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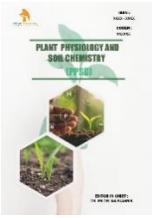

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RESEARCH ARTICLE

# IMPACT OF ORGANIC AND INORGANIC FERTILIZER ON THE PERFORMANCE OF INDIAN SPINACH AND RED AMARANTH IN FLOATING BED IN SUMMER SEASON

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**ABSTRACT**

The study was undertaken to investigate the performance of organic and inorganic fertilizers in floating bed on the development and yield of Indian spinach and red amaranth in 2014 and 2015 in Gopalganj, Bangladesh. The single factor experiment was conducted in Randomized Complete Block Design (RCBD) with three replications. There were four treatments like control, cowdung, suggested dose of NPK, fifty percent cowdung + fifty percent suggested dose of NPK. Organic and inorganic fertilizers have positive impact in floating bed for the performance of Indian spinach and red amaranth. In case of Indian spinach, the heighteststem length (187.17 and 185.33 cm, respectively) was found in fifty percent cow dung + fifty percent suggested dose of NPK. The highest weight of leaves varied from 567.00 and 521.33 to 853.67 and 843.00 g while the total weight of stems varied from 686.67 and 694.00 to 1009.33 and 998.67 g in 2014 and 2015, respectively. The highest yield (57.30 and 55.60 t $ha^{-1}$, respectively) was obtained from suggested dose of NPK followed by fifty percent Cow dung + fifty percent suggested dose of NPK. The minimum yield (37.60 and 36.50 t $ha^{-1}$, respectively) was obtained within the control in 2014 & 2015. Similar tendency was also observed in red amaranth in both the growing season. Including economic consideration, the results suggested that the use of fifty percent cow dung + fifty percent NPK of suggested dose of fertilizers in floating bed was appropriate for development and yield as well as cost effective for Indian spinach and red amaranth production.

**KEYWORDS**

Floating bed, Organic & inorganic fertilizer, Vegetable's production, Economic analysis

## 1. INTRODUCTION

Floating agriculture have a farmers' innovation that's being practiced in submerged or low laying areas of middle and southern districts of Bangladesh. Floating-bed vegetables cultivation is a technique that has been practiced on a limited scale within the coastal wetlands of southern Bangladesh before 200 years. This sort of cultivation is usually carried out on a compacted platform made by water hyacinths (*Eichhornia crassipes*), and after decomposed of water hyacinth it is a highly fertile cultivation ground for growing a wide range of crops and provide nutrients and moisture for the cultivated crop. Indian spinach (*Basella alba* L.) and Red amaranth (*Amaranthus gangaticus* L.) are now widely gown as vegetables both in topics and sub-tropics area of the globe. It's often grown round the year and might be harvested in an exceedingly very short time. As both of the nutritious and delicious vegetables, Indian spinach and red amaranth are popular vegetables in Bangladesh. It's also faster growing character and better yield potential. Thus, both vegetables play a predominant role both in nutrition and food security.

Vegetable production is n't uniform around the year in Bangladesh. Vegetables are abundant in wintertime and scanty in summertime and there's an acute shortage during two slack seasons: from March to April and from October to November because of transition from season to another (Hossain, 1992). About 70% of the vegetables are produced in winter season and rests are produced within the summer season (Hossain and Arangzeb, 1992). Development and yield of Indian spinach and red amaranth depends on nutrition availability in floating bed as growing media, which is related to the judicial use of manures and fertilizers. Inorganic fertilizer supplies sufficient nutrients for development and development of plant. Use of organic source is limited. Neither the chemical nor organic fertilizer alone can help achieve sustainable crop production. But increased use of inorganic fertilizers in crop production causes health hazards, creates problem to the environment including the pollution of air, water, soil etc. On the opposite hand, organic manures are important for proper development and development of plants and it's a good source of plant nutrients. The balanced use of nutrient is that the best approach to maintain soil fertility and productivity on sustainable basis.

There is no information on the impact of organic and inorganic fertilizers on performance of Indian spinach and red amaranth development and yield on floating bed in Bangladesh even within the world. Farmers cultivate vegetables in floating bed traditionally and don't follow any methodology. To make sure better yield from floating bed proper management of organic and inorganic fertilizer with an appropriate dose have to be assured. However, information on the use of inorganic fertilizers and cowdung together with decomposed water hyacinth for Indian spinach and red amaranth are not available. In accordance of consideration of the above-discussed factors, the present study entitled as "Impact of organic and inorganic fertilizer on the performance of Indian spinach and red amaranth in floating bed in summer season" was undertaken with the subsequent objectives:

1. To identify the impact of organic and inorganic fertilizer on the performance of Indian spinach and red amaranth in floating bed in summer season.

