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# Response of Chilli to Integrated Fertilizer Management in North-eastern Brown Hill Soils of Bangladesh

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**Abstract:** Field experiments were conducted in north-eastern hilly region (Chittagong Hill Tracts) of Ramgarh, Khagrachari Hill district to find out the response of Chilli cv. Balijhuri to different doses of N P K S and Zn under rainfed condition during the rabi seasons of 1996-97 and 1997-98. There were four levels each of N: 0,50,100 and 150 kg $ha^{-1}$; four levels each of $P_2O_5$: 0, 60, 90 and 120 kg $ha^{-1}$; $K_2O$: 0, 60, 90 and 120 kg $ha^{-1}$; three levels each of S: 0, 10 and 20 kg $ha^{-1}$ and Zn :0, 2 and 4 kg $ha^{-1}$. The effect of nitrogen was highly pronounced and that of P, K, S and Zn were beneficial on number of fruits per plant, fresh yield as well as dry yield. The fruits per plant, fresh yield and dry yield ton $ha^{-1}$ were markedly increased with the increase of N P K S and Zn up to a certain (dose) level but had a hardly increase in yield of chilli (***Capsicum annum Linn.***) beyond this limit. The economic analysis recommended the treatment combination ($T_{13}$) of 100:90:90:20:2 kg $ha^{-1}$ of N: $P_2O_5$: $K_2O$: S: Zn respectively to be more suitable dose for fresh yield of chilli (20.03 t $ha^{-1}$ in 1996-97; 21.11 ton $ha^{-1}$ in 1997-98 and 20.57 t $ha^{-1}$ in average of two years) and for getting the highest marginal rate of return (27552.88 %) with gross margin of TK. 5,08,106.98 $ha^{-1}$.

**Key words:** Chilli cv. Balijhuri, integrated nutrient management, brown hill soil, green chilli

## Introduction

Chilli (***Capsicum annum Lnn.***) is the very popular and common spice found in green or dried ripe fruit of pungent form. It is an indispensable spice in every house on the tropical countries. Chilli is specially liked for it pungency, spicy taste, besides the appealing colour it adds to the food. Green chillies also contain high amount of vitamin A and C. Chittagong Hill Tracts region is the very potential area for growing spice crops especially for Chillies. Though it can be grown in almost all the areas of the country. The hilly growers generally produce these crops extensively in some selective locations. But the producers do not get the real price due to poor marketing and inadequate transportation facilities. An ideal medium for growing Chilli is a light loamy soil. But, however it can be grown in a varieties type of soils provided they are well-drained and rich in organic matter. As a rainfed crop well drained black soils are also suitable.

In sandy soils, the crop may be grown with success provided adequate irrigation and fertilizers are ensured. Mostly Hilly soils are sandy loam suited for chilli cultivation. Soil moisture generally do not affect the fruit set as it is rainfed spicy crop but severe moisture stress might be the cause of fruit drop. The nutrient removal and uptake capacity by capsicum cultivar is more higher which indicates high nutrient requirements by the plants. Correct manuring practices with both organic and inorganic nutrients were found to be increasing the growth and yield (Sharma ***et al.***, 1996 and Hedge, 1997). During the early part of the flowering an increase dose of nitrogen required for flower production but do not affect the percentage of fruit set (Subbiah, 1994).

Experimental evidences (Mallangouda ***et al.***, 1995 and Singh ***et al.***, 1999) indicated side dressing of higher rates of phosphorus and potassium are more beneficial to the root development of Chilli and increase total dry and yield. Another experimental report suggests that application of N (0, 60, 90 or 120 kg $ha^{-1}$) and P (0, 30 or 60 kg $ha^{-1}$) on the growth and yield of Chilli, the yield of fruits significantly increased with the increasing rates of nitrogen (120 kg $ha^{-1}$) and phosphorous (60 kg $ha^{-1}$) respectively (Sharma ***et al.***, 1996). People in the hilly region cultivate this spicy crop traditionally. However they do not use balanced dose of fertilizers for chilly production. Besides, limited and sporadic research works have been done on fertilizer management for chilly cultivation in the country. Considering the importance of the above points of view, this investigation was therefore undertaken to find out the balance dose of fertilizers for maximizing high yield of Chilli in hilly region.

