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# Poultry Manure with Inorganic Nitrogen on Growth and Yield of Onion (*Allium cepa* L.)

M. A. Baset Mia[1*], Sanjida Akter[1], A. H. Molla[1] and G. K. M. Mustafizur Rahman[2]

[1]*Departments of Crop Botany,* [2]*Soil Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh*
**Corresponding author, Email: miabaset@yahoo.com*

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**Abstract**
An experiment was conducted at the research farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) in 2004 to investigate the effect of poultry manure along with inorganic N-fertilizer on the nutrient uptake, growth and yield of onion. The onion (*Allium cepa* L.) cv. "Taherpuri" was grown under six treatments viz. recommended dose of inorganic N (115 kg $ha^{-1}$, 100% N), 75% of inorganic N + 5 t $ha^{-1}$ poultry manure, 50% inorganic N + 10 t $ha^{-1}$ poultry manure, 25% inorganic N + 15 t $ha^{-1}$ poultry manure, 15 t $ha^{-1}$ poultry manure and absolute control (without poultry manure and inorganic N). Plant height, total dry matter, single bulb weight, yield and nutrients uptake at different growth stages of onion varied significantly due to application of poultry manure and inorganic-N fertilizer. Among the treatments, the highest yield (10.1t $ha^{-1}$) and yield attributes of onion were recorded under the application of 50% inorganic N with 10 t $ha^{-1}$ of poultry manure, which was 14% higher compared to 100% inorganic-N fertilizer. The higher nutrient uptake viz. N, P and K was noted in plot where poultry manure was applied at 10 t $ha^{-1}$ along with 50% inorganic-N. It is concluded that application of 10 t $ha^{-1}$ poultry manure was enough to reduce 50% inorganic-N in onion cultivation.

***Keywords*:** Onion, poultry manure, nutrient uptake, growth and yield

## 1. Introduction

Onion (*Allium cepa* L.) is an important spice crop in Bangladesh. It is extensively cultivated as a winter crop almost in all the districts of Bangladesh (Satter and Haque, 1975). The total area under onion cultivation and its production are not satisfactory to meet the domestic demand and the country has to import thousands of tons of onion every year. The average yield of onion per hectare is very low compared to that of other developed countries.

Cultivation of onion requires large amounts of fertilizers, and excessive use of chemical fertilizers increases the production cost and degrades the environment. Poultry manure is an excellent source of promising organic fertilizer, which is cost-effective to the farmers. It has high nutritional value for plant growth (Zang *et al*., 1998; Ishak *et al*., 1999) and is a relatively cheaper source of both macronutrients and micronutrients. Application of manure alone can show toxicity consequently damage the crop especially in bulb crops. Its application along with inorganic-N can ensure the vegetable production through reducing the production cost and keep the environment friendly. Therefore, the present investigation was undertaken to determine the effect of poultry manure along with inorganic N-fertilizer on nutrient uptake, growth and yield of onion.

## 2. Materials and Methods

The experiment was conducted at the research farm of the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during January to April 2004. The experiment was laid out in a randomized complete block design (RCBD) with six treatments viz. $T_1$: $N_{100\%}$ (115 kg N $ha^{-1}$)-PM (poultry manure), $T_2$: $N_{75\%}$ + 5 t $ha^{-1}$ PM, $T_3$: $N_{50\%}$ + 10 t $ha^{-1}$ PM, $T_4$: $N_{25\%}$ + 15 t $ha^{-1}$ PM, $T_5$: 15 t $ha^{-1}$ PM and $T_6$: $N_{0\%}$ -PM, each with three replicates. The physico-chemical properties of the soil and poultry manure were presented in the Table 1 and Table 2, respectively. The unit plot size was 2.5 × 3.0m having plant spacing of 20 × 15 cm. The full amount of poultry manure, triple super phosphate (TSP) and muriate of potash (MP) and one-third of inorganic-N as urea were applied in respective plots during final land preparation and thoroughly mixed with soil. The remaining ⅔rd N was applied at 3rd and 5th week after planting as top dressing. Onion (*Allium cepa* L.) cultivar ''Taherpuri'' was used as the test crop. The seedlings were collected from BADC farm, Kashimpur, Gazipur. Healthy and uniform seedlings were transplanted in the plot. After transplanting the seedlings, intercultural operations like weeding, irrigation and control of pest were done as and when necessary for better growth and development of the plants.

