Fundamental and Applied Agriculture
Vol. 3(1), pp. 355–362: 2018
doi: 10.5455/faa.281678

*Horticulture*
ORIGINAL ARTICLE

# Development of fertilizer recommendation for cabbage production in Low Ganges River Floodplain of Bangladesh

**AFM Ruhul Quddus[1*], Selim Ahmed[1], MM Kamrozzaman[2], Md Motasim Ahmmed[3], Rumpa Sarker[2]**

[1]On-Farm Research Division (OFRD), Bangladesh Agricultural Research Institute (BARI), Faridpur, Bangladesh
[2]Spices Research Sub Centre (SRSC), Bangladesh Agricultural Research Institute (BARI), Faridpur, Bangladesh
[3]Soil Resource Development Institute (SRDI), Faridpur, Bangladesh

ARTICLE INFORMATION

*Article History*
Submitted: 26 October 2017
Revised: 04 December 2017
Accepted: 10 December 2017
First online: 12 December 2017

*Academic Editor*
Md. Harun Ar Rashid

*Corresponding Author
AFM Ruhul Quddus
kbdruhulbari@yahoo.com



ABSTRACT

The study was conducted during rabi season of 2013-14 and 2014-15 at the farmer's field of Farming System Research and Development (FSRD) site, Hatgobindapur, Faridpur under On-Farm Research Division (OFRD), Bangladesh Agricultural Research Institute (BARI) to evaluate the performance of chemical fertilizers for maximum yield of cabbage and higher economic return. The experiment was laid out in Randomized Complete Block Design (RCBD) with five dispersed replications. The experiment consisted of eight treatments *viz.* $N_{242}P_{120}K_{33}S_{19}Zn_{1.4}B_{0.6}$ kg ha$^{-1}$ (100% NPKSZnB from Soil Test Based (STB) dose, $T_1$), $T_1$+25% N ($T_2$), $T_1$+25% NP ($T_3$), $T_1$+25% NK ($T_4$), $T_1$+25% PK ($T_5$), $T_1$+25% NPK ($T_6$), 75% of $T_1$ ($T_7$), and native nutrient (control, $T_8$). The treatment 100% NPKSZnB (soil test based) and additional 25% NPK ($T_6$) treatment produced maximum head yield of cabbage (78.89 t ha$^{-1}$) which was statistically identical with 100% soil test based NPKSZnB ($T_1$), 100% NPKSZnB with additional 25% N ($T_2$), 100% NPKSZnB with additional 25% NP ($T_3$) and 100% NPKSZnB with additional 25% NK ($T_4$) treatments. The lowest head yield (33.92 t ha$^{-1}$) was obtained from native nutrient (control). The highest gross margin (Tk 756,093 ha$^{-1}$) was obtained from $T_6$ (100% NPKSZnB from STB with additional 25% NPK) followed by $T_2$ ($T_1$ with additional 25% N) and $T_1$ treatments. The results indicated that, the marginal rate of return (MRR) of changing from $T_7$ to $T_1$ was 1818% (for every Tk 100 of additional investment Tk 1,818 was obtained) and a changing from $T_1$ to $T_2$ gave MRR of 319%. From the experimental results, it was concluded that application of 100% chemical fertilizers of $N_{242}P_{120}K_{33}S_{19}Zn_{1.4}B_{0.6}$ kg ha$^{-1}$ from soil test based ($T_1$) would be suitable for higher yield and economic return of cabbage production in calcareous soil under Low Ganges River Floodplain (Agroecological Zone 12).

**Keywords:** Soil test based fertilizer, partial budget and dominance analysis, marginal rate of return, cabbage

*Cite this article*: Quddus AFMR, Ahmed S, Kamrozzaman MM, Ahmmed MM, Sarker R. 2018. Development of fertilizer recommendation for cabbage production in Low Ganges River Floodplain of Bangladesh. Fundam Appl Agric 3(1): 355–362. doi: 10.5455/faa.281678

## 1 Introduction

Cabbage (*Brassica oleracea* L. var. capitata) is an important and nutritious leafy vegetable for winter season in Bangladesh. It is identified as one of the top twenty vegetables as well as an important source of food globally (FAO, 1988). Nutritionally, it contains vitamin A, B, C, E, and mineral such as iron, potassium, zinc, etc. Edible fibre content is significantly high in cabbage. In addition, the various other nutrients present in cabbage such as protein, manganese, folate, thiamin (vitamin B1), riboflavin (vitamin B2), omega-3 fatty acids, calcium, magnesium, potassium, etc., are very useful and blended 250 mL of raw cabbage contains 21 kilocalories whereas cooked contains 58 kilocalories (Haque, 2006).