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## 2. Materials and Methods

### 2.1 Location of the Experimental Site and Duration

The experiment was conducted at Mitrodangha under Tungipara upazila of Gopalganj district in Bangladesh during the period from June to October, 2014 and June to October, 2015. It is located between $23^{0}00^{`}$ and $23^{0}50^{`}$ North latitudes and $89^{0}50^{`}$ and $89^{0}59^{`}$ East longitude.

### 2.2 Experimental Design and Planting Materials

The single factor experiment was conducted in Randomized Complete Block Design (RCBD) with three replications and with four treatments like control, cowdung, suggested dose of NPK, fifty percent cowdung + fifty percent suggested dose of NPK and two crops viz. Red amaranth (*Amaranthus gangaticus* L.) and Indian spinach (*Basella alba* L.), seeds were used as the planting materials in the experiment.The floating bed (dhap) was prepared with desired thickness, width and length and therefore the four treatments were then distributed randomly among the each block so as to all treatments were placed once in each unit.

### 2.3 Shape and Size of the Floating Bed (locally called- dhap)

The size of every unit floating bed (dhap) was 2.5 m height (water hyacinth thickness) x 5 m length x 1m width.

### 2.4 Floating Bed Preparation

Matured water hyacinths were collected from the nearby canal, river and other wetland where it grows profusely. After collecting, a primary layer was made with 1.7 m thickness, 1.0 m width and 5m length. Water hyacinths were again dump on first layer after 10 days later from the primary dumping with 0.8m thickness and then the bed was left for decomposition before sowing or planting of seedlings.

### 2.5 Maintenance of Floating Bed

The decomposed parts of floating bed, roots of water hyacinth were cutting and put them underneath the seedlings so that, the seedlings get nutrients. Bamboos were used as anchorage of floating beds to stay them fixed in a place and stop from floating away by wind or water current.

### 2.6 Raising of Seedlings

A small ball was made with decomposed water hyacinth that locally called as "Tema". After two or three days sprouted treated seeds of Indian spinach were put inside the Tema. Two sprouted seeds were put in each Tema and put the Tema on seedbed. The seed bed was shaded by polythene for protected heavy rainfall as and when needed.

### 2.7 Transplanting and Seed Sowing on Floating Bed

Before transplanting a hole was made on floating bed with maintaining plant spacing 50 cm x 50 cm with Indian spinach in two rows and before sowing of Red amaranth seeds a layer was made with decomposed water hyacinth on floating bed. Then after 2 days left for reduce excessive moisture. Red amaranth seeds were mixed with ash and sown on floating bed.

### 2.8 Use of Cowdung and Chemical Fertilizers and Other Operations

Cowdung and chemical fertilizers were used in line with the treatments considering the suggested fertilizer dose on the basis of decomposed water hyacinth test value for respective crops. Irrigation, weeding and plant protection measures were done as and when needed especially at the primary stage of seedlings established. Fungicide 'Knowin 50 WP' for leaf spot of Indian spinach and 'Ridomil Gold MZ 68 WG' for fungus of red amaranth were used to control.

### 2.9 Data Collection

Five plants were selected randomly from every unit dhap plot and the parameters were recorded at 15 days intervalsincludingmain stem length (cm), number of leaves and branches plant$^{-1}$, total leaf and stem weight (g), fresh yield plant$^{-1}$ (kg) and yield (t ha$^{-1}$), in respect of Indian spinachand plant height (cm), number of leaves plant$^{-1}$, fresh weight of 5 plants (g) and yield (t ha$^{-1}$) just in case of red amaranth. Collected data were analyzed statistically with MSTAT-C and therefore the mean differences were adjudged by DUNCAN'S NEW MULTIPLE RANGE TEST (DMRT) at 5% level of probability for interpretation of the results (Gomez and Gomez, 1984).

## 3. Results and Discussion

Four treatments viz. control (without organic and inorganic fertilizer), cowdung, suggested dose of NPK, fifty percent cowdung + fifty percent suggested dose of NPK and crops of Indian spinach and red amaranth were used for this study.