Ten onion plants were harvested at 21 days after intervals, plant height was measured from the base of the soil to tip of the tallest leaf, and plants were separated into root, stem and leaves and dried in an electrical oven for 48 hours at $70^0$C. The dried samples were weighed and ground to 390 µm. Samples (500 mg) of this ground material were analyzed for N, P and K by semi-micro Kjeldahl method (Bremner, 1996). Total N content in plant samples was determined by distillation and titration. Total P content in the extract was determined following Vanado-Molybdate yellow color method as described by Jackson (1973). Total K content was determined by Atomic Absorption Spectrophotometer. Total accumulation of N, P and K uptake was computed using N, P and K concentration and biomass data.

The collected data were statistically analyzed using MSTATC computer package program developed by Russel (1986). The means for all the treatments were calculated and analysis of variances for each of the characters was performed and means were separated by Duncan Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

## 3. Results and Discussion

### *3.1. Plant height (cm)*

Application of poultry manure along with inorganic-N increased plant height of onion at different growth stages (Fig.1). Generally plant height increased gradually up to 63 days after transplanting (DAT) and thereafter declined sharply due to leaf senescence. The tallest plant was found in the treatment $T_3$, followed by $T_2$ whereas the control treatment produced the shortest plant. However, the treatments $T_3$ and $T_2$ recorded identical plant height throughout the growth period. Plant height increased due to the cell division of apical meristems of shoot which was enhanced by the supply of balanced nutrients. The results were supported by Baloch *et al.* (1991) who found that optimum nutrient could enhance height significantly in onion plants.

### *3.2. Total dry matter accumulation*

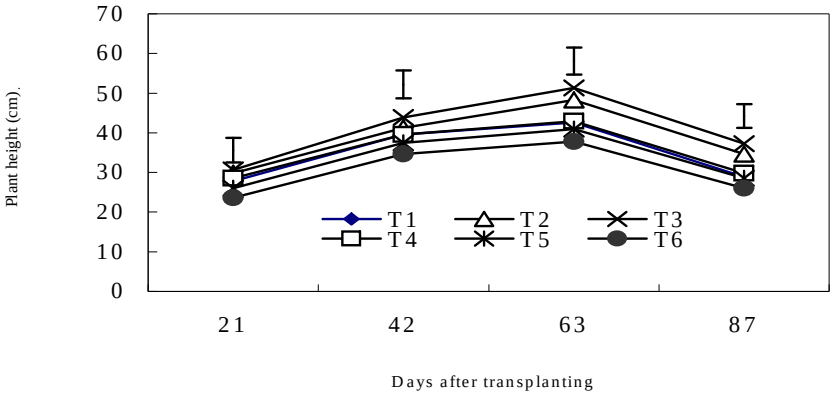
Significant variation in total dry matter (leaf + bulb + root) production of onion was observed due to application of different combinations of poultry manure and inorganic-N fertilizer at different growth stages (Fig. 2). The highest amount of dry matter (1.61 g $plant^{-1}$) was recorded in $T_3$ treatment at all growth stages. On the contrary, the plants in control treatment produced the lowest dry matter at all growth stages. The significant variation in total dry matter production at different growth stages might be due to differences among the source of nutrients. Consistently higher dry matter was produced by the application of 50% inorganic N with 10 t $ha^{-1}$ poultry manures at all growth stages.

**Table 1.** Some physico-chemical properties of soil of the experimental field

| Soil characteristics | Analytical value |
|---|---|
| % Sand | 17.64 |
| % Silt | 47.34 |
| % Clay | 35.02 |
| Textural class | Silty clay loam |
| Bulk density (g/cc) | 1.40 |
| Particle density | 2.62 |
| Field capacity | 28.55 |
| Porosity (%) | 46.56 |
| Soil pH (soil: water 1:2.5) | 6.1 |
| Organic carbon (%) | 0.87 |
| Total N (%) | 0.10 |
| Available P (ppm) | 12.10 |
| Exchangeable K (meq/100 g soil) | 0.56 |
| Total S (ug/g soil) | 10.02 |