Cabbage is grown throughout the world where China alone is growing about 45% and India 12% of the total world production (FAO, 2015). Bangladesh is also growing cabbage with an average production of 0.26 million tonnes per year (BBS, 2015). Among the winter vegetables grown in Bangladesh, cabbage ranks 7th and 5th in respect of area and production, respectively. The total area, production and yield of winter vegetable in Faridpur was 4125 ha, 87412 t and 21 t $ha^{-1}$, respectively (Anonymous, 2015). Different types of vegetables are cultivated mainly in high land to medium high land either in *Vegetables-Vegetables-Vegetables* cropping pattern (4850 ha of land covering 3% area by this pattern) or other minor pattern (12% area covered by this pattern) with different field crops. In the year of 2014-15, total area and production of cabbage in Faridpur was 254 ha and 7920 t, respectively. Faridpur Sadar upazilla covered 23% area for cabbage production followed by Modhukhali upazilla (22%) and Nagarkanda upazilla (17%) (BBS, 2013). However, the productivity of cabbage per unit area is quite low as compared to the developed countries of the world (Anonymous, 2006).

Among the various factors involved, nutrient supply is an important input for realizing higher cabbage yield and its nutrient content. Results from the previous experiment showed that the response of cabbage is high to nitrogen and moderate to phosphorus application. The importance of nitrogen, phosphorus, potassium and sulphur on the growth and yield of vegetable crops is well established (Hossain et al., 2011). Among the nutrients, nitrogen plays the most important role for vegetative growth of the crop. Phosphorus is also essential nutrient element which helps in the good growth of the roots of vegetable crops. Potassium exerts balancing role on the effects of both nitrogen and phosphorus. Boron nutrient is important in cell division, nitrogen and carbohydrate metabolism and water relation in plant growth (Brady, 1990). The cultivation of cabbage is required proper supply of plant nutrients. The requirement of these plant nutrients can be provided by applying inorganic fertilizer or organic manure or both. But, excessive fertilizer application caused a higher production cost and worse soil structure such as physical, chemical and biological degradation (Khosla et al., 2002; Li et al., 2007). As such, the nutrient deficient soils of cabbage production should be enriched with nitrogen, phosphorus, potassium, sulphur, etc through balanced use of fertilizer. The agronomic and economic data upon which the recommendations are based must be relevant to the farmers' own agro-ecological conditions, and the evaluation of those data should be consistent with the farmers' goals and socio-economic circumstances. The present study was, therefore, undertaken to find out the suitable combination of chemical fertilizers for maximum yield of cabbage as well as economically viable for farmers.

## 2 Materials and Methods

### 2.1 Physical environment of the study area

The study was conducted by On-Farm Research Division (OFRD), Bangladesh Agricultural Research Institute (BARI) in the farmer's field of Farming System Research and Development (FSRD) site, Hatgobindapur, Faridpur during the two consecutive seasons of 2013-2014 and 2014-2015. The experimental field is situated in the eastern part of Krishnanagar union and south western part of Faridpur Sadar upazilla (23.6204° N to N 89.8130° E). The topography of the study area was mainly high land having irrigated facilities with moderately well drained and falls under calcareous soil of Low Ganges River Floodplain (Agroecological Zone 12). The soil belongs to the Gopalpur series having loamy textural class.

### 2.2 Collection of soil sample and chemical soil analysis

The initial soil sample of the experimental site was collected from 0-15 cm depth. Chemical properties like exchangeable K and available P, S, Zn and B of collected soil samples were analyzed in the Soil Resource Development Institute (SRDI) laboratory in Faridpur and Dhaka following standard laboratory procedures (Hunter, 1984). Results of soil physical and chemical properties of initial soil samples are presented in Table 1. Characteristically, the soil was loam having pH 7.4 to 8.0, low in organic matter (1.31% $\sim$ 2.43%). The fertility status of N, P and B was below the critical level and above the critical level for S, Zn and K nutrients (FRG, 2012).