### 3.1 Effect of Organic Manure and Inorganic Fertilizers on Vegetables Production on Floating Bed

### 3.2 Effects on Development Parameters, Yield Components and Economic Consideration of Indian Spinach

The results revealed that the main stem length increased significantly with suggested dose of NPK and fifty percent cow dung + fifty percent suggested dose of NPK as compared to the control and cowdung only. The lowest stem length (115.83 and 126.87 cm, respectively) was found from the control and also the highest (187.17 and 185.33 cm, respectively) was found in fifty percent cow dung + fifty percent suggested dose of NPK in 2014 and 2015. Number of branches varied from 6.33 to 9.33 and 6.33 to 10.00, respectively while number of leaves varied from 107.67 to 165.00 and 95.67 to 155.67 in 2014 and 2015, respectively. The very best weight of leaves varied from 567.00 and 521.33 to 853.67 and 843.00 g while the total weight of stems varied from 686.67 and 694.00 to 1009.33 and 998.67 g in 2014 and 2015, respectively. The highest yield (57.30 and 55.60 t ha$^{-1}$, respectively) was obtained from suggested dose of NPK followed by fifty percent Cow dung + fifty percent suggested dose of NPK. The minimum yield (37.60 and 36.50 t ha$^{-1}$, respectively) was obtained from the control in 2014 and 2015 (Table 1). However, there was no significant difference in most of the parameters between suggested dose of NPK and fifty percent cow dung + fifty percent suggested dose of NPK.

**Table 1:** Development and yield contributing characters and yield of Indian spinach as influenced by organic & inorganic fertilizer use in floating bed

| Treat. | Main stem length (cm) | | Branches plant$^{-1}$ (No.) | | Leaves plant$^{-1}$ (No.) | | Total leaf weight (g) | | Total stem weight (g) | | Fresh yield plant$^{1}$ (kg) | | Yield (t ha$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st yr | 2nd yr | 1st yr | 2nd yr | 1st yr | 2nd yr | 1st yr | 2nd yr | 1st yr | 2nd yr | 1st yr | 2nd yr | 1st yr | 2nd yr |
| $T_1$ | 115.83 b | 126.87 b | 6.33 c | 6.33 c | 107.67 c | 95.67 c | 567.00 c | 521.33 c | 686.67 c | 694.00 c | 1.25 c | 0.92 b | 37.6 c | 36.5 b |
| $T_2$ | 132.97 b | 141.97 b | 8.00b | 7.67 b | 120.00 b | 114.00 b | 639.00 b | 607.67 b | 833.67 b | 791.00 b | 1.51 bc | 1.14 ab | 45.4 bc | 45.4 ab |
| $T_3$ | 179.07 a | 177.00 a | 9.33 a | 9.67 a | 165.00 a | 144.67 a | 849.00 a | 843.00 a | 1009.33 a | 998.67 a | 1.91 a | 1.39 a | 57.3 a | 55.6 a |
| $T_4$ | 187.17 a | 185.33 a | 9.00 a | 10.00 a | 164.33 b | 155.67 a | 853.67 a | 838.00 a | 986.33 a | 952.67 a | 1.79 ab | 1.33 a | 53.7 ab | 53.2 a |
| CV (%) | 9.52 | 8.71 | 11.03 | 9.69 | 16.52 | 9.48 | 12.84 | 7.25 | 10.02 | 11.30 | 10.47 | 13.70 | 10.47 | 12.25 |

Figures in a column having common letter (s) do not differ significantly (P≤0.05). Here, $T_1$ =Control, $T_2$ =Cowdung, $T_3$ = Suggested dose of NPK, $T_4$= fifty percent cowdung + fifty percent Suggested dose of NPK.

This result's in concurrence (Bar et al., 2001; Bowen and Frey, 2002). The stem length of a plant depends on plant vigour and development habit. *B. alba* is a vigorous growing plant and nitrogen had a significant effect on the length of vines. Nitrogen is crucial for plant biological process especially during early vegetative development in plant (Salisbury and Ross, 1986). Some researcher showed high N rates increased the number of side shoots at early phases of development (Acton and Klayman, 2004). Similar result was also found in their research with fertilizers and manures where NPK (Suggested dose) fertilizers gave the best yield and yield contributing parameters of Indian spinach (Islam et al., 2011; Olanrewaju, 2011). The explanation for this kind of results may be due to of huge and available nitrogen in suggested dose of fertilizers, cow dung and organic manure (decomposed water hyacinth) as Indian spinach is a leafy vegetable.