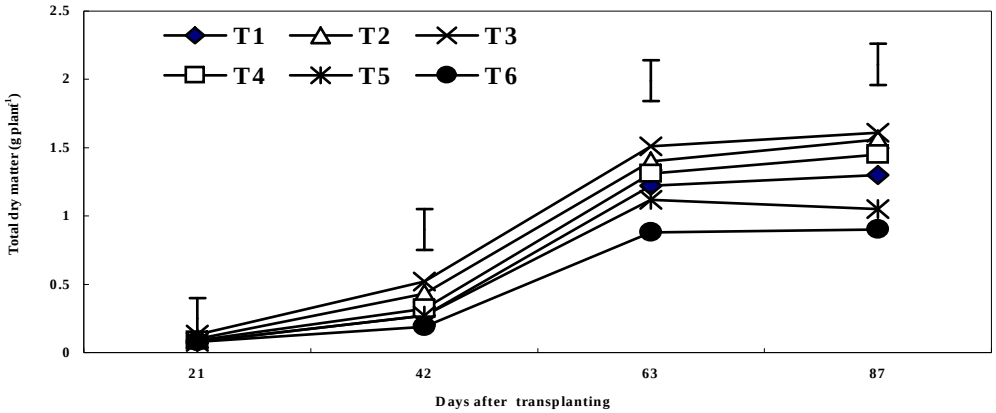
**Table 2.** Some chemical properties of poultry manure used in the experimental field

| Chemical properties | Analytical value |
|---|---|
| Total N (%) | 2.41 |
| Total P (%) | 1.38 |
| Total K (%) | 0.49 |
| Total S (%) | 0.73 |
| Total Zn (%) | 0.11 |




N.B. $T_1 = N_{100\%}$ (115 Kg $ha^{-1}$), $T_2 = N_{75\%}$ + 5 t $ha^{-1}$ PM, $T_3 = N_{50\%}$ + 10 PM, $T_4 = N_{25\%}$ + 15 t $ha^{-1}$ PM, $T_5 = N_{0\%}$ +15 t $ha^{-1}$ PM, $T_6$ = -N -PM

**Fig. 1.** Effect of poultry manure with different doses of N- fertilizer on the height of onion plant at different growth stages; vertical bar represents LSD at $P \geq 0.05$ level of probability




N.B. $T_1 = N_{100\%}$ (115 kg $ha^{-1}$) , $T_2 = N_{75\%}$ + 5 t $ha^{-1}$ PM, $T_3 = N_{50\%}$ + 10 PM, $T_4 = N_{25\%}$ + 15 t $ha^{-1}$ PM, $T_5 = N_{0\%}$ +15 t $ha^{-1}$ PM, $T_6$ = -N -PM

**Fig. 2.** Total dry matter of onion as influenced by different doses of poultry manure in combination with inorganic-N at different growth stages; vertical bar represents LSD at *P≥0.05* level of probability

### *3.3. Single bulb weight*

Bulb weight is an important yield contributing character for onion. Single bulb weight of onion was influenced by different doses of poultry manure in combinations with inorganic nitrogenous fertilizer at maturity stages (Table 3). The highest individual bulb weight (36.66g) was recorded in treatment $T_3$ while the control treatment produced the lowest (31.92g). The treatment $T_3$ produced 9% bigger sized bulb as compared to $T_1$.

Application of poultry manure at 10 t $ha^{-1}$ and 50% inorganic N produced the highest bulb diameter of onion, which might be due to production of taller plants with larger number of leaves leading to increased formation of vegetative structure and higher chlorophyll content for better photosynthesis.

### *3.4. Number of bulbs $m^{-2}$*

Application of poultry manure in combination with inorganic-N significantly increased the number of bulb per unit area (Table 3). The highest bulb number was produced by the treatment $T_3$, which was treated with 10 t poultry manure along with 50% of inorganic–N compared to the control ($T_6$). There were no significant differences in bulb number due to application of 50% and 75% inorganic-N by reducing or increasing poultry manure.

The highest number of leaves was given by the application of 50% inorganic N along with 10 t $ha^{-1}$ poultry manure, which might be attributed due to higher availability of nutrient especially nitrogen than other treatment. However, plant grown in control plots produced the lowest number of leaves. This result is supported by Amin and Rahim (1995) who found that the increasing level of N increased the number of leaves in onion. Anwar *et al*. (1998) found that the application of N, P, K, S and Zn increased the number of leaves $plant^{-1}$.

### *3.5. Bulb yield*

The yield of onion varied from 7.5 t to 10.1 t $ha^{-1}$ due to different treatments (Table 3). The highest yield (10.1 t $ha^{-1}$) was found in $T_3$ treatment and the lowest bulb yield (7.5 t) was recorded in control plot ($T_6$). The treatment $T_3$ produced 14% more bulb yield than the recommended

dose of N in $T_1$. Application of 5 t or 10 t poultry manure per hectare along with 75 or 50% inorganic-N could not influence bulb yield.