Table 1. Initial soil properties of farmer's field at FSRD site, Hatgobindapur, Faridpur

| Items | Texture | pH | OM (%) | TN (%) | Avail. P ($\mu g\ g^{-1}$) | S ($\mu g\ g^{-1}$) | Zn ($\mu g\ g^{-1}$) | B ($\mu g\ g^{-1}$) | K (meq $100g^{-1}$ soil) |
|---|---|---|---|---|---|---|---|---|---|
| Average | | | 1.7 | 0.087 | 8.46 | 22.11 | 1.07 | 0.24 | 0.21 |
| Interpretation | Loam | SA | L | VL | L | M | M | L | M |
| Critical level | | | – | 0.12 | 10 | 10 | 0.6 | 0.2 | 0.12 |

OM=organic matter, TN=total nitrogen, SA=slightly alkaline, L=low, VL=very low, M=Medium

Table 2. Treatment combination with different fertilizer dose for cabbage production

| Treatment | Fertilizer dose (NPKSZnB Kg $ha^{-1}$) |
|---|---|
| $T_1$ (100% NPKSZn from STB dose) | $N_{242}P_{120}K_{33}S_{19}Zn_{1.4}B_{0.6}$ |
| $T_2$ ($T_1$+25% N) | $N_{302}P_{120}K_{33}S_{19}Zn_{1.4}B_{0.6}$ |
| $T_3$ ($T_1$+25% NP) | $N_{302}P_{150}K_{33}S_{19}Zn_{1.4}B_{0.6}$ |
| $T_4$ ($T_1$+25% NK) | $N_{302}P_{120}K_{41}S_{19}Zn_{1.4}B_{0.6}$ |
| $T_5$ ($T_1$+25% PK) | $N_{242}P_{150}K_{41}S_{19}Zn_{1.4}B_{0.6}$ |
| $T_6$ ($T_1$+25% NPK) | $N_{302}P_{150}K_{41}S_{19}Zn_{1.4}B_{0.6}$ |
| $T_7$ (75% of $T_1$) | $N_{182}P_{90}K_{25}S_{14}Zn_{1.05}B_{0.45}$ |
| $T_8$ (native fertility without addition of fertilizers) | Absolute control |

## 2.3 Experimental design

The tested cabbage variety was Atlas 70. The experiment was laid out in a Randomized Complete Block Design (RCBD) with eight treatments containing five dispersed replications. The unit plot size was 5 m $\times$ 4 m. The treatment $T_1$ comprises with soil test based (STB) fertilizer dose for high yield goal. The treatment combination is given in Table 2.

## 2.4 Agronomic management and harvesting of cabbage

Full doses of P, S, Zn and B was broadcasted and incorporated during final land preparation. Urea, TSP, MoP, gypsum, zinc sulphate monohydrate and boric acid were used as the source of N, P, K, S, Zn and B, respectively. N and K were applied in two equal installments at 15 and 35 days after transplanting (DAT) using ring method around the plants followed by irrigation. One month aged equal sized healthy seedling of cabbage was transplanted on 2 to 15 November, 2013 and 25 October to 2 November, 2014 maintaining a spacing of 60 cm $\times$ 45 cm.

Intercultural operations weeding and mulching at 14 to 16 DAT and 34 to 36 DAT, respectively, and irrigation at 15 to 17 DAT and 35 to 37 DAT were applied. Plant protection measures (Insecticide i.e. Darsban (Chloropyriphos), Regent (Fipronil) and Nitro (Chloropyriphos and cypermethrin) 2 to 3 times and Fungicide i.e. Bavistin (Carbendazim) 2 to 3 times at 35 to 36 DAT, 45 to 47 DAT and 60 to 63 DAT) were applied to ensure luxuriant growth of the crop. Harvesting of cabbage was done when the head attained right maturity stage. Harvesting of cabbage was continued for 15 to 18 days from starting of first harvesting in the experimental plot.

Ten plants from each plot were tagged at random to keep records on number of unfolded leaves $plant^{-1}$, head height $plant^{-1}$ (cm), circumference of head $plant^{-1}$, whole head weight (kg $plant^{-1}$), marketable head weight (kg $plant^{-1}$) and head yield (t $ha^{-1}$). During harvest, total number of plant population per unit plot was counted. After the harvest, whole head weight was measured with unfolded leaves. After that, number of unfolded leaves was counted. Then, marketable head without unfolded leaves was determined by weighing. At harvest, the head circumference of cabbage was measured by measuring tape at the widest part of the head. Finally, heads were cut on longer side and head height was measured. Different agronomic parameters and yield contributing attributes were analyzed statistically using MSTATC software and the mean separations were tested at 5% by Least Significant Difference (LSD) test.

Gross margin of the different fertilizer treatments was counted using the head yield of cabbage from the two year's pooled data at average market price during 2014 and 2015 for the crops and fertilizer inputs. Partial budget and marginal analyses were used to determine the most economically acceptable fertilizer dose (Elias and Karim, 1984). Marginal rate of return is calculated by the following equation:

$$MRR = \frac{AdB}{AdC} \times 100 \qquad (1)$$

where, MRR=marginal rate of return, AdB=Additional benefits between each pair of non-dominated treatments, AdC=Additional costs between each pair of non-dominated treatments.

