial fertilizer (conventional farming) to organic farming causes changes in the soil other than the fertility effects that can affect plant growth (Power and Doran, 1984). According to Chhonkar (2003), organic farming is eco-friendly, improves soil fertility and sustains higher yield. Red amaranth, a member of the Amaranthaceae family, Bengali name "lal

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shak” for which average yield varies from 5 to 8 t ha⁻¹ in conventional farming (BARI, 1991). There is little information available on the effect of organic farming on soil and yield of red amaranth in Bangladesh even in the world. Thus the objectives of the experiment were to assess the influence of organic farming on some soil properties and growth of red amaranth and to compare between the conventional and organic farming on red amaranth production.

Materials and methods

Geographically the experimental site is located at 24° 75' N latitude and 90° 50' E longitude at an elevation of 18 m above the sea level. The soil in the experimental field belongs to the Sonatola soil series of Non-calcareous, Dark Grey Floodplain Soils and AEZ Old Brahmaputra Floodplain (AEZ-9) during Rabi season from January to February 2008, which is more or less neutral in reaction. The experimental field was a medium high land with leveled topography and poor drainage condition (FAO and UNDP, 1988). Physicochemical properties of soil of the experimental field have been shown in Table 1.

Table 1: Physicochemical properties of initial soil sample

Soil Properties	Laboratory Results
Soil pH	6.46
Soil moisture (%)	24.80
Total N (%)	0.118
Available P (mg/Kg)	14.24
Exchangeable K (me/100g soil)	0.137
Organic matter content (%)	1.92
Organic Carbon (%)	1.55
Textural classes	Silt loam
Sand (%)	30.26
Silt (%)	58
Clay (%)	11.71

Red amaranth was used as test crop in this experiment. This crop has gained popularity among the farmers of Bangladesh for its high yield potential. The seeds were collected from BADC, Mymensingh. The land was ploughed several times to obtain a good tilth condition and then leveled, weeds, stubbles, and crop residues were removed. The land was then finally prepared six days before planting the seed.

Table 2: The nutrient contents of different organic sources which were used as treatments in the experiment

Organic manure	%N	%P	%K
Cowdung	0.74	0.28	0.163
Poultry manure	1.52	0.62	0.526

The experiment was laid out in RCBD with six treatments and each of three replications. The total numbers of plots were 18. The size of a unit plot was 1.0 m x 1.0 m. Inter block and inter plot spacing were 0.50 m and 0.50 m respectively. The treatments were no fertilizer (control) (T₀), cowdung (T₁), poultry manure (T₂), synthetic fertilizer (T₃), cowdung in combination with synthetic fertilizer (T₄) and poultry manure in combination with synthetic fertilizer (T₅). The nutrient contents of organic sources used as treatments in this experiment are shown in Table 2. For organic farming cowdung and poultry manure were used whereas for the interactive roll

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between conventional and organic farming combinations (cowdung + synthetic fertilizers and poultry manure + synthetic fertilizers) were used. Cowdung and poultry manure were applied at the rate of 10 t ha⁻¹ and 5 t ha⁻¹ respectively (BARI, 1991). Urea, TSP and MP were used as the source of N, P, and K respectively in traditional farming. The dose of fertilizers and organic manures were applied in the experimental plots are given in Table 3. Well decomposed cow-dung and poultry manure were incorporated in the plots as per treatment at 4 days before sowing and after 2 days they were mixed thoroughly with the soil. All the fertilizers were applied during the final preparation of plot as Red amaranth is a short duration crop.

Table 3: The dose of fertilizers and organic manures were applied in the experimental plots

Manures and fertilizers	Amount applied	
	Per hectare	Per plot
Cowdung	10t	1kg
Poultry manure	5t	500g
Synthetic fertilizers	Urea	250kg
	TSP	140kg
	MP	120kg

The seeds were sown at the rate of 3 seeds per hole by hand keeping uniform distance at the rate of 1kg/ha and then the seed were covered with soils. Row to row distance was 20 cm and plant to plant distance was 5 cm. Germination of the seeds started from 3rd day of sowing. On the 6th to 8th all the seeds were germinated. One seedling was kept in each hole. Gap fillings, Weeding and Irrigation were done time to time. The experimental crop was harvested after 34 days of sowing on 27 February, 2008.

Collection and preparation of soil and plant samples: Initial soil sample was collected randomly from 10 different spots from a depth of 0-15 cm before manuring and fertilization. All samples were composited to make a single sample for analysis. After crop harvest, soil samples were collected again from each plot at 0-15 cm depth. After removing weeds and other unwanted things, the samples were air-dried, ground, sieved through a 2 mm sieve and kept for analysis. The plant samples were collected from each plot and were dried in an oven at 80°C for about 72 hours. Then they were ground to pass through a 20-mesh sieve in a grinding mill. The prepared samples were then put into polythene bags. The methods for soil and plant sample analyses are given in Table 4.