### *3.2.1 Economic Analysis*

Meaningful variations were found among the treatments in respect of the benefit cost ratio (BCR). From the treatment of fifty percent cowdung + fifty percent suggested dose of NPK the highest BCR (1.97) value was recorded. The lowest BCR (1.57) value was found within the control (Table 2). The results revealed that fifty percent cowdung + fifty percent suggested dose of NPK was found to be appropriate for higher economic return from Indian spinach in the climate of Gopalganj (Ying et al., 1997).

**Table 2:** Cost and return analysis of Indian spinach production due to use of organic & inorganic fertilizers in floating bed in 2014 and 2015

| Treatment | Mean marketable yield of two years (t ha$^{-1}$) | Mean total variable cost of two years (t ha$^{-1}$) | Mean gross return of two years (t ha$^{-1}$) | Mean net return of two years (t ha$^{-1}$) | Mean benefit cost ratio of two years (BCR) |
|---|---|---|---|---|---|
| $T_1$ | 37.05 d | 355000.00 c | 555750.00 d | 200750.00 c | 1.57 d |
| $T_2$ | 45.40 c | 388340.00 b | 681000.00 c | 292660.00 b | 1.75 c |
| $T_3$ | 56.45 a | 449980.00 a | 846750.00 a | 396770.00 a | 1.88 b |
| $T_4$ | 53.45 b | 406660.00 b | 801750.00 b | 395090.00 a | 1.97 a |
| CV (%) | 2.8 | 4.04 | 2.67 | 7.73 | 5.5 |
| Level of significance | * | * | * | * | * |

*= Significant at 5% level. Means followed by common letter(s) in a column do not differ significantly by DMRT.Here, $T_1$ =Control, $T_2$ =Cowdung, $T_3$ = Suggested dose of NPK, $T_4$= fifty percent cowdung + fifty percent Suggested dose of NPK.

Salable Indian spinach @ Tk.15000 per ton, Net return=Gross return – Total variable cost, Benefit cost ratio (BCR) = Gross return ÷ Total variable cost.

### 3.3 Effects on development parameters, yield components and economic consideration of red amaranth

Both development parameters and yield of red amaranth were significantly influenced (P≤0.05) by the applying of organic manure and inorganic fertilizer treatments in floating bed (Table 3). The very best plant height (26.73 and 27.13 cm, respectively) was found in suggested dose of NPK while the lowest (14.53 and 17.40 cm, respectively) was obtained from the control in both the years. The highest number of leaves per plant (16.67 and 16.00, respectively) was found from suggested dose of NPK and therefore the lowest number of leaves per plant (9.33 and 10.17, respectively) was obtained from the control in 2014 and 2015.

The highest yield (16.40 and 16.08 t ha$^{-1}$, respectively) was obtained from suggested dose of NPK followed by fifty percent cowdung +fifty percent suggested dose of NPK whereas the lowest yield (10.36 and 10.02 t ha$^{-1}$, respectively) was found within the control in 2014 and 2015. There was no significant difference between suggested dose of NPK and fifty percent cowdung +fifty percent suggested dose of NPK. Fresh weight of 5 plants followed the similar trend of increase.

**Table 3:** Development and yield contributing characters and yield of red amaranth as influenced by organic and inorganic fertilizer use in floating bed

| Treatment | Plant height (cm) | | Leaves plant$^{-1}$ (No.) | | Fresh wt. of 5 plants (g) | | Yield (t ha$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|
| | 1$^{st}$ yr | 2$^{nd}$ yr | 1$^{st}$ yr | 2$^{nd}$ yr | 1$^{st}$ yr | 2$^{nd}$ yr | 1$^{st}$ yr | 2$^{nd}$ yr |
| $T_1$ | 14.53 c | 17.40 c | 9.33 c | 10.17 c | 22.33 c | 20.00 c | 10.36 c | 10.02 c |
| $T_2$ | 19.30 b | 21.20 b | 13.00 b | 12.00 b | 27.00 b | 29.00 b | 13.37 b | 13.69 b |
| $T_3$ | 26.73 a | 27.13 a | 16.67 a | 16.00 a | 46.67 a | 44.00 a | 16.40 a | 16.08 a |
| $T_4$ | 25.10 a | 25.83 a | 15.00 a | 14.67 a | 44.67 a | 42.33 a | 15.36 a | 15.16 a |
| CV (%) | 9.53 | 6.32 | 4.91 | 6.61 | 9.69 | 10.73 | 10.33 | 8.66 |

Figures in a column having common letter (s) do not differ significantly (P≤0.05). Here, $T_1$ =Control, $T_2$ =Cowdung, $T_3$ = Suggested dose of NPK, $T_4$= fifty percent cowdung + fifty percent Suggested dose of NPK.