## 3 Results and Discussion

Similar trend of yield and yield attributes of cabbage was observed in both the years of 2013-14 and 2014-15. Hence, pooled analysis was done, results are discussed below accordingly.

### 3.1 Head height of cabbage

In both the years, significant variation of head height of cabbage was found due to the application of different chemical fertilizers (Table 3). The maximum head height was 13.75 cm and 12.20 cm obtained from the 100% STB inorganic fertilizers dose and 25% additional NPK ($T_6$) during 2013-14 and 2014-15, respectively. In pooled analysis, the maximum head height (12.93 cm) was obtained from $T_6$ which was statistically similar to 100% STB inorganic fertilizers dose ($T_1$), 25% additional N with $T_1$ ($T_2$), 25% additional NP with $T_1$ ($T_3$) and 25% additional PK with $T_1$ ($T_5$). The lowest head height (8.83 cm) was observed from control ($T_8$) as during individual year, the lowest head height was observed from that control treatment.

### 3.2 Number of unfolded leaves per plant

The highest number of unfolded leaves was not found in the same treatment in the year 2013-14 and 2014-15 (Table 3). During 2013-14, it was found highest from $T_6$ (17.56) and this result has the similarity with the findings of Hossain et al. (2011). Again, during 2014-15, control treatment gave the maximum number of unfolded leaves (11.92). From pooled analysis, no statistically significant difference was observed on the number of unfolded leaves plant$^{-1}$ due to different fertilizer treatments. However, number of unfolded leaves plant$^{-1}$ was varied from 12.23 $\sim$ 13.96. The highest number of unfolded leaves plant$^{-1}$ was recorded from control treatment ($T_8$) followed by 75% of $T_1$ ($T_7$). This result also is in line with that of Sen et al. (2009) whom reported that from control treatment, the highest unfolded leaves of cabbage was recorded. The lowest (12.23) was found from 100% STB inorganic fertilizers dose and 25% additional NP ($T_3$).

### 3.3 Circumference of cabbage head

Different fertilizer levels markedly influenced the circumference of head of cabbage. From both the year, the maximum and minimum circumference was observed from $T_6$ treatment (100% STB inorganic fertilizers dose and 25% additional NPK) and $T_8$ (Native nutrient), respectively. From the pooled analysis, it was observed that, significant variation in circumference of head among the treatment, varying from 44.71 to 65.63 cm. There was no significant difference on circumference of cabbage head among 100% STB inorganic fertilizers dose ($T_1$) to 100% STB inorganic fertilizers dose and 25% additional NPK ($T_6$). The maximum was found from the $T_6$ where the highest fertilizer doses was used followed by $T_1$. The minimum was recorded from control ($T_8$) (Table 3). This result was in agreement with the report of Din et al. (2007).

### 3.4 Plant population at harvest

There was no significant effect of chemical fertilizers on the final plant population in cabbage in the year of 2013-14 and 2014-15. However, in pooled analysis, the final plant population varied from 77 to 78 (Table 4).

### 3.5 Whole head weight and marketable weight

Table 4 represents the whole head weight and marketable weight of cabbage was influenced by different nutrient packages during both the years. In both years, the treatment comprises of $T_1$ to $T_6$ showed statistically identical head weight but showed significant difference from $T_7$ treatment. In 2013-14 and 2014-15, whole head weight ranged from 1.43 to 3.15 and 1.22 to 2.36 kg plant$^{-1}$, respectively. From the pooled analysis, it was observed that, the highest whole head weight (2.73 kg plant$^{-1}$) was obtained from $T_6$ (100% STB with 25% NPK) followed by $T_1$ (100% STB). The lowest head weight (1.32 kg plant$^{-1}$) was obtained from $T_8$ treatment. Same result was showed from marketable head weight. In 2013-14 and 2014-15, marketable head weight ranged from 0.94 to 2.36 and 0.79 to 1.73 kg plant$^{-1}$, respectively. From the pooled analysis, it was observed that, the highest marketable head weight (2.05 kg plant$^{-1}$) was obtained from $T_6$ (100% STB with 25% NPK) due to might be maximum circumference of head followed by $T_2$ (100% STB with 25% N). The lowest marketable head weight (0.98 kg plant$^{-1}$) was obtained from $T_8$ treatment due to might be found the maximum number of unfolded leaves. Kamal et al. (2007) found that nitrogen at the rate of 20 kg N ha$^{-1}$ gave the highest total weight (1257 g plant$^{-1}$) as well as weight of head (1032 g) in Chinese cabbage.

