*J. Indian Soc. Coastal Agric. Res.* 37(2): 60-63 (2019)

# Deep Placement of Urea Increased Fertilizer Use Efficiency and Yield of Summer Tomato

S. S. A. KAMAR[1]*, M. A. WOHAB[1], M. A. RAHMAN[2] and RAZIUDDIN[2]

[1]Bangladesh Agricultural Research Institute (BARI), Gazipur - 1701, Bangladesh
[2]Regional Agricultural Research Station (RARS), BARI, Barishal - 8211, Bangladesh

Received: 20.05.2019 Accepted: 28.07.2019

**The coastal areas cover about 20% of the geographical area of Bangladesh and comprise more than 30% of the cultivable lands of the country. Agricultural land use in these areas is very poor compared to the country's average cropping intensity of 191%. Fertilizer deep placement (FDP) is a proven technology for nutrient supply to different crops all over the world. FDP is more effective than the traditional method (surface broadcasting) of applying fertilizer across a field. In Bangladesh, demand for vegetable production in terms of domestic and export market is increasing day by day, but soil fertility is the major constraint for agriculture especially in vegetable production. Most of the farmers in Bangladesh do not follow the judicious nutrient management strategies for vegetable production and so the farmers cannot get maximum benefit of fertilizer application. At Rahmatpur, Barishal during two seasons of 2016-17 and 2017-18, the effects of different forms of urea fertilizer deep placement were tested to quantify the fertilizer use efficiency and yield of summer tomato cultivation. The treatments were *viz*. prilled urea broadcasting (Farmers' Practice; FP), prilled urea deep placement (DPU) and urea super granules deep placement (USG). Fertilizer use efficiency was increased after application of deep placement of urea. Economic yield was higher (27.4 t $ha^{-1}$) with USG followed by DPU (24.5 t $ha^{-1}$), lowest being observed in case of FP (18.9 t $ha^{-1}$). The benefit cost ratio (BCR) was greater with USG (2.01) and DPU (1.81) application than FP (1.31). Deep placement of both forms of urea was more efficient than broadcasting of prilled urea for summer tomato cultivation.**

(***Key words:*** *Fertilizer use efficiency, Prilled urea, Tomato, Urea super granule, Yield)*

Many reports show that 20% or more yield increase can be obtained by basal deep placement of urea compared to split broadcast. In addition, urea deep placement reduces farmers' fertilizer expenses (because they use less) and decreases the negative environmental impacts of N loss from urea fertilizer (IFDC, 2013). Fertilizer use efficiency by broadcast application on the soil surface in upland farming condition is only 50 to 60% (Craswell and Velk, 1979). By contrast, point placement of urea super granule (USG) at 10 cm depth resulted in negligible loss. In Philippines and India, only 15 to 35% of the total fertilizer N is used by the rice plant. N loss is mainly caused due to ammonia volatilization, de-nitrification, run off, seepage, etc. Fertilizer deep placement reduces wastage of urea about 35% and increase rice yield by 15-20% (Savant *et al*., 1992; Bautista *et al*., 2000).

Efficient urea deep placement (UDP) applicators were developed in Bangladesh (Savant *et al*., 1991; Wohab *et al*., 2009; Hoque, 2013; Ahamed, 2014). While FDP has been used most widely in rice, there has been limited evaluation of this technology in high N requiring vegetable crops such as tomato. Use of FDP in vegetable production is more effective than urea broadcasting. The growth of vegetables need uniform supply of nutrients. So far economic benefit of fertilizer application is concerned, FDP is more efficient than broadcasting. Keeping these facts in view, the present experiment was carried out based on two objectives a) to determine the effects of prilled urea and USG deep placement on growth and yield of summer tomato, and b) to estimate the fertilizer use efficiency of summer tomato for different methods of urea placement.

## MATERIALS AND METHODS

The field experiment was conducted at the Regional Agricultural Research Station (RARS), Bangladesh Agricultural Research Institute (BARI), Rahmatpur, Barishal during two *rabi* (winter) seasons of 2016-17 and 2017-18. The site is located on the Ganges tidal flood plain at 22.42°N latitude and 90.23°E longitude. The soil of the experimental plot was silt loam with

**Corresponding author:* E-mail: alamkamar91@gmail.com

pH varying from 6.25 to 6.8. The test crop variety was BARI Tomato-8. Plant to plant spacing was 40 cm and row to row spacing was 60 cm. The seedlings were transplanted at 2nd week of May in both years. Tomato was harvested three times for both the years.

