Defence Life Science Journal, Vol. 3, No. 2, April 2018, pp. 100-104, DOI : 10.14429/dlsj.3.12569


# Effect of Some Organic Manure on Growth and Yield of Garlic in Greenhouse Condition at Cold Desert High Altitude Ladakh Region

Somen Acharya* and Hitesh Kumar

*DRDO-Defence Institute of High Altitude Research, Leh-Ladakh-194101, India*
**E-mail: someniari@gmail.com*

**ABSTRACT**

A field experiment was conducted to investigate effects of four organic manure sources (vermicompost, poultry manure, sheep & goat manure and cattle FYM) on growth and yield attributing characters of garlic in greenhouse condition during extreme winter months (October to May) at Leh-Ladakh, India with three application rates of organic manures *viz*. 10, 20 and 30 tons $ha^{-1}$. The results revealed that, organic manure application enhanced plant growth, improved garlic yield and its components *viz*. no. of cloves per bulb, bulb diameter and weight. Also, with increasing rate of application of organic manures from 10 to 20 tons $ha^{-1}$, all growth and yield characters of garlic were improved. Vermicompost and poultry manure had significant effects on plant growth characters *viz*. plant height, number of leaves per plant, length and width of leaves especially in the $T_3$ and $T_6$ treatments. Highest garlic yield (105.03q $ha^{-1}$) was achieved in $T_6$ treatment (poultry manure @ 20 tons $ha^{-1}$). Overall, application of organic manures proved to be beneficial for garlic production and its application should be popularised for sustainable agriculture in fragile ecosystem of cold arid desert of Ladakh region.

**Keywords:** Garlic; Greenhouse; Organic manures; High altitude cultivation

## 1. INTRODUCTION

Garlic (*Allium sativum* L.) belonging to family Alliaceae is the second most widely used cultivated bulb crops after onion in the World. It is an erect annual herb generally cultivated during dry and mild winter season. The world average yield of garlic is about 10 tons/ha. India ranks second in area and production of garlic in the world. In India, average productivity of garlic is 5.27 tons $ha^{-1}$, cultivated over 2.62 lakh hectares and producing 14.24 lakh MT[1]. It is widely used as spice and has higher nutritional value than other crops of onion family. Besides nutritive values, it is included in Indian system of medicines (Ayurvedic, Unani and Siddha) as a carminative and gastric stimulant to help digestion and absorption of food[2].

Most vegetables are grown conventionally worldwide. Conventional agriculture has resulted in environmental pollution and deterioration at global scale. Further, it has also diminished the biodiversity, negatively affected the ecosystem balance and natural resources all over the world. For obtaining higher yield in vegetable crops excessive amounts of inorganic fertilizers are used[3], which has resulted in deficiency of nutrients other than applied and caused decline in organic carbon in the soil[4]. Application of chemical fertilizers and pesticides has further costs other than economic one including human and environment health[5].

Organic manure is an eco-friendly, economically viable and ecologically sound that also played a significant role in improving physical, chemical and biological properties of soil. Organic manure improves soil structure and water holding capacity, resulting in more extensive root development and enhanced soil micro flora and fauna activity, which results in availability of plants available micronutrients[6]. Organic farming makes positive contribution not only to the soil and environment but also to the human health as well[7].

Ladakh is the cold desert trans-Himalayan region of India and the total area under cold deserts in Ladakh being about 45,110 $m^2$. Soil of Ladakh is taxonomically classified as typic cryorthids[8], physically thin, porous, coarse textured, permeable, and having poor water holding capacity and low nutrient availability for growing crops[9]. Because of extreme winter conditions, only one cropping season in a year (span from May to October) is typical characteristics of this region. During winter months air temperature remains well below sub-zero with minimum temperature recorded as low as -25$^0$C. In such conditions it is not possible to grow even a single blade of grass in open fields. But under greenhouse conditions, successful experiments were carried out by Defence Institute of High Altitude Research (DIHAR) for growing leafy vegetables like spinach, fenugreek, coriander in such extreme winter months. Considering the facts and challenges, the present work aimed to study the response of growth characters and yield of garlic to some organic manure and their different application rates under greenhouse condition in extreme winter condition at cold desert Ladakh region.

Received : 13 June 2017, Revised : 30 November 2017
Accepted : 05 December 2017, Online published : 20 March 2018

## 2. MATERIALS AND METHODS

This study was carried out in randomised block design (RBD) with four types of organic manure (*viz*. Vermicompost, poultry manure, sheep & goat manure and FYM) and three application rates e.g. 10, 20 and 30 tons.ha$^{-1}$ at experimental fields of DIHAR in greenhouse condition from Oct 2010 to May 2011. Soils of the experimental fields were sandy, coarse textured having low in organic carbon content. Garlic variety Agrifound Parvati was selected for the experiment. All organic manures were applied as a basal dose. Plot size was kept at 2m X 1.5m and the cloves were planted at spacing of 15 cm apart in each row and same distance was maintained between rows. Big size cloves were selected for planting. Harvesting of mature bulbs was done when the top leaves turn yellow and brownish showing signs of drying up and bending. Garlic plants were harvested during 1$^{st}$ week of May. Plant growth parameters *viz*. Plant-height, number of leaves per plant, length and width of plants were recorded one week before harvesting. From each plot randomly ten plants were selected to measure yield attributing characters *viz*. bulb weight, bulb diameter and number of cloves per bulb. After harvesting, total fresh garlic weight were measured from each and every treatment by digital weighing balance and final data were calculated per hectare basis. The data were analysed through one-way analysis of variance (ANOVA) to determine the effect of treatments, using SPSS statistical software (SPSS for Windows, Release 16).

## 3. RESULT AND DISCUSSION

As per the garlic production data under greenhouse condition, performance of garlic was greatly influenced by different organic manure treatments. The results obtained from the present work as well as relevant discussion have been summarised under following heads.

### 3.1 Plant Growth Characters

Table 1 showed that only vermicompost and poultry manure increased plant height significantly over control treatments. From the Table 1 it is seen that, maximum plant height before harvesting was observed in treatment $T_3$ (117.2 cm) but no significant differences were observed among $T_3$, $T_4$, $T_5$ and $T_6$. For rest of the treatments non-significant ($p>0.05$) results were obtained when compared with $T_1$ i.e. control (89.2 cm). Similar to plant height, significantly higher number of leaves (10.0) was shown by only treatment $T_5$ and $T_6$ followed by $T_3$ and $T_4$ (9.67). However, remaining treatments were found at par with control (Table 1). El-Hifny[10] also found that interaction between sources of organic fertilizers and different rates did not reflect any significant effect on plant height and no of leaves per plant of Chinese garlic plant.

The highest (55.6 cm) and lowest (43.7 cm) length of leaves was recorded in treatment $T_3$ and $T_1$ respectively. But data on width of leaves showed that for all the organic manure treatments, significant increase in leave width was recorded than control (9.53 mm) with highest leave width observed in $T_5$ (13.8 mm) followed by $T_6$ (13.47 mm) and $T_3$ (12.83 mm). Highest plant survivability was observed in treatment $T_5$ (93%) followed by $T_6$, $T_4$, $T_2$ and $T_3$. Among four sources of organic manure, application of poultry manure and vermicompost showed better results as compared to other treatments.

The garlic cloves were planted during 1$^{st}$ week of October. During that period low temperature and short photoperiod helped to promote germination and vegetative growth. But from December onwards upto February, temperature inside the greenhouse was also too low (minimum temperature inside greenhouse was around -10$^0$C whereas outside temperature went beyond -20$^0$C) for plant growth and plants remain in dormant stage. After February plant growth again started with increase in greenhouse temperature (minimum temperature increased to +6-7$^0$C). These vegetative characters are primary characters which decide vigour of the crop and influence on yield through enhanced dry matter production. Enhanced plant growth characters might be due to higher nutrient availability as well as better nutrient uptake by the crop[11]. Also, using organic manure improves soil texture and help plant to have a good root proliferation, which leads to improvement in plant growth as well[12]. It is also cleared that the different growth parameters improved with increasing application rate of organic manures. All growth characters results indicated that poultry manure @ 10 & 20tons ha$^{-1}$ was the most effective treatments. Poultry manure is good source of both macro nutrients (N, P, K, Ca, Mg, S) and micronutrients (Cu, Fe, Mn, B) and can increase soil carbon and N content, soil porosity and enhance soil microbial activity[13]. It contains about 3.03% N, 2.63% $P_2O_5$ and 1.4% $K_2O$ whereas average nutrient content of FYM is only 0.5% N, 0.2% $P_2O_5$ and 0.5% $K_2O$. The effects of manures on garlic plant growth characters was in the order of poultry manure>vermicompost>sheep and goat manure>cattle FYM.

### 3.2 Garlic Yield and Yield Attributing Characters

The results in respect of bulb diameter (Table 2), treatment $T_6$ i.e. poultry manure @ 20 tons.ha$^{-1}$ recorded highest value (58.1 mm) which is 33.5% higher than control i.e. $T_1$ (38.6 mm). Among the treatments, cattle FYM showed non-significant ($p>0.05$) increase in bulb diameter. The size of bulb was directly influenced by the enhanced vegetative growth on the plants *viz*. significant increase in height, number of green leaves and length and width of leaves as influenced by organic treatments. One of the reasons might be more accumulation of carbohydrates resulting into increased diameter of the bulb, which is the storage organ. These results are in agreement with those reported by Singh *et al*. in onion[14].

Average bulb weight is one of the most important yield attributing traits. Mean bulb weight was significantly affected due to various organic manure treatments (Table 2). Average weight of bulb was significantly ($p<0.05$) influenced by vermicompost and poultry manure applications whereas cattle FYM and sheep and goat manure @ 10 tons.ha$^{-1}$ ($T_8$) did not significantly enhanced mean bulb weight. Similar to mean bulb diameter, highest (42.6%) increase in mean bulb weight was recorded in $T_6$ treatment. Increase in average bulb weight especially in Vermicompost and poultry manure treatments was mainly due to enhanced nutrient supply which resulted into increased bulb diameter as discussed earlier. Increase in weight of bulb resulted increase in garlic yield.

In control ($T_1$), number of cloves per bulb was recorded

**Table 1: Effect of various sources of organic manure on survivability and growth characteristics of garlic grown in greenhouse condition**

| Treatment | Survivability of plants (%) | Plant height (cm) | No. of leaves per plant | Length of leaves (cm) | Width of leaves (mm) |
|---|---|---|---|---|---|
| $T_1$ – Control | 85.8±0.62$^{a}$ | 89.2±1.3$^{a}$ | 8.33±0.33$^{a}$ | 43.7±1.9$^{a}$ | 9.53±0.29$^{a}$ |
| $T_2$ - Vermicompost (10 tons.ha$^{-1}$) | 91.2±0.39$^{ef}$ | 96.2±1.8$^{a}$ | 9.33±0.33$^{abc}$ | 51.5±1.2$^{bcdef}$ | 12.37±0.24$^{bcd}$ |
| $T_3$ - vermicompost (20 tons.ha$^{-1}$) | 90.5±0.78$^{cdef}$ | 117.2±6.7$^{b}$ | 9.67±0.33$^{bc}$ | 55.6±1.4$^{f}$ | 12.83±0.39$^{def}$ |
| $T_4$ - Vermicompost (30 tons.ha$^{-1}$) | 91.5±0.55$^{ef}$ | 111.4±1.6$^{b}$ | 9.67±0.33$^{bc}$ | 52.6±1.6$^{cdef}$ | 12.37±0.42$^{bcd}$ |
| $T_5$ - Poultry manure (10 tons.ha$^{-1}$) | 93.0±0.90$^{f}$ | 113.4±4.2$^{b}$ | 10.00 ±0.0$^{c}$ | 53.8±1.3$^{ef}$ | 13.80±0.23$^{f}$ |
| $T_6$ - Poultry manure (20 tons.ha$^{-1}$) | 92.3±1.25$^{ef}$ | 109.3±3.0$^{b}$ | 10.00±0.0$^{c}$ | 53.5±1.2$^{def}$ | 13.47±0.17$^{ef}$ |
| $T_7$ - Poultry manure (30 tons.ha$^{-1}$) | 86.5±1.19$^{ab}$ | 92.2±3.3$^{a}$ | 8.67±0.33$^{ab}$ | 47.6±1.2$^{abc}$ | 12.73±0.12$^{cde}$ |
| $T_8$ - Sheep & Goat Manure (10 tons.ha$^{-1}$) | 89.8±0.86$^{cde}$ | 91.5±1.8$^{a}$ | 9.33±0.33$^{abc}$ | 48.5±1.5$^{abcd}$ | 11.30±0.41$^{b}$ |
| $T_9$ - Sheep & Goat Manure (20 tons.ha$^{-1}$) | 90.1±0.60$^{cde}$ | 90.5±5.0$^{a}$ | 9.33±0.33$^{abc}$ | 50.4±1.9$^{bcde}$ | 11.73±0.23$^{bc}$ |
| $T_{10}$- Sheep & Goat Manure (30 tons.ha$^{-1}$) | 87.9±1.2$^{abc}$ | 94.6±4.3$^{a}$ | 9.33±0.33$^{abc}$ | 53.9±1.7$^{ef}$ | 11.47±0.52$^{b}$ |
| $T_{11}$ - FYM (10 tons.ha$^{-1}$) | 88.0±0.86$^{abc}$ | 89.5±2.0$^{a}$ | 8.67±0.33$^{ab}$ | 47.4±1.4$^{ab}$ | 11.37±0.30$^{b}$ |
| $T_{12}$ - FYM (20 tons.ha$^{-1}$) | 88.9±1.07$^{bcd}$ | 91.4±3.5$^{a}$ | 9.00±0.58$^{abc}$ | 50.2±1.9$^{bcde}$ | 11.50±0.21$^{b}$ |
| $T_{13}$ - FYM (30 tons.ha$^{-1}$) | 90.0±0.35$^{cde}$ | 91.3±1.2$^{a}$ | 9.00±0.0$^{abc}$ | 48.5±1.3$^{abcd}$ | 11.83±0.43$^{bcd}$ |

**Table 2: Effect of various sources of organic manure on yield attributing characters of garlic grown in greenhouse condition**

| Treatment | Bulb Diameter (mm) | Weight of Bulb (gm) | No. of cloves per ulb | Garlic Yield (q ha$^{-1}$) |
|---|---|---|---|---|
| $T_1$ – Control | 38.6±0.92$^{a}$ | 32.37±0.92$^{a}$ | 9.33±0.33$^{a}$ | 72.03±2.7$^{a}$ |
| $T_2$ - Vermicompost (10 tons.ha$^{-1}$) | 47.4±0.55$^{c}$ | 37.13±0.55$^{b}$ | 10.67±0.33$^{bcd}$ | 87.47±2.0$^{cde}$ |
| $T_3$ - vermicompost (20 tons.ha$^{-1}$) | 47.5±0.78$^{c}$ | 38.67±0.23$^{b}$ | 12.67±0.33$^{f}$ | 89.07±3.0$^{de}$ |
| $T_4$ - Vermicompost (30 tons.ha$^{-1}$) | 44.2±1.16$^{bc}$ | 45.20±0.43$^{c}$ | 11.83±0.17$^{ef}$ | 92.00±1.4$^{e}$ |
| $T_5$ - Poultry manure (10 tons.ha$^{-1}$) | 57.5±0.56$^{e}$ | 53.07±1.09$^{d}$ | 11.33±0.33$^{de}$ | 99.60±1.6$^{f}$ |
| $T_6$ - Poultry manure (20 tons.ha$^{-1}$) | 58.1±1.75$^{e}$ | 56.40±0.93$^{e}$ | 11.33±0.33$^{de}$ | 105.03±0.6$^{f}$ |
| $T_7$ - Poultry manure (30 tons.ha$^{-1}$) | 53.9±1.79$^{d}$ | 45.83±1.05$^{c}$ | 11.00±0.57$^{cde}$ | 88.17±3.2$^{de}$ |
| $T_8$ - Sheep & Goat Manure (10 tons.ha$^{-1}$) | 45.2±0.35$^{c}$ | 35.40±1.00$^{ab}$ | 10.33±0.33$^{abcd}$ | 82.87±1.5$^{bcd}$ |
| $T_9$ - Sheep & Goat Manure (20 tons.ha$^{-1}$) | 45.6±0.58$^{c}$ | 37.40±1.38$^{b}$ | 11.00±0.28$^{cde}$ | 84.03±2.5$^{bcd}$ |
| $T_{10}$- Sheep & Goat Manure (30 tons.ha$^{-1}$) | 44.5±0.69$^{bc}$ | 36.97±1.30$^{b}$ | 10.00±0.0$^{abc}$ | 80.00±2.2$^{bc}$ |
| $T_{11}$ - FYM (10 tons.ha$^{-1}$) | 39.5±0.50$^{a}$ | 32.23±1.56$^{a}$ | 9.67±0.33$^{ab}$ | 77.10±2.6$^{b}$ |
| $T_{12}$ - FYM (20 tons.ha$^{-1}$) | 40.3±2.60$^{a}$ | 33.23±1.75$^{a}$ | 9.67±0.33$^{ab}$ | 79.03±3.1$^{b}$ |
| $T_{13}$ - FYM (30 tons.ha$^{-1}$) | 41.4±1.10$^{ab}$ | 33.33±0.41$^{a}$ | 9.33±0.33$^{a}$ | 80.53±2.7$^{bc}$ |

9.33 which were found at par with all FYM treatments. Meanwhile, highest number of cloves per bulb (12.33) was obtained in $T_3$ treatment followed by $T_4$, $T_5$ and $T_6$.

Data pertaining to garlic yield as influenced by various organic manure is presented in Table 2. The garlic yield is significantly increased in all the treatments. Treatment $T_6$ showed highest yield (105.03 q.ha$^{-1}$ and 31.4% increased yield as compared to $T_1$) followed by $T_5$ and $T_4$. Among all the organic manures applied, poultry manure showed better results followed by vermicompost, sheep & goat manure and FYM. Similar kind of results was obtained by Olatunji *et al.*[15] where okra and tomatoes grown in poultry manure performed better than their counterparts in other manure types. FYM could not provide nutritional demands of garlic crop as it is a heavy feeder crop. Pereira and Fornazier[16] reported that applying 20 tons ha$^{-1}$ compost increased garlic yield and decreased storage loss and pest and disease incidence. Arancon *et al.*[17] reported that application of vermicompost to the field soils increased microbial populations and activities which are key factor in rates of soil nutrient cycling, production of plant-growth-influencing materials, the build-up of plant resistance or tolerance to crop disease and nematode attack. In a study of conventional, low input and organic systems, yield of tomato, safflower, maize and bean in organic systems were found to be comparable with conventional system[18]. But higher level of poultry manure @30 tons.ha$^{-1}$ proved to be detrimental for overall plant growth and yield. This might be due to excess nitrogen from poultry manure which leads to burning effect which resulted into reduced plant growth and yield. Generally, nitrogen balance is required for the optimum growth and development of vegetable crops, but excess nitrogen causes increase susceptibility of vegetable crops to various diseases and deterioration of keeping quality[19]. The increase in yield with organic manure treatments especially with vermicompost

and poultry manure attributed to overall increase in plant growth characters as discussed. These organic sources besides supplying N, P and K also make unavailable form of nutrients into an available form to facilitate the plants to absorb the nutrients. Application of organic sources encouraged the growth and activity of beneficial microorganisms in the soil and is also helpful in alleviating the increasing incidence or deficiency of secondary and micronutrients and is capable of sustaining high crop productivity and soil health[20]. The healthy growth of plants might leads to higher rate of photosynthesis and carbohydrate accumulation[21] which resulted into increased size of bulbs as indicated by bulb diameter and average bulb weight and ultimately overall yield enhancement of garlic. Organically grown foods are perceived as better quality, healthier and more nutritious than conventional counterparts[22].

## 4. CONCLUSION

The results clearly showed that application of poultry manure and vermicompost significantly improves garlic yield under greenhouse condition during extreme winter months at high altitude cold desert Ladakh condition. It may be proposed that mixing of cattle FYM and poultry manure for making vermicompost will surely improve soil condition and give better response to garlic yield. Farmers shall be trained on making of different types of compost and vermicompost and its beneficial role in sustainable agriculture and human health. This type of organic farming should be promoted for sustainable crop production at these fragile cold desert high altitude regions.

**Conflict of Interest:** None

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## ACKNOWLEDGEMENT

The study was supported by Defence Research and Development Organisation (DRDO), Ministry of Defence, Government of India.

## CONTRIBUTOR

**Dr. Somen Acharya** is Scientist 'D', Vegetable Science Division at DRDO-DIHAR, Leh. He received his M.Sc & Ph.D in Environmental Sciences from Indian Agricultural Research Institute, New Delhi. He is currently working on plant nutrition, improving vegetable production and soil health status of Ladakh region. He has about 20 publications in reputed national and international journals and 07 book chapters to his credit.
Has conceived the topic, designed the field experiment, collected and compiled the data, wrote the manuscript.

**Sh. Hitesh Kumar** is Technical Officer 'B' in the Plant Science Division, DIHAR, Leh. He has vast knowledge in vegetable cultivation and greenhouse crop production in Ladakh region.
Has contributed towards monitoring field experiments.