Table 4: Soil analyzed by different methods for different parameters

	Parameters	Method	Reference
For Soil Sample	Textural class	Hydrometer method	Black, 1965
	Soil pH	As suggested by Jackson	Jackson, 1973
	Soil moisture	Gravimetric method	Black, 1965
	Organic carbon	Wet Oxidation method	Black, 1965
	Total nitrogen	Micro-Kjeldahl method	Jackson, 1962
	Available Phosphorus	Olsen Extractant method	Jackson, 1962
	Exchangeable Potassium	Atomic Absorption Spectroscopy	Page <i>et al.</i> , 1989
For Plant Sample	Total N	Micro-Kjeldahl method	Page <i>et al.</i> , 1989
	Ca	Atomic Absorption Spectroscopy	Peterson, 2002
	Fe	Atomic Absorption Spectroscopy	Clesceri <i>et al.</i> , 1989

Statistical analysis: The analysis of variance was done following the computer package MSTAT. The mean differences were adjudged by DMRT (Gomez and Gomez, 1984) and ranking was indicated by letters.

Results and Discussion

The soil properties as effected by organic farming: The chemical properties of soil are shown in Table 5.

Table 5: Effect of organic farming on soil properties

Treatment	pH	Moisture (%)	Organic carbon (%)	Total N (%)	Available P (mg/Kg)	Exchangeable K (me/100g soil)
T ₀	6.37a	24.44c	1.08d	0.088e	12.49c	0.135b
T ₁	6.17a	26.76a	1.61ab	1.174bc	15.74a	0.183a
T ₂	6.09a	26.56a	1.75a	1.135c	15.80a	0.182a
T ₃	6.50a	24.60c	1.06d	0.985d	12.57c	0.147b
T ₄	6.26a	25.69b	1.27c	1.228ab	14.31b	0.150b
T ₅	6.16a	25.57b	1.52b	1.281a	14.39b	0.151b
CV (%)	4.27	2.35	7.40	2.33	3.66	5.11

Figure(s) in the column having common letter(s) do not differ significantly at 5% level or at 1% level. Here, T₀: No fertilizer, T₁: Cowdung, T₂: Poultry manure, T₃: Inorganic fertilizer, T₄: Cowdung + Inorganic fertilizer and T₅: Poultry manure + Inorganic fertilizer.

Soil pH: The pH of the post harvest soils did differ statistically from each other (T₀ to T₅) and ranged from 6.09 to 6.50. The highest soil pH was obtained from T₃ and the lowest was from T₂.

Soil moisture: Application of organic manures caused a significant increase in soil moisture contents. All the treatments increased the soil moisture except T₃ and T₀ (Table 5). T₁ and T₂ increased the highest soil moisture followed by T₄ and T₅.

Organic carbon: The organic C of the post harvest soil was significantly influenced by different treatments. The highest organic C (1.75%) was obtained from T₂ and the lowest (1.06 %) from T₃ and T₀.

Total N in soil: The total N content of post harvest soil varied significantly among the treatments. The highest N content was (1.28%) obtained from T₅ and the lowest value (0.088%) from T₀. The interaction of organic and conventional farming also increases total nitrogen content of soil over conventional (Table 5).

Available phosphorus of soil: Available P content varied from 15.80 to 12.49 mg/Kg (Table 5). Soils treated with organic manures gave higher values of available P compared to conventional practice and control. The release of more available P from the decomposition of poultry manure and cowdung might be a cause of higher value in soils treated with organic manure.

Exchangeable K of soil: The highest exchangeable K content in post harvest soil was obtained from plots treated with organic manures (Table 5). Results indicated that K content was higher in soils treated with organic manures than treated with synthetic fertilizer.

Effects of organic farming on the growth and yield of Red amaranth: Experimental results on growth and yield of red amaranth are presented in Table 6.

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Treatment	Plant height (cm)	Shoot length (cm)	Root length (cm)	Leaves plant ⁻¹		Leaf area index (LAI)	Yield plot ⁻¹ (kg)	Yield (t ha ⁻¹)	Moisture content (%)	Dry matter content (%)	N content (%)	Ca content (%)	Fe content (%)
				Large leaves	Small leaves								
T ₀	17.13 c	12.40 d	3.43 b	5.47 c	5.00 d	0.255 d	0.200 d	1.970 d	95.08 ab	4.58 c	0.220 e	0.365 b	2.32 d
T ₁	34.53 a	25.27 bc	5.27 a	6.93 b	12.93 b	0.747 b	0.963 b	9.473 b	94.39 ab	5.93 ab	0.399 c	0.391 a	3.32 c
T ₂	35.73 a	28.47 ab	5.77 a	8.00 ab	15.13 b	1.055 a	1.197 a	11.780 a	93.38 b	6.61 a	0.398 c	0.394 a	3.71 b
T ₃	25.33 b	21.00 c	3.57 b	6.80 b	9.07 c	0.529 c	0.643 c	6.330 c	95.95 a	4.04 c	0.318 d	0.366 b	3.01 c
T ₄	35.87 a	29.13 ab	5.80 a	7.27 b	13.87 b	0.840 b	1.013 b	9.977 b	94.72 ab	5.27 b	0.456 b	0.385 a	3.29 c
T ₅	37.53 a	31.07 a	5.97 a	8.73 a	19.33 a	1.103 a	1.217 a	11.970 a	94.57 ab	5.43 b	0.477 a	0.383 a	4.23 a
CV (%)	8.62	9.95	9.01	9.14	9.79	14.98	7.01	7.20	3.07	7.01 s	5.43	2.91	5.77

