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Anil Kumar Patle
Research Scholar (Horticulture), Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidyalaya, Chitrakoot, District Satna, Madhya Pradesh, India

Dr. SS Singh
Assistant Professor, Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidyalaya, Chitrakoot, District Satna, Madhya Pradesh, India

Mahendra Jadia
Research Scholar (Horticulture), Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidyalaya, Chitrakoot, District Satna, Madhya Pradesh, India

Krapal Singh Verma
Research Scholar (Horticulture), Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidyalaya, Chitrakoot, District Satna, Madhya Pradesh, India

Corresponding Author:
Mahendra Jadia
Research Scholar (Horticulture), Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidyalaya, Chitrakoot, District Satna, Madhya Pradesh, India

Effect of organic, inorganic sources of nutrients on growth of garlic (*Allium sativum* L.)

Anil Kumar Patle, Dr. SS Singh, Mahendra Jadia and Krapal Singh Verma

Abstract
The experiment was carried out to find out the effect of organic, inorganic sources of nutrients on growth of Garlic. The treatment combinations involving ten levels of C_1 O_1 Control + Control, C1 O2 Control + FYM @ 15 t/ha, C_1 O_3 Control + Vermicompost @ 5 t/ha, C1 O4 Control + Goat manure @ 5 t/ha, C_2 O_1 100% RDF- N:P:K:S(100:60:60:45 kg NPKS/ha) + Control, C_2 O_2 100% RDF- N:P:K:S(100:60:60:45 kg NPKS/ha)+ FYM@ 15 t/ha, C_2 O_3 100% RDF- N:P:K:S(100:60:60:45 kg NPKS/ha)+ Vermicompost @ 5 t/ha, C_2 O_4 100% RDF- N:P:K:S(100:60:60:45 kg NPKS/ha)+ Goat manure @ 5 t/ha, C_3 O_1 75% RDF- N:P:K:S(75:45:45:33.75 kg NPKS/ha) + Control, C_3 O_2 75% RDF- N:P:K:S(75:45:45:33.75 kg NPKS/ha)+ FYM@ 15 t/ha, C_3 O_3 75% RDF- N:P:K:S(75:45:45:33.75 kg NPKS/ha)+ Vermicompost @ 5 t/ha, C_3 O_4 75% RDF- N:P:K:S(75:45:45:33.75 kg NPKS/ha)+ Goat manure@ 5 t/ha, C_4 O_1 50% RDF- N:P:K:S(50:30:30:22.5 kg NPKS/ha) +Control, C_4 O_2 50% RDF- N:P:K:S(50:30:30:22.5 kg NPKS/ha)+ FYM @ 15 t/ha, C_4 O_3 50% RDF- N:P:K:S(50:30:30:22.5 kg NPKS/ha)+ Vermicompost @ 5 t/ha, C_4 O_4 50% RDF- N:P:K:S(50:30:30:22.5 kg NPKS/ha)+ Goat manure @ 5 t/ha Practices were given in G-50 variety. Plant height cm, number of leaves per plant, Leaf area per plant (cm^2). Were observed by the maximum at 30,60,90, and 120 DAS were observed under the treatment C_2 O_2 100% RDF- N:P:K:S(100:60:60:45 kg NPKS/ha)+ FYM@ 15 t/ha, at all the growth stages.

Keywords: FYM, goat manure, plant, stages

Introduction
Garlic (*Allium sativum* L.), grown at commercial level is a spices crop and is of a bulbous spice category. In India it is second most widely consumed spice after onion. However, it is as valuable all over the world as it is in our country.

The name Garlic is derived from the English word 'gar' meaning spear, referred to the clove. As far as its origin is considered it is from Central Asia, from where it spread to Mediterranean region. It is grown for medicinal usage in pharmaceutical industry also. Garlic belongs to the Alliaceae family. It is herbaceous annual. The underground developed part of the Garlic plant is edible stem and is known as Bulb.

In India it is grown in 281 thousand hectare producing 1617 thousand MT with average productivity of 5.75 tones per hectare (Anonymous, 2017). The largest producer of Garlic in the world is China. The largest Garlic producing state in India is Madhya Pradesh, it is grown in about 81 thousand hectare with total production of 424 thousand MT giving an average production of 5.23 tones per hectare.