### 3.6 Head yield

The head yield of cabbage was significantly affected by different combinations of nutrient treatments (Table 4). From both the year's result, it was found that the treatment $T_6$ which comprises of 100% NPKSZnB with 25% NPK treatment produced maximum head yield. In 2013-14 and 2014-15, the maximum head yield of cabbage was 86.62 t ha$^{-1}$ and 69.48 t ha$^{-1}$, respectively. In pooled analysis, the maximum head yield was 78.89 t ha$^{-1}$. Increase in maximum head

Table 3. Effect of fertilizer dose on head height plant$^{-1}$, number of unfolded leaves plant$^{-1}$ and circumference head plant$^{-1}$ of cabbage (individual year wise and pooled of 2013-14 and 2014-15)

| Treatment† | Head height plant$^{-1}$ (cm) | | | Unfolded leaves plant$^{-1}$ | | | Circumference of head plant$^{-1}$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled |
| $T_1$ | 13.45ab | 12.08a | 12.71ab | 14.05 | 11.24ab | 12.85 | 72.60a | 57.34ab | 64.82a |
| $T_2$ | 13.26bc | 11.92a | 12.54ab | 14.04 | 10.68b | 12.34 | 72.69a | 56.88 ab | 64.66a |
| $T_3$ | 13.73a | 12.00a | 12.77ab | 13.86 | 10.92ab | 12.23 | 72.53a | 56.58 ab | 64.12a |
| $T_4$ | 12.98c | 11.80a | 12.40b | 14.71 | 11.56ab | 13.25 | 72.00a | 55.26b | 63.51a |
| $T_5$ | 13.17bc | 11.86a | 12.54ab | 15.57 | 11.04ab | 13.32 | 71.81a | 55.86ab | 63.61a |
| $T_6$ | 13.75a | 12.20a | 12.93a | 17.56 | 11.20ab | 13.17 | 73.48a | 58.06a | 65.63a |
| $T_7$ | 12.88c | 11.14b | 11.94c | 14.9 | 11.44ab | 13.42 | 69.69b | 52.96 c | 60.84b |
| $T_8$ | 8.38d | 8.06c | 8.83d | 15.52 | 11.92a | 13.96 | 50.60c | 38.76d | 44.71c |
| CV (%) | 2.75 | 2.75 | 2.83 | 9.67 | 6.63 | 9.7 | 2.78 | 2.89 | 3.08 |
| LSD (0.05) | 0.38 | 0.41 | 0.44 | NS | 0.96 | NS | 2.08 | 2.02 | 2.4 |

† $T_1$=100% NPKSZn from STB dose, $T_2$=$T_1$+ 25% N, $T_3$=$T_1$+ 25% NP, $T_4$=$T_1$+ 25% NK, $T_5$=$T_1$+ 25% PK, $T_6$=$T_1$+ 25% NPK, $T_7$=75% of $T_1$, $T_8$=native fertility without addition of fertilizers
‡ In a column, means followed by same letter(s) are statistically similar at 5% level by DMRT, and NS=Not significant

Table 4. Effect of fertilizer dose on yield and yield contributing characters of cabbage (individual year wise and pooled of 2013-14 and 2014-15)

| Treatment† | Plant population (30m$^2$) at harvest | | | Whole head wt. (kg plant$^{-1}$) | | | Marketable head wt. kg plant$^{-1}$ | | | Head yield (t ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled |
| $T_1$ | 74.23 | 79.6 | 77 | 3.01a | 2.36a | 2.69a | 2.27ab | 1.71a | 1.99ab | 82.38ab | 68.08a | 76.21ab |
| $T_2$ | 75.14 | 79.6 | 77 | 2.99a | 2.28a | 2.63a | 2.29ab | 1.72 a | 2.01ab | 84.24ab | 68.44a | 77.31ab |
| $T_3$ | 75 | 79.4 | 77 | 2.95a | 2.31a | 2.63a | 2.21ab | 1.67 ab | 1.94ab | 83.29ab | 65.94ab | 74.28ab |
| $T_4$ | 74.71 | 80.2 | 77 | 3.03a | 2.20a | 2.61a | 2.24ab | 1.63 ab | 1.94ab | 80.98b | 65.32ab | 74.20ab |
| $T_5$ | 74.71 | 80.2 | 78 | 2.94a | 2.15a | 2.64a | 2.18b | 1.55 b | 1.87ab | 79.02b | 62.10b | 71.54 b |
| $T_6$ | 75 | 80 | 77 | 3.15a | 2.32a | 2.73a | 2.36a | 1.73 a | 2.05a | 86.62a | 69.48a | 78.89a |
| $T_7$ | 74.43 | 80 | 77 | 2.63b | 1.93b | 2.28b | 1.96c | 1.35c | 1.76b | 70.65c | 53.94c | 63.44c |
| $T_8$ | 74.86 | 80.8 | 78 | 1.43c | 1.22c | 1.32c | 0.94d | 0.79d | 0.98c | 36.05d | 31.9d | 33.92d |
| CV (%) | 0.97 | 1.19 | 1.57 | 8.03 | 7.74 | 8.53 | 5.46 | 6.21 | 10.1 | 6.08 | 6.33 | 6.03 |
| LSD (0.05) | NS | NS | NS | 0.29 | 0.21 | 0.27 | 0.15 | 0.12 | 0.24 | 4.95 | 4.97 | 5.25 |