**Materials and Methods**

Field trials were carried out at the Hill tracts Agricultural Research Station, Ramgarh, Khagrachari Hill district during two consecutive years of 1996-97 and 1997-98. The experimental soil was sandy clay loam belongs to the north-eastern hilly region. The physical and Chemical properties of soil is presented in Table 1. Soil pH, total nitrogen, organic matter and other nutrients were analyzed by glass electrode pH meter (Jackson, 1960), micro Kjaldahl method (Page ***et al.***, 1989) and ASI method as described by Hunter (1984). The experiment was laid out in a randomized block design with three replications. Four levels of nitrogen (0, 50, 100 and 150 kg $ha^{-1}$), four levels of phosphorus (0, 60, 90 and 120 kg $ha^{-1}$), four levels of potassium (0, 60, 90 and 120 kg $ha^{-1}$), three levels of Sulphur (0, 10 and 20 kg $ha^{-1}$) and three levels of Zinc (0, 2 and 4 kg $ha^{-1}$) were evaluated. Entire fertilizers were applied during final land preparation except nitrogen. First half of N was applied just fifteen days after planting. The rest ½ of N was top-dressed during flower initiation stage. The 30 days seedlings of chilli (cv. Balijhuri) were planted on first week of October in 1996 and 1997. Necessary intercultural operations were performed timely. The green chillies were harvested time to time for data collection. Data on different fruit characters were recorded and analyzed statistically. The mean differences were adjusted by least significant difference (LSD) test at 5% level of significance along with Duncan's multiple range test (DMRT). for ranking of the two means to be compared in response of chilli to N P K S and Zn in both years. Partial budget analyzes of undominated fertilizer responses on the fresh yield of chilli (average of two years) were done following the method suggested by Elias and Karim

(1984). The cost of fertilizers and gross return were calculated considering the following rate of fertilizers and market price of green chilli : TK. 6.00 $kg^{-1}$ urea, TK. 14.00 $kg^{-1}$ T.S.P; TK.. 9.00 $kg^{-1}$ M.P., Tk 4.00 $Kg^{-1}$ Gypsum, TK. 50.00 $kg^{-1}$ Zn $SO_4$ and that of TK. 25.00 $kg^{-1}$ of Chilli.

**Results and Discussion**

The means of observation of fruits per plant, fresh yield and dry yield ton per hectare are presented in Table 2. All fertilizer treatments significantly increased the fruits per plant over control ($T_1$). The number of fruits profusely increased with the increase of N up to 150 kg $ha^{-1}$.The significant increase in fruits number was also recorded with the application of 90, 90, 10 and 2 kg $P_2O_5$, $K_2O$, S and Zn $ha^{-1}$ respectively. The maximum number of fruits per plant 109 in 1996-97 and 110 in 1997-98 were recorded in $T_{13}$ ($N_{100}P_{90}K_{90}S_{20}Zn_2$) Which was identical to the fruits per plant produced in $T_{15}$ ($N_{100}P_{90}K_{90}S_{20}Zn_4$), $T_4$ ($N_{100}P_{90}K_{90}S_{10}Zn_2$), $T_5$ ($N_{150}P_{90}K_{90}S_{10}Zn_2$) and $T_8$

Table 1: Some Physical and Chemical properties of soils of experimental plot prior to fertilizer application at HARS, Ramgarh, Khagrachari Hill district

| | | | | meq/100 g | | | | μg $ml^{-1}$ | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Texture | pH | OM % | Ca | Mg | K | Total N% | P | S | B | Cu | Fe | Mn | Zn |
| 1996-97 | Sandy loam | 4.2 | 1.04 | 1.07 | 0.41 | 0.08 | 0.055 | 3.6 | 14 | 0.20 | 1.01 | 165.0 | 17.7 | 0.96 |
| 1997-98 | Sandy loam | 4.0 | 1.70 | 1.5 | 0.62 | 0.07 | 0.083 | 2.5 | 12 | 0.25 | 1.06 | 76.20 | 18.5 | 1.10 |
| Critical level - | | - | - | 2.0 | 0.8 | 0.2 | - | 14 | 14 | 0.20 | 1.0 | 10 | 5.0 | 2.0 |