Table 6: Effect of organic farming on growth and yield of Red amaranth

Figure(s) in the column having common letter(s) do not differ significantly at 5% level or at 1% level. Here, T₀: No fertilizer, T₁: Cowdung, T₂: Poultry Manure, T₃: Inorganic fertilizer, T₄: Cowdung + Inorganic fertilizer and T₅: Poultry manure + Inorganic fertilizer.

Plant height: The height of the Red amaranth was significantly influenced by different treatments. The highest plant height was observed in organic manure and organic manure + synthetic fertilizer treated plots and the lowest (17.13 cm) was from T₀ (Table 6).

Shoot length: Shoot length was significantly affected by different treatments. The highest shoot length (31.07 cm) was obtained from T₅ and the lowest value (12.40 cm) was from T₀. This result might be due to higher N level in organic manures than in control treatment (T₀) (Table 6).

Leaf number: Leaf number varied significantly among the treatments. Results showed that large leaves number ranged from 5.47 to 8.73 and small leaf number was from 5.0 to 19.33. Higher leaf number was obtained from organic manure + synthetic fertilizer treated plants (Table 6).

Leaf area index (LAI): The LAI of Red amaranth varied significantly among the treatments. The highest LAI was found from T₂ and T₅ and the lowest (0.255) was in T₀ (Table 6).

Yield plot⁻¹: There was a significant variation in yield between organic farming and control. The highest yield plot⁻¹ was recorded in T₅ and T₂ and the lowest (0.20 kg plot⁻¹) was in T₀ (Table 6).

Moisture content: Moisture content in Red amaranth was not significantly varied among the treatments. The highest moisture content (95.95%) was recorded from T₃ which was statistically different from others and the lowest (93.38%) was from T₂ (Table 6).

Dry matter content: Dry matter varied significantly with different treatment and it varied from 4.04 to 6.61%. The highest dry matter yield (6.61%) was obtained from T₂ and the lowest (4.04%) from conventional (T₃) followed by control (T₀) (4.58%) (Table 6).

Nitrogen content: Nitrogen content in Red amaranth varied significantly among treatments applied. The content of N in Red amaranth varied from 0.220 to 0.477%. The highest amount was (0.477%) observed from T₅ and the lowest (0.220%) was from T₀ (Table 6).

Calcium content: Results indicated that Ca content in Red amaranth was varied statistically among the treatments. The content of Ca varied from 0.365 to 0.394%. The highest value was (0.394%) observed from T₂ and the lowest (0.365%) was from T₀ (Table 6).

Iron content: Iron content in Red amaranth differed significantly by different treatments. The highest iron content (4.23 mg/100g) was found in T₅ and the lowest (2.32 mg/100g) was in T₀. The results indicated that Red amaranth contained more iron level in organic farming over conventional practice and control treatment (Table 6).

Conclusion

The influence of organic farming practice on soil properties and growth and yield of Red amaranth were investigated. Before seed sowing the soil of the experimental field was silt loam having a pH 6.46, organic matter 1.92%, total N 0.118%, available P 14.24 mg/Kg, exchangeable K 0.137 me/100g soil and moisture 24.80%. Post harvest soil samples were also analyzed. All the data were analyzed statistically and means were adjusted by DMRT and LSD test. The highest positive effects were found for application of cowdung and poultry manure on soil moisture (26.76 and 26.56%), available P (15.74 and 15.80 mg/Kg) and exchangeable K (0.183 and 0.182 me/100g soil). Poultry manure produced the highest effect on organic carbon (1.75%). Control and synthetic fertilizer treatments produced the lowest effect on above characters. Organic manure alone or in combination with synthetic fertilizer showed best performance for plant height and root length. The height yield and LAI were found in poultry manure alone and in combination with synthetic fertilizer treated plots. The highest dry matter content (6.61%) and the lowest moisture content (93.38%) was produced by poultry manure. Poultry manure in combination with synthetic fertilizer gave maximum shoot length and no. of leaves plant⁻¹. Control treatment caused the minimum effect on the above characters but maximum effect on the moisture content (95.08%). For growth and yield of Red amaranth, poultry manure alone and in combination with synthetic fertilizer was superior to conventional farming. Poultry manure + synthetic fertilizer showed its superiority on yield and yield contributing characters of Red amaranth but poultry manure and poultry manure + synthetic fertilizer showed their superiority on nutrient content and their uptake. For assuring Red amaranth quality, poultry manure or poultry manure in combination with synthetic fertilizer would be the best. In order to maintain good soil and Red amaranth quality and keep the environment sound, it would be best to advise farmers for the application of organic farming over conventional farming.

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