The treatments were as follows: Prilled urea broadcasting (Farmers' Practice), Prilled urea deep placement (DUP), Urea super granules deep placement (USG). The treatments were arranged in a randomized complete block design with three replications in plots of 8 $m^2$.

250 kg $ha^{-1}$ triple super phosphate (TSP) and 7500 kg $ha^{-1}$ cow dung were applied uniformly in the experimental field at the time of land preparation. The rest 7500 kg $ha^{-1}$ cow dung was applied to all plots before transplanting of seedlings. The muriate of potash (MoP) was applied at the rate of 100 kg $ha^{-1}$ as basal. The rest 160 kg $ha^{-1}$ MoP was applied at 25 and 40 days after planting. The urea application procedure was separated according to the treatments. For FP the prilled urea fertilizer was applied in three split doses. Prilled urea @ 300 kg $ha^{-1}$ was first top dressed at 10 days after planting and again at 25 days after planting; the third dose was applied after 40 days of planting @ of 150 kg $ha^{-1}$. The DUP was applied at 5-8 cm depth into the soil at 12-15 days after planting. Three or 4 holes were made approximately at 10-13 cm from the base of each tomato plant. Then 10.8 gm (540 kg $ha^{-1}$) urea was divided into 3 or 4 portions and placed into the hole. After that the hole was tightly closed by soil. The USG (urea super granule) was placed 3-6 cm depth under the soil and 6 pieces (450 kg $ha^{-1}$) of USG (each USG containing 1.8 gm) was deep placed keeping 10-12 cm distance from each tomato plant.

The first weeding was done manually at 15 days after planting and the second was done when it was necessary to keep the field free from weeds. Sex pheromone trap was used there for controlling the insect attack. The experimental plots were surrounded by nets to protect the plants from birds attack. Five plants from each plot were selected randomly for collecting plant height, number of fruits per plant, individual fruit weight, fruit length and fruit diameter data. Fruit yield data was collected from whole of the plot. The fertilizer use efficiency was calculated by using the following equation.

$$\text{Fertilizer use efficiency (\%)} = \frac{\text{Yield}}{\text{Nutrient Applied}} * 100$$

Nutrient loss was calculated at the laboratory of soil science division, BARI, Gazipur. Soil samples were collected and analyzed before and after application of fertilizer at regular interval. The collected data were analyzed using R software.

## RESULTS AND DISCUSSION

### Interaction effects between years and treatments on growth and yield parameters

For all parameters the effect of urea placement varied between years (Table 1). The plant height was highest with USG for both years (173 and 167 cm) but the lowest mean values were in FP (123 cm) and DUP (122 cm) in years 1 and 2, respectively. Initial number of plants per plot was significant in both the years but the treatments were not significant in each year. The highest initial number of plants per plot (44) was during second year in every treatment. Final number of plants per plot was also statistically significant.

The fruit length was highest for USG in both years (4.28 and 4.25 cm for year 1 and 2, respectively) and the lowest value (3.87 cm) was observed for FP in the year 2. The fruit length was statistically significant for both years and treatments. Fruit diameter was also observed to statistically significant (Table 1) in second year. The highest (4.37 cm) diameter was found at USG in year 1 and the lowest (4.28 cm) was observed with DUP, however, the differences in fruit diameter were non-significant in year 1. The number of fruits per plot was highest (426) for DUP and USG in year 2 and the lowest (325) was found with FP in year 1. It was observed from Table 1 that the highest (52.5 g) and lowest (33.1 g) mean value of individual fruit weight was obtained with FP in the consecutive years. The yield was highest (27.73 t $ha^{-1}$) with USG and lowest 17.32 t $ha^{-1}$ with FP. The second highest mean value was for DUP in both the years.

The interaction effects (year x treatment) of biomass on summer tomato were statistically significant (Table 2). The leaf, plant and root biomass were highest with USG in second year. In year 1, total (leaf, plant and root) biomass was highest (Table 2) with USG. The second highest value of total biomass (leaf, plant and root) was recorded with FP in consecutive years.