Maximum yield of bulbs by the $T_3$ (application of 50% inorganic N and 10 t $ha^{-1}$ poultry manure) which was followed by $T_2$ (application of 75% inorganic N with 5 t $ha^{-1}$ poultry manure) might be due to production of taller plants with higher number of leaves leading to increased photosynthesis and increased production of assimilates to fill the sink. Plants grown in control treatment (without N and manure) had the lowest bulb yield of onion. Fertilizer deficiency disturbed the balance of nutritional environment in plants, which resulted in biological inactivation of life process of plants and had adverse effect on plant growth (Singh and Dhankar, 1998). Jitendra *et al*. (1991) reported that high N levels increased plant growth and yield of onion. Similarly, Dixit (1997) noticed that increasing N application rates increased bulb yields up to 120 kg N $ha^{-1}$. Higher yields were also obtained by the application of higher farmyard manure.

**Table 3.** Yield and yield contributing characters of onion as influenced by different treatment combinations

| Treatment | Weight of single bulb (g) | No. of bulbs $m^{-2}$ | Bulb yield (t $ha^{-1}$) |
|---|---|---|---|
| $T_1$ ($N_{100\%}$) | 33.46 b | 26.6 b | 8.9 b |
| $T_2$ ($N_{75\%}$ +5 t PM) | 36.43 ab | 26.9 ab | 9.8 ab |
| $T_3$ ($N_{50\%}$+10 t PM) | 36.66 a | 27.7 a | 10.1 a |
| $T_4$ ($N_{25\%}$+15 t PM) | 34.23 b | 26.8 b | 9.2 b |
| $T_5$ (15 t PM) | 33.33 c | 26.1 bc | 8.7 bc |
| $T_6$ (-N-PM) | 31.92 d | 23.5 c | 7.5 c |

N.B. Means followed by the same letter (s) in a column are not significantly different at 5% level of significance

**Table 4.** Concentrations of N, P and K in onion bulb as influenced by the application of different doses of poultry manure in combination with inorganic N fertilizer

| | Concentration (%) | | | Total accumulation (kg $ha^{-1}$) | | |
|---|---|---|---|---|---|---|
| Treatment | N | P | K | N | P | K |
| $T_1$ ($N_{100\%}$) | 1.83 b | 0.69 b | 1.23 b | 29.81 b | 8.92 bc | 18.91 b |
| $T_2$ ($N_{75\%}$ + 5 t PM) | 3.09 ab | 0.75 ab | 1.51 ab | 47.04 ab | 11.73 ab | 24.58 ab |
| $T_3$ ($N_{50\%}$ + 10 t PM) | 3.57 a | 0.78 a | 1.72 a | 58.92 a | 12.81 a | 28.63 a |
| $T_4$ ($N_{25\%}$ + 15 t PM) | 2.71 b | 0.72 ab | 1.32 b | 36.13 b | 10.58 b | 20.69 b |
| $T_5$ (15 t PM) | 1.69 c | 0.61 bc | 1.01 bc | 19.18 c | 6.56 c | 12.72 bc |
| $T_6$ (-N-PM) | 1.02 d | 0.52 c | 0.88 c | 13.82 d | 4.77 d | 10.52 c |

N.B. Means followed by the same letter (s) in a column are not significantly different at 5% level of significance

### *3.6. Nitrogen uptake*

Application of poultry manure in combination with inorganic N influenced the N concentration in onion bulb (Table 4). Plants treated with 50% N and 10 t poultry manure ($T_3$) showed the highest N concentration (3.57%) and this was similar to those in $T_2$. The lowest concentration (1.02 % N) was recorded in control plot ($T_6$). The treatment $T_3$ recorded 95% higher N concentration as compared to control ($T_1$). Among the treatments, the highest total N accumulation was observed in $T_3$ (58.92 kg $ha^{-1}$), followed by $T_2$ and $T_4$. The lowest N accumulation in plant (13.92 kg $ha^{-1}$) was recorded in control plot ($T_6$). The $T_3$ treated plant accumulated 98% more nitrogen compared to the control ($T_6$). The highest N accumulation was observed in the plants treated with 50% inorganic-N along with 10 t $ha^{-1}$ of poultry manure. Application of 5 t $ha^{-1}$ poultry manure with 75% of inorganic nitrogen also possessed higher N accumulation of 24.58 kg $ha^{-1}$. Those two treatments accumulated nearly 97% N compared to the plants when it was applied 100% inorganic-N (control, $T_1$). The higher accumulation of N might be due nutrient release by poultry manure. This result is supported by Abdel *et al.* (1995) who found that the uptake of N and K increased with the increasing rate of poultry manure application. Similarly, Singh *et al.* (1987) concluded that application of poultry manure incorporation with urea increased the concentration and accumulation of N in rice, which was 80% as efficient as urea N at all rates of applications.

### *3.7. Phosphorus uptake*

The trend of P concentration of onion was more or less similar to that of N (Table 4). The highest P concentration in bulb (0.78%) was produced by $T_3$ and the lowest P concentration (0.51% P) was produced by the control treatment ($T_6$). Higher reproductive organ might have higher accumulation of P in the latter stage. Phosphorus accumulation varied between 4.77 to 12.81 kg $ha^{-1}$ in onion bulb. The highest phosphorus accumulation in bulb (12.81 kg $ha^{-1}$) was produced by $T_3$ and the lowest in bulb (4.77 kg $ha^{-1}$) was produced by control treatment ($T_6$). Application of 50% inorganic nitrogen with 10 t $ha^{-1}$ poultry manure produced the highest P uptake. Sikora and Enkiri (2005) also found that composed manure along with fertilizer-N enhanced the P availability to the crops.

### *3.8. Potassium uptake*

Application of poultry manure along with different doses of inorganic-N influenced K uptake in onion, with the highest K concentration (1.72%) observed in $T_3$, followed by $T_2$ and the lowest (0.88%) was recorded in $T_6$ treatment (Table 4). The highest K accumulation (28.63 kg $ha^{-1}$) was observed in $T_3$ treatment and the lowest (10.52 kg $ha^{-1}$) was recorded in $T_6$ treatment.

Application of 50% inorganic nitrogen with 10 t $ha^{-1}$ poultry manure possessed higher potassium (K) uptake which might be due to higher availability of nutrient induced by inorganic-N. The lowest potassium accumulation was observed in plant where poultry manure was not applied. The higher accumulation of N, P and K in onion bulb found in the present experiment is in good agreement with the findings of Toor and Bishnoi (1996) who found that poultry manure was effective for available N and P. Application of inorganic N alone also increased available N content but decreased available P and K content in the soil. They finally concluded that poultry manure, as a source of plant nutrients is better than farmyard manure for maintaining soil fertility. Our results clearly indicated that application of poultry manure increased the availability of nutrients as indicated by higher uptake.

The tallest plants were produced by 50% inorganic N with 10 t $ha^{-1}$ poultry manure. However, shorter plants were produced in control treatment. Poultry manure is highly nitrogenous organic manure than other animal manures. Taller plant development by the application of 10 t $ha^{-1}$ poultry manure combined with 50% inorganic N might be due to availability of nutrient source, which influenced the absorption of nutrients by roots. This organic manure released the N-slowly for a longer

period. Higher concentration of N, P and K in plant supported the results strongly. Nitrogen enhanced cell division, cell enlargement consequently increased plant elongation. Higher N-fertilizer may also increase the chlorophyll content, which consequently increased the photosynthetic activity of the plants, which reflected through dry matter production. The reduction in the plant height may be achieved by the activity of ageing of plants which accelerated by nutrient shortage consequently reduce the physiological activities of the plants. In addition, the reduction in the plant height may be attributed due to nitrogen deficiency. These findings agreed with the results of Bhuiyan and Haque (1979) who found that application of balanced nitrogen increased the plant height in onion. Similarly, Bhordwaj *et al*. (1991) and Haque and Mamun (2001) also found taller plants with increasing levels of nitrogen. Adequate supply of NPK fertilizers increase the plant growth by increase the cell division and cell expansion consequently enhanced plant elongation. Plants grown without NPK fertilizer shorten the height of plants at all growth stages. The shortness was attributed due to less photosynthetic product.

**4. Conclusions**

Application of 10 t $ha^{-1}$ of poultry manure was found to be useful to reduce 50% inorganic N in onion cultivation. For yield maximization, poultry manure @ 10 t $ha^{-1}$ along with 50% recommended dose of inorganic N appeared to be the best in respect of fertility management by enriching the soil with organic matter and turning vegetable cultivation towards organic farming. Replacing the chemical fertilizers by poultry manure will considerably benefit the farmers and it will definitely reduce the environmental pollution caused by chemical fertilizers.

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