The plant height and number of leaves are the most important yield contributing parameters of red amaranth. The resultis in agreement with the findings of who stated that use of NPK and S significantly, increased plant height, number of leaves per plant of broccoli (Anwar et al., 2001; Kadir, 2002). The findings are in partial agreement with many researchers in several vegetable crops in brinjal and carrot; in potato; in cabbage, in lady's finger, in carrot; in broccoli; (Tomar et al., 1998; Saikia et al., 1998; Azad 2000; Ali and Jahan, 2001; Kadir 2002; broccoli and Alam, 2005)

### *3.3.1 Economic Analysis*

Meaningful variations were found among the treatments in respect of the benefit cost ratio (BCR). From the treatment of fifty percent cowdung + fifty percent suggested dose of NPK the best BCR (1.60) value was recorded and therefore the lowest BCR (1.22) value was found within the control (Table 4) (FRG, 2012). The results revealed that fifty percent cowdung + fifty percent suggested dose of NPK was found to be appropriate for higher economic return from red amaranth under the climate of Gopalganj.

**Table 4:** Cost and return analysis of red amaranth production due to use of organic & inorganic fertilizers in floating bed in 2014 and 2015

| Treatment | Mean marketable yield of two years (t ha$^{-1}$) | Mean total variable cost of two years (t ha$^{-1}$) | Mean gross return of two years (t ha$^{-1}$) | Mean net return of two years (t ha$^{-1}$) | Mean benefit cost ratio of two years (BCR) |
|---|---|---|---|---|---|
| $T_1$ | 10.19 c | 291660.00 c | 356650.00 d | 64990.00 c | 1.22 d |
| $T_2$ | 13.53 b | 325000.00 b | 473550.00 c | 148550.00 b | 1.46 c |
| $T_3$ | 16.24 a | 360600.00 a | 568400.00 a | 207800.00 a | 1.58 b |
| $T_4$ | 15.26 a | 334460.00ab | 534100.00 b | 199640.00 a | 1.60 a |
| CV (%) | 3.7 | 1.45 | 1.90 | 3.64 | 4.2 |
| Level of significance | * | * | * | * | * |

*= Significant at 5% level. Means followed by common letter(s) in a column do not differ significantly by DMRT. Here, $T_1$ =Control, $T_2$ =Cowdung, $T_3$ = Suggested dose of NPK, $T_4$= fifty percent cowdung + fifty percent Suggested dose of NPK.
Salable red amaranth @ Tk.35000 per ton, Net return=Gross return – Total variable cost, Benefit cost ratio (BCR) = Gross return ÷ Total variable cost.

The findings of the experiment, it was observed that just about all the parameters attained the best values when suggested dose of NPK were applied. But there was no significant different between suggested dose of NPK and fifty percent cow dung + fifty percent suggested dose of NPK in both the years (2014 and 2015, respectively). The control treatment gave the lowest values all told the characters of all studied crops (Gomez and Gomez, 1984). The reason for this kind of results may be because of nutrients were more readily available when organic manure and inorganic fertilizers were combined use in corporation with floating bed (decomposed water hyacinth) act as a growing media.

## 4. Conclusion

From the results of the experiment, it was found that, as good as all the characters attained the highest values when suggested dose of NPK were applied. But there was no significant different between suggested dose of NPK and fifty percent cow dung + fifty percent suggested dose of NPK in both years. The control treatment gave the lowest values in all the characters and from the economic consideration, the highest mean BCR value was found from fifty percent cowdung + fifty percent suggested dose of NPK fertilizers because of comparatively lower mean total variable cost of the two years than cost of suggested dose of NPK which was again followed by suggested dose of NPK mean BCR value and the lowest value was found in the control. So, the use of fifty percent cowdung + fifty percent suggested dose of NPK may be suggested for profitable Indian spinach production. From the above results of the present study, it can be concluded that use of fifty percent cow dung + fifty percent NPK of suggested dose of fertilizers in floating bed was appropriate for development and yield as well as cost effective for Indian spinach and red amaranth production.

## Conflict of Interest

The researchers indicate no conflict of interest for this work.

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