† $T_1$=100% NPKSZn from STB dose, $T_2$=$T_1$+ 25% N, $T_3$=$T_1$+ 25% NP, $T_4$=$T_1$+ 25% NK, $T_5$=$T_1$+ 25% PK, $T_6$=$T_1$+ 25% NPK, $T_7$=75% of $T_1$, $T_8$=native fertility without addition of fertilizers
‡ In a column, means followed by same letter(s) are statistically similar at 5% level by DMRT, and NS=Not significant

Table 5. Cost and return analysis of cabbage production as influenced by different fertilizer doses†

| Treatment | Gross return (Tk ha$^{-1}$) | Nutrient cost (Tk ha$^{-1}$) | Gross margin (Tk ha$^{-1}$) |
|---|---|---|---|
| $T_1$ | 762,100 | 26,634 | 735,466 |
| $T_2$ | 773,100 | 29,259 | 743,841 |
| $T_3$ | 742,800 | 32,559 | 710,241 |
| $T_4$ | 742,000 | 29,507 | 712,493 |
| $T_5$ | 715,400 | 30,182 | 685,218 |
| $T_6$ | 788,900 | 32,807 | 756,093 |
| $T_7$ | 634,400 | 19,975 | 614,425 |
| $T_8$ | 339,200 | 0 | 339,200 |

† Price of input (Tk kg$^{-1}$): Urea Tk 20.00, TSP Tk 22.00, MoP Tk 15.00, Gypsum Tk 8.00, Boric acid Tk 160.00, Zinc sulphate monohydrate Tk 150.00 Labor Cost (Tk labor$^{-1}$): 300.00 No. of labor required for 1 ha fertilizer application (3 times): 10 (2 labor needed for applying basal dose, 4 for one time fertilizer application by ring method)
Average output price of cabbage (Tk kg$^{-1}$): 10.00
$T_1$=100% NPKSZn from STB dose, $T_2$=$T_1$+ 25% N, $T_3$=$T_1$+ 25% NP, $T_4$=$T_1$+ 25% NK, $T_5$=$T_1$+ 25% PK, $T_6$=$T_1$+ 25% NPK, $T_7$=75% of $T_1$, $T_8$=native fertility without addition of fertilizers

Table 6. Marginal analysis of cost undominated treatments applied in cabbage at FSRD site, Faridpur

| Treatment | Nutrient cost (Tk ha$^{-1}$) | Marg. increase in fert. cost (Tk ha$^{-1}$) | Gross margin (Tk ha$^{-1}$) | Marg. increase in gross margin (Tk ha$^{-1}$) | MRR (%) |
|---|---|---|---|---|---|
| $T_8$ | 0 | – | 339,200 | – | – |
| $T_7$ | 19,975 | 19,975 | 614,425 | 275,225 | 1,378 |
| $T_1$ | 26,634 | 6,659 | 735,466 | 121,041 | 1,818 |
| $T_2$ | 29,259 | 2,625 | 743,841 | 8,375 | 319 |
| $T_6$ | 32,807 | 3,548 | 756,093 | 12,252 | 345 |

$T_1$=100% NPKSZn from STB dose, $T_2$=$T_1$+ 25% N, $T_6$=$T_1$+ 25% NPK, $T_7$=75% of $T_1$, $T_8$=native fertility without addition of fertilizers