Source: Soil Science Laboratory, BARI

Table 2: Effect of different fertilizer treatments on the fruit per plant, fresh yield and dry yield of chilli (cv. Balijhuri) at Ramgarh, Khagrachari Hill district during rabi season of 1996-97 and 1997-98

| | Fertilizer combination kg $ha^{-1}$ | | | | | Fruits/plant | | Fresh yield t $ha^{-1}$ | | Dry yield (t $ha^{-1}$) | | Fresh yield (t $ha^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment code | N | $P_2O_5$ | $K_2O$ | S | Zn | 1996-97 | 1997-98 | 1996-97 | 1997-98 | 1996-97 | 1997-98 | Average of two years | % yield increase over control |
| $T_1$ | 0 | 0 | 0 | 0 | 0 | 48bd | 37d | 6.80i | 6.67i | 1.50g | 1.66g | 6.74i | - |
| $T_2$ | 0 | 90 | 90 | 10 | 2 | 77bc | 68c | 14.51f | 10.33h | 2.73d | 2.74f | 12.42g | 84.27 |
| $T_3$ | 50 | 90 | 90 | 10 | 2 | 92b | 88b | 17.70c | 14.47f | 4.88b | 3.72d | 16.09e | 138.72 |
| $T_4$ | 100 | 90 | 90 | 10 | 2 | 106a | 97a | 18.50c | 17.71c | 4.83b | 4.81b | 18.11bc | 169.45 |
| $T_5$ | 150 | 90 | 90 | 10 | 2 | 107a | 105a | 12.00g | 18.03c | 3.12e | 4.80b | 15.02e | 122.85 |
| $T_6$ | 100 | 0 | 90 | 10 | 2 | 64d | 64c | 13.50f | 11.88d | 3.75d | 3.00e | 12.69g | 88.28 |
| $T_7$ | 100 | 60 | 90 | 10 | 2 | 87b | 83b | 17.79c | 13.72f | 4.82b | 3.76d | 15.76e | 133.83 |
| $T_8$ | 100 | 120 | 0 | 10 | 2 | 107a | 104a | 14.53f | 16.89c | 3.78d | 4.78b | 15.71e | 133.09 |
| $T_9$ | 100 | 90 | 60 | 10 | 2 | 85b | 81b | 16.02c | 15.88f | 4.01cd | 3.81d | 14.95e | 121.81 |
| $T_{10}$ | 100 | 90 | 120 | 10 | 2 | 90b | 92b | 16.67d | 16.22e | 4.71c | 4.00cd | 16.45e | 144.07 |
| $T_{11}$ | 100 | 90 | 90 | 10 | 2 | 93b | 91b | 15.69e | 17.02c | 3.96cd | 4.36c | 16.36e | 142.73 |
| $T_{12}$ | 100 | 90 | 90 | 0 | 2 | 92b | 89b | 14.77f | 15.66e | 3.72d | 3.92cd | 15.22e | 125.82 |
| $T_{13}$ | 100 | 90 | 90 | 20 | 2 | 109a | 110a | 20.03a | 21.11a | 5.50a | 5.67a | 20.57a | 205.19 |
| $T_{14}$ | 100 | 90 | 90 | 10 | 0 | 91b | 93b | 17.00c | 17.21c | 4.37c | 4.42c | 17.11c | 153.86 |
| $T_{15}$ | 100 | 90 | 90 | 10 | 4 | 105a | 106a | 18.90b | 18.89b | 5.15ab | 5.18ab | 18.90b | 180.42 |

Table 3: Marginal analysis of undominated fertilizer response on the yield of chilli (cv. Balijhuri) at HARS, Ramgarh, Khagrachari Hill district (Average of two years data)

| Treatment code | Fertilizer combination (kg ha$^{-1}$) N | $P_2O_5$ | $K_2O$ | S | Zn | Gross margin (TK. ha$^{-1}$) | Variable cost (TK. ha$^{-1}$) | Marginal increase in gross margin (TK. ha$^{-1}$) | Marginal increase in variablecost (TK. ha$^{-1}$) | Marginal rate of return (MRR)% |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_{13}$ | 100 | 90 | 90 | 20 | 2 | 5,08,106.98 | 6,143.02 | 61277.60 | 222.40 | 27552.88 |
| $T_{11}$ | 100 | 90 | 90 | 10 | 2 | 4,46,829.38 | 5,920.62 | 24722.00 | 278.00 | 8892.81 |
| $T_{14}$ | 100 | 90 | 90 | 10 | 0 | 4,22,107.38 | 5,642.62 | 25111.37 | 388.66 | 6461.01 |
| $T_3$ | 50 | 90 | 90 | 10 | 2 | 3,96,996.04 | 5,253.96 | 8005.23 | 244.74 | 3270.91 |
| $T_7$ | 100 | 60 | 90 | 10 | 2 | 3,88,990.78 | 5009.22 | 74927.20 | 1822.80 | 4110.56 |
| $T_6$ | 100 | 0 | 90 | 10 | 2 | 3,14,063.58 | 3186.42 | 145563.58 | 3186.42 | 4568.25 |
| $T_1$ | 0 | 0 | 0 | 0 | 0 | 1,68,500 | - | - | - | - |