### Fertilizer use efficiency

The urea fertilizer use efficiency was highest

***Table 1.*** *Effect of urea placement treatments on growth and yield of summer tomato during two consecutive years*

| Treatment | Plant height (cm) | | Initial number of plant plot$^{-1}$ | | Final number of plant plot$^{-1}$ (no.) | | Fruit length (cm) | | Fruit diameter (cm) | | Number of fruits plot$^{-1}$ | | Individual fruit weight (g) | | Yield (t ha$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 1 | Year 2 | Year 1 | Year 2 | Year 1 | Year 2 | Year 1 | Year 2 | Year 1 | Year 2 | Year 1 | Year 2 | Year 1 | Year 2 |
| FP | 123b | 161a | 37.7b | 44.0a | 33.3b | 34.3b | 4.07b | 3.87c | 4.34a | 3.57d | 325b | 420a | 52.5a | 33.1d | 20.6bc | 17.3c |
| DUP | 138b | 122b | 39.0b | 44.0a | 35.7b | 40.3a | 3.95b | 4.04b | 4.28a | 3.78c | 409a | 426a | 46.3b | 42.4c | 26.4a | 22.6b |
| USG | 173a | 167a | 39.7b | 44.0a | 35.3b | 41.0a | 4.28a | 4.25a | 4.37a | 4.12b | 408a | 426a | 45.1bc | 50.8a | 27.7a | 27.0a |

Values followed by common letter(s) within the same column do not differ significantly at 5% level of significance analyzed by DMRT

***Table 2.*** *Effects of urea placement treatments on biomass of summer tomato in consecutive years*

| Treatments | Leaf | | Plant | | Root | |
|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 1 | Year 2 | Year 1 | Year 2 |
| FP | 40.47b | 35.73b | 58.25bc | 59.36bc | 3.42c | 5.27bc |
| DUP | 35.16b | 31.86b | 57.43c | 53.92c | 5.27bc | 6.10bc |
| USG | 70.37a | 74.71a | 80.63ab | 89.48a | 8.53ab | 12.97a |

Values followed by common letter(s) within the same column do not differ significantly at 5% level of significance analyzed by DMRT

(46.06%) with USG and lowest (25.25%) for FP (Table 3). The second highest (43.23%) result was observed with DUP. The differences in treatments were found to be statistically significant.

***Table 3.*** Urea fertilizer use efficiency in different treatments

| Treatments | Fertilizer use efficiency (%) |
|---|---|
| FP | 25.25 |
| DUP | 43.23 |
| USG | 46.06 |
| LSD | 3.08 |

## Economic Analysis

The highest (2.01) benefit cost ratio (BCR) was due to application of USG and the lowest (1.31) was at with FP (Table 4). The second highest BCR was 1.81 with treatment DUP. Average farm gate price of tomato was USD 0.58 per kg. The prilled urea fertilizer price was USD 0.19 whereas USG price was USD 0.25 at the retailer level. For this reason the fertilizer cost was low for DUP among others. In case of urea deep placement treatments the labor cost was lower than FP in summer tomato cultivation. Because farmers need labor to broadcast urea every time while in deep placement treatments farmers need to apply urea only one time. The net return was (Table 4) highest (USD 8005) for USG, followed by DUP (USD 6397), and the lowest net return was USD 2547 for FP.

***Table 4.*** *Economic analysis for urea placement in summer tomato*

| Parameters | FP | DUP | USG |
|---|---|---|---|
| Tillage cost (\$ ha$^{-1}$) | 72 | 72 | 72 |
| Fertilizer cost (\$ ha$^{-1}$) | 252 | 215 | 264 |
| Labor cost (\$ ha$^{-1}$) | 6319 | 5744 | 5744 |
| Irrigation cost (\$ ha$^{-1}$) | 23 | 23 | 23 |
| Input cost (\$ ha$^{-1}$) | 1741 | 1741 | 1741 |
| Pesticide cost (\$ ha$^{-1}$) | 58 | 58 | 58 |
| Total cost (\$ ha$^{-1}$) | 8464 | 7853 | 7902 |
| Yield (t ha$^{-1}$) | 18.94 | 24.51 | 27.36 |
| Gross return (\$ ha$^{-1}$) | 11012 | 14250 | 15849 |
| Net return (\$ ha$^{-1}$) | 2547 | 6397 | 8005 |
| Benefit cost ratio (BCR) | 1.30 | 1.81 | 2.01 |