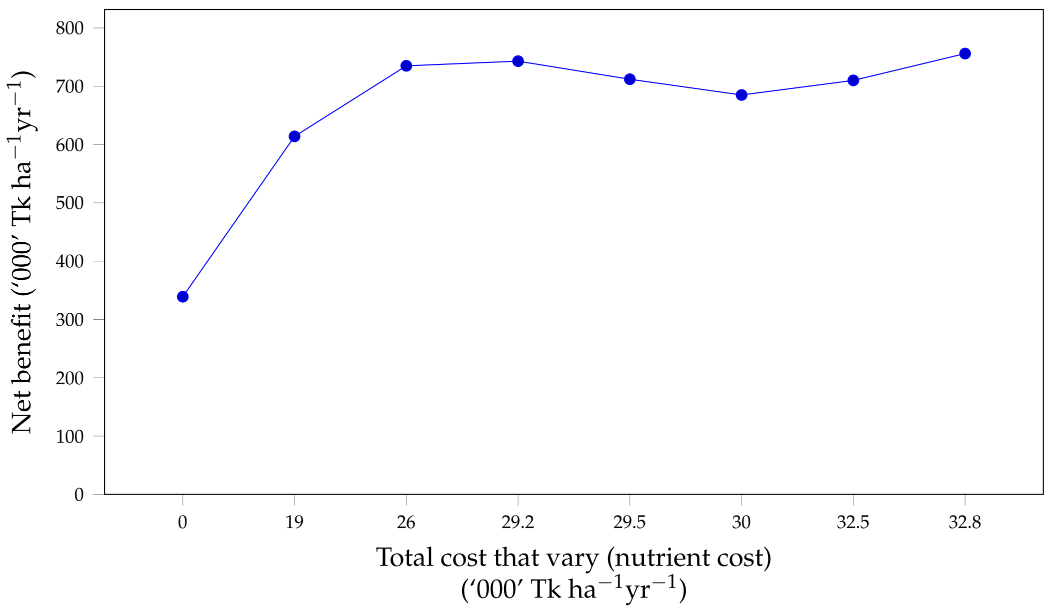


Figure 1. Net benefit curve for different fertilizer treatments in cabbage including cost dominated and cost un-dominated treatments

yield of cabbage could be explained by higher marketable head weight plant$^{-1}$ which might be due to the use of balanced fertilizers. Moreover, application of chemical fertilizer might helped in maintaining soil fertility and offered favorable response in the required nutrient uptake by the plants, which reflect greater yield. This treatment showed statistically identical yield with $T_1$ to $T_4$ treatments. The head yield production increased progressively with the increase amount of N-fertilizer along with phosphorus fertilizer which could be supported by the report of Humadi and Hadi (1988) and Mohans and Hossain (1998). Reduced fertilizer dose in treatment $T_7$ failed to show higher yield. Plants grown without added fertilizer ($T_8$) produced the lowest head yield (33.92 t ha$^{-1}$) presumably due to lower availability of nutrients.

### 3.7 Partial budget analysis

A partial budget was developed as a part of economic analysis to calculate the total costs that vary and the gross margin for each treatment of the fertilizer experiment. The highest gross return (Tk 788,900 ha$^{-1}$) and gross margin (Tk 756,093 ha$^{-1}$) was obtained from 100% soil test based fertilizer dose along with additional 25% NPK ($T_6$). The lowest gross margin (Tk 339,200 ha$^{-1}$) was obtained from control treatment (Table 5).

### 3.8 Dominance analysis

For dominance analysis, the treatments were listed in order of increasing total costs that vary (fertilizer cost). The gross margin also increased, except treatments $T_3$, $T_4$ and $T_5$ where gross margin were lower than in Treatment $T_2$ (Table 5). Farmers would not select treatment $T_3$, $T_4$ and $T_5$ in comparison with Treatment $T_2$ because former treatments had higher nutrient cost but lower in gross margin. Such treatments are called a cost dominated treatment. Therefore, from the net benefit curve in Figure 1, it showed that, treatments $T_6$= $T_1$+25% NPK, $T_2$=$T_1$+25% N, $T_1$=100% NPKSZn (STB), $T_7$=75% of $T_1$, $T_8$=Native nutrient (Control) were cost undominated. The treatments $T_4$=$T_1$+25% NK, $T_3$=$T_1$+25% NP and $T_5$=$T_1$+25% PK were dominated by cost.

### 3.9 Marginal rate of return (MRR)

The marginal rate of return for changing from $T_8$ to $T_7$ is 1378% (Table 6). This means, if farmer invest Tk 19,975, he could recover Tk 19,975, plus an additional amount of Tk 275,225. In this way, the other marginal rate of return found from $T_7$ to $T_1$ treatment, $T_1$ to $T_2$ treatment and $T_2$ to $T_6$ treatment were 1818%, 319% and 345%, respectively. The highest marginal rate of return was observed from $T_7$ to $T_1$ (1818%) i.e. for every Tk 100 of additional investment Tk 1,818 was returned. Application of 100% chemical fertilizers of NPKSZnB from Soil test based ($T_1$) appeared as the best treatment combination for cultivation of cabbage from economic point of view when considering MRR.

## 4 Conclusion

Two years' consecutive study revealed that, the maximum (78.89 t ha$^{-1}$) marketable head yield was obtained from $N_{302}P_{150}K_{41}S_{19}Zn_{1.4}B_{0.6}$ Kg ha$^{-1}$ ($T_1$+25% NPK) treatment whereas application of $N_{242}P_{120}K_{33}S_{19}Zn_{1.4}B_{0.6}$ Kg ha$^{-1}$ of chemical fertilizer (100% chemical fertilizers of NPKSZnB from soil test based) might be suitable and economically viable for cabbage cultivation in the Faridpur under Low Ganges River Floodplain (Agroecological Zone 12).

## References

Anonymous. 2006. Effect of chemical fertilizer and organic manure on the yield and quality of cabbage. Annual Rep, BARI, Joydebpur :186–189.

Anonymous. 2015. Annual Report in Regional Research and Extension Review Workshop 2014-15 and Future Research Planning 2015-16. Department of Agriculture Extension (DAE) held on 26-28 May in RARS, BARI, Rahmatpur, Barisal .

BBS. 2013. Bangladesh Bureau of Statistics. Statistics and Informatics Division. District Statistics. 2011. Faridpur Published in December 2013. p. 38 .

BBS. 2015. Bangladesh Bureau of Statistics. Statistics and informatics Division (SID). Ministry of Planning. Government of the People's Republic of Bangladesh. Yearbook of Agricultural Statistics 2015. p. 286 .

Brady N. 1990. The Nature and Properties of Soils (10th edition). A.K. Ghosh Printing Hall Pvt Ltd, New Delhi, India.

Din M, Qasim M, Alam M. 2007. Effect of different levels of N, P and K on the growth and yield of cabbage. J Agril Res 45:171–176.

Elias S, Karim M. 1984. Application of partial budget technique on cropping system research at Chittagong. AEER No 10 April. Report of Agricultural Economics Division, BARI, Joydebpur, Gazipur. pp. 75–71 .

FAO. 1988. Production Year Book. Basic Data Unit, Statistics Division, Food and Agricultural Organization of the United Nations. Rome, Italy. pp. 157-158 .

FAO. 2015. Year Book. Food and Agriculture Organization of the United Nations. Rome, Italy .

FRG. 2012. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka 1215. p. 251 .

Haque K. 2006. Yield and nutritional quality of cabbage as affected by nitrogen and phosphorus fertilization. Bangladesh J Sci Ind Res 41:41–46.

Hossain D, Haque M, Abuyusuf M, Riad M, Hussain A. 2011. Response of cabbage to different levels of fertilizer application in Salna clay loam soil. Bangladesth Res Pub J 6:155–166.

Humadi M F, Hadi H. 1988. Effect of different source and rates of nitrogen and phosphorus fertilizer on the yield and quality of cabbage. J Agric Water Resour Plant Produc 7:249–259.

Hunter A. 1984. Soil Fertility Analytical Services in Bangladesh. Consultancy Report, Agric Res Project Phase II, BARC, Dhaka. Contract Aid 388–0051 .

Kamal M, Islam M, Karim A, Solaiman A, Hossain M. 2007. Effect of irrigation and N on the yield performance of Chinese cabbage. Ann Bangladesh Agric 11:53–62.

Khosla R, Fleming K, Delgado J, Shaver T, Westfall D. 2002. Use of site specific management zones to improve nitrogen management for precision agriculture. J Soil Water Conserv 57:513–518.

Li X, Hu C, Delgado J, Zhang Y, Ouy-ang Z. 2007. Increased nitrogen use efficiences as a key mitigation alternative to reduce nitrate leaching in North China Plain. Agric Water Mangt 89:137–147. doi: 10.1016/j.agwat.2006.12.012.

Mohans B, Hossain M. 1998. A role on effects of nitrogen and phosphorus on cabbage. Orissa J Hort 26:106–108.

Sen R, Akhter S, Haque M, Noor S, Rahman M. 2009. Comparative performance of cowdung, poultry manure and their slurry on the growth and yield of cabbage. Bangladesh J Agri Res 34:61–67.



The Official Journal of the
**Farm to Fork Foundation**
ISSN: 2518–2021 (print)
ISSN: 2415–4474 (electronic)
http://www.f2ffoundation.org/faa