($N_{100}P_{120}K_0S_{10}Zn_2$) Table 2. The results are in partial agreement with the findings of Revanappa ***et al.*** (1998) and Macia ***et al.*** (1997). Thus it revealed that nitrogen application was more pronounced as compared to P K S and Zn.

The highest fresh yield (20.03 t ha$^{-1}$) in 1996-97 and (21.11 t ha$^{-1}$) in 1997-98; maximum dry yield (5.50 t ha$^{-1}$) in 1996-97 and (5.67 t ha$^{-1}$) in 1997-98 and highest fresh yield (20.57 t ha$^{-1}$) in average of two years were found at 100 kg N in combination with 90: 9: 20: 2 of $P_2O_5$: $K_2O$: S and Zn kg ha$^{-1}$ ($T_{13}$) and differed to lower rates of N (o and 50 kg ha$^{-1}$) and higher rate of N (150 kg ha$^{-1}$) Table 2. Results indicated that the response of N was significant up to 100 kg N ha$^{-1}$ and further increases in N rate (150 kg ha$^{-1}$) did not bring any significant change on the yield of chilli. Sharma ***et al.*** (1996), Sontakke ***et al.*** (1995) and Madero (1995) corroborated with the present findings but Prabhakar and Naik (1997) observed that application of higher nitrogen rate of 180 kg ha$^{-1}$ significantly contributed the yield of chilli.

Significant increase in fresh yield (18.5 t ha$^{-1}$) in 1996-97 and (17.71 t ha$^{-1}$) in 1997-98; dry yield (4.83 t ha$^{-1}$) in 1996-97 and (4.81 t ha$^{-1}$) in 1997-98 and fresh yield (18.11 t ha$^{-1}$) in average of two years and yield increase (169.45%) over control were recorded at 90 kg $P_2$ $O_5$ ha$^{-1}$ along with 100 kg N, 90 kg $K_2O$, 10 kg S and 2 kg Zn ha$^{-1}$ ($T_4$)

The increase of fresh yield and dry yield of chilli due to applied $P_2O_5$ with N, K and other elements were reported by Kocevsky ***et al.*** (1995) and Trpesky ***et al.*** (1995). The application of potassium also increased the fresh yield as well as dry yield significantly with the increase of $K_2O$ up to 90 kg ha$^{-1}$ in both the years (Table 2). The result is in partially supported by the findings of Johnson (1996) and Gotcz (1995). The effect of sulphur and zinc on number of fruits per plant, fresh yield and dry yield were beneficial up to 20 kg S ha$^{-1}$ and 2 kg Zn ha$^{-1}$ in both the years.

The highest fresh yield (20.57 t ha$^{-1}$) in average of two years and maximum yield increase (205.19 %) over control were produced by combined effect of 100: 90: 90: 20: 2 of N: $P_2O_5$: $K_2O$: S: Zn: kg ha$^{-1}$ ($T_{13}$) and significantly higher over other treatments combination. The lowest fresh fruit yield (6.80 t ha$^{-1}$) in 1996-97 and (6.67 t ha$^{-1}$) in 1997-98 and (6.74 t ha$^{-1}$) in average of two years were obtained in control treatment ($T_1$) Table 2. The marginal analysis of cost undominated treatments are shown in Table 3. The highest marginal rate of return (MRR) 27522.88% with gross margin TK. 5,08,106.98 ha$^{-1}$ obtained from the treatment ($T_{13}$) (100:90:90:20:2 of N:$P_2O_5$:$K_2O$:S:Zn kg ha$^{-1}$) was found to be most suitable fertilizer dose for chilli (cv.Balijhuri) production from the aspect of economic point of view in soil under trial and in its extrapolation purview as well.

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