In Madhya Pradesh, Garlic is grown in large scale in Mandsaur, Ratlam, Neemuch, Shajapur and Ujjain (Malwa region). Garlic production has given a good earning to the farmers in this region. Madhya Pradesh and Rajasthan produces 49.5 percent of Garlic of the country. The important garlic growing states in India are Madhya Pradesh, Rajasthan, Gujarat, Uttar Pradesh and Orissa. Garlic production percentage in different states is around in Madhya Pradesh (26.25%), Rajasthan (23.34%), Gujarat (19.67%) and in Uttar Pradesh (12%).

The organic farming makes positive contribution not only to the soil and environment but human health also. Hence, to eliminate all these bad effects, integrated plant nutrient farming is best alternative. Integration of chemical fertilizers with organic manures and biofertilizers are able to maintain the soil health, productivity and fertility. Organically grown food is expected to fetch higher price and this can offset any loss due to lower yields.

Material and method
The present experiment was carriedout in the Research Farm, Department of Horticulture, Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidyalaya, Chitrakoot, District – Satna (M.P.). C_1 O_1 Control + Control, C1 O2 Control + FYM @ 15 t/ha, C_1 O_3 Control +

Vermicompost @ 5 t/ha, C1 O4 Control + Goat manure @ 5 t/ha, C_2 O_1 100% RDF- N:P:K:S(100:60:60:45 kg NPKS/ha) + Control, C_2 O_2 100% RDF- N:P:K:S(100:60:60:45 kg NPKS/ha)+ FYM@ 15 t/ha, C_2 O_3 100% RDF- N:P:K:S(100:60:60:45 kg NPKS/ha)+ Vermicompost @ 5 t/ha, C_2 O_4 100% RDF- N:P:K:S(100:60:60:45 kg NPKS/ha)+ Goat manure @ 5 t/ha, C_3 O_1 75% RDF- N:P:K:S(75:45:45:33.75 kg NPKS/ha) + Control, C_3 O_2 75% RDF- N:P:K:S(75:45:45:33.75 kg NPKS/ha)+ FYM@ 15 t/ha, C_3 O_3 75% RDF- N:P:K:S(75:45:45:33.75 kg NPKS/ha)+ Vermicompost @ 5 t/ha, C_3 O_4 75% RDF- N:P:K:S(75:45:45:33.75 kg NPKS/ha)+ Goat manure@ 5 t/ha, C_4 O_1 50% RDF- N:P:K:S(50:30:30:22.5 kg NPKS/ha) +Control, C_4 O_2 50% RDF- N:P:K:S(50:30:30:22.5 kg NPKS/ha)+ FYM @ 15 t/ha, C_4 O_3 50% RDF- N:P:K:S(50:30:30:22.5 kg NPKS/ha)+ Vermicompost @ 5 t/ha, C_4 O_4 50% RDF- N:P:K:S(50:30:30:22.5 kg NPKS/ha)+ Goat manure @ 5 t/ha were given in G-50 variety. The climate of the region is semi-arid and sub-tropical having extreme winter and summer. During the winter months, the temperature drops down to as low as 2°C while in the summer months the temperature extend above 47°C, hot desiccating winds (Loo) are regular symptom during summers while, there may be infrequent spell of frost during the winter months. The soil of the investigation field was clay loam with good drainage and uniform texture with medium NPK status. Observations were recorded according to standard procedure on plant height cm, number of leaves per plant, Leaf area per plant (cm^2).

Result & discussion

Among growth parameters, the plant height, number of leaves $plant^{-1}$ leaf area per plant) were studies in garlic. It is evident from the data that significantly maximum plant height were recorded in the treatment O_2 (FYM@ 15 t/ha) followed by O_3 (VERMICOMPOST@ 5 t/ha). While, the plant height was observed lowest in the treatment O_1 (CONTROL) at all the stages during both the years. Farm yard manure has the nutrient and was able to release these nutrients for garlic plant competitively faster than goat manure but slower than vermicompost. Higher dose of FYM provides more amount of nutrients for the plant. The probable reasons for increased plant height may be due to addition of organic manure to increase in cat ion exchange capacity and water holding capacity. It can also supply all the necessary nutrients require for plant growth i.e. height. Similar results have been reported by Patil *et al.*, 2007 [7], Nasreen *et al.*, 2009, Acharya and Kumar, 2018 [1], Nainwal, *et al.*, 2015 [6], Ali *et al*., 2018 [2], Sachin *et al*., 2017 [14], Tripathy *et al*., 2017 and Kumar *et al*., 2019 [5].

As regards to chemical fertilizers, the treatment C_2 (100% RDF- N:P:K:S (100:60:60:45 kg NPKS/ha)) was observed significantly maximum plant height, however, minimum was observed in treatment C_1 (control) at all the stages in both the years. This might be due to better nutritional environment in the root zone for growth and development of plant by the application of NPK. The NPK are considered as one of the major nutrients required for proper growth and development of the plant. Nitrogen is the most indispensable of all mineral nutrients for growth and development of the plant as it is the basis of fundamental constituents of all living matter. It is also a main constituent of protoplasm, cell nucleus, amino acids, proteins, chlorophyll and many other metabolic products. The biological role of nitrogen as an essential constitute of chlorophyll in harvesting solar energy, phosphorylated compound in energy transformation, nucleic acids in the transfer of genetic information and the regulation of cellular metabolism and of protein as structural units and biological catalysts is well known. Phosphorus is a constituent of adenosine tri-phosphate (ATP), the energy molecule and thus plasys a vital role in the photosynthesis. Similarly, the role of potassium in stomata opening and thereby governing the entry of CO_2 in widely known. Potassium plays a vital role in controlling water economy in the plants and in improving the drought tolerance. Sulphur is the constituent of several enzymes and amino acids which are required for chlorophyll synthesis. Besides it increases the uptake of N which is a chief constituent of chlorophyll. The findings are in close harmony with the result of Verma *et al.*, 2013 [10], Patil *et al.*, 2007 [7], Nainwal, *et al.*, 2015 [6], Sachin *et al*., 2017 [14], Tripathy *et al*., 2017, Kumar *et al*., 2019 [5] and Joshi *et al*., 2005 [3].

The interaction effect was significantly affected the plant height. The significantly maximum plant height were recorded in treatment combination O_2 C_1 (FYM@ 15 t/ha + 100% RDF- N:P:K:S (100:60:60:45 kg NPKS/ha)) While, it was recorded lowest in treatment combination O_1C_1 (control + control) at all the stages during both the years. This may be due to application of major and minor nutrients, Indole Acetic Acid (IAA), Gibberlic Acid (GA_3) and Cytokinin through organic manure and chemical fertilizers, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the plant height. These findings are in agreement with the findings of Patil *et al.*, 2007 [7], Nasreen *et al.*, 2009, Nainwal, *et al.*, 2015 [6], Ram *et al*., 2017 [8] and Kumar *et al*., 2017 [4].

The data revealed that significantly maximum number of leaves per plant were recorded in the treatment O_2 (FYM@ 15 t/ha) followed by O_3 (VERMICOMPOST@ 5 t/ha). While, the number of leaves per plant was observed lowest in the treatment O_1 (CONTROL) at all the stages during both the years. The probable reasons for increased number of leaves $plant^{-1}$ may be due to addition of FYM to increase in cat ion exchange capacity leads to increase water holding capacity in soil. It can also supply all the necessary nutrients require for increase number of leaves $plant^{-1}$. Similar results have been reported by Damse *et al.*, 2014, Patil *et al.*, 2007 [7], Nasreen *et al.*, 2009, Acharya and Kumar, 2018 [1], Nainwal, *et al.*, 2015 [6], Ali *et al*., 2018 [2], Sachin *et al*., 2017 [14], Tripathy *et al*., 2017 and Kumar *et al*., 2019 [5].

As regards to chemical fertilizers, the treatment C_2 (100% RDF- N:P:K:S (100:60:60:45 kg NPKS/ha)) was observed significantly maximum number of leaves per plant, however, minimum was observed in treatment C_1 (control) at all the stages during both the years. A proper supply of nitrogen, phosphorus, potassium and sulphur through inorganic fertilizers at their recommended doses might have led to formation of soil solution rich in almost all ions required to be essentially to the plants. It is again an established fact that among other things, the nutrients acquisition power of a plant greatly depends on the concentration of the ions in soil solution. It can therefore