(Note: Input cost includes seed, polythene, bamboo, rope and other cost; 1dollar = BDT 86)

Fertilizer deep placement (FDP) is a field-tested technology that increases crop yields, uses less fertilizer and decreases environmental damage (Ahamed, 2014). From fertilizer application rate, it was observed that high rate of urea fertilizer was applied at FP. While in deep placement treatments almost one third less urea was applied. The progress made to date is encouraging (particularly in Bangladesh) and the potential for FDP expansion remains immense. Switching from the broadcast fertilizer application method to FDP may save labor in weeding but may increase labor requirements for harvesting. Higher yields also mean more labor is needed for harvesting. For this reason the labor cost was similar for deep placement treatments (Table 4). FDP also decreases weed growth, reducing time and labor for weeding (Hossen *et al*., 2013). The yield was highest with USG and lowest with FP. The second highest mean value was at DUP in both the years (Table 1). Many reports show that 20% or more yield increase can be obtained by basal deep placement of urea compared to split broadcast application (Savant *et al*., 1992; Bautista *et al*., 2000). In spite of over 60 years of efforts, it has not been possible to transfer these important research findings to farm level (Khan, 1984). The yield increase percentage was high in urea deep placement treatments than farmers' practice in summer tomato cultivation. The deep placement of USG and prilled urea (DUP) increased growth and yield parameters compared to broadcasting of urea, the current farmer practice. The number of fruits was increased by 12% as compared to farmers' practice. Farmers will get benefit by deep placing of any type of urea for summer tomato cultivation during the *kharif* season in southern region of Bangladesh.

## REFERENCES


Ahamed, M. S., Ziauddin A. T. M. and Sarker R. I. (2014). Design of improved urea super granule applicator. *International Journal of Applied Science* **3**: 98-100.

Bautista, E. U., Suministrado, D. C. and Koike, M. (2000). Mechanical deep placement of fertilizer in puddled soils. *Journal of Japanese Society of Agricultural Machinery* **62**: 146-157.

Craswell, E. T. and Velk, P. L. G. (1979). Fate of fertilizer nitrogen applied to wetland rice. In: *Nitrogen and Rice*, IRRI, Los Banos, Philippines. pp 175-192.

Hoque, M. A., Wohab, M. A., Hossain, M. A., Saha, K. K. and Hassan, M. S. (2013). Improvement and evaluation of BARI USG applicator. *CIGR Journal* **15** (2): 87-94.

Hossen, M. A., Islam, M. S., Rahman, M. A., Huda, M. D., Bhuyain, M. G. K. and Nath, B. C. (2013). Design and development of manually operated urea supper granule (USG) applicator. *Journal of Agricultural Mechanization in Asia, Africa and Latin America* **44** (2): 85-91.

IFDC. (2013). IFDC Report 2013, Muscle Shoals, AL, USA. http://ifdcorg.files.wordpress.com/15/01/2013ifdcreport_vol32no2_final_web.pdf

Khan, A. U. (1984). Deep placement fertilizer applicators for improved fertilizer use efficiency. *Journal of Agricultural Mechanization in Asia, Africa and Latin America* **15**(3): 25-32.

Savant, N. K., Ongkingco P. S., Zarate I. V., Torrizo F. M. and Stangel, P. J. (1991). Urea briquette applicator for transplanted rice. *Fertilizer Research Journal* **28**: 323-331.

Savant, N. K., Ongkingco, P. S., Garcia, F. D., Dhane, S. S., Khadse, R. R., Chavan, S. A. and Rao, K. S. (1992). Agronomic performance of urea briquette applicator in transplanted rice. *Fertilizer Research Journal* **32**(2): 139-142.

Wohab, M. A., Islam, M. S., Haque, M. A., Hossain, M. A. and Ahmed, M. S. (2009). Design and development of a urea super granule applicator for puddled rice field. *Journal of Agricultural Engineering* **37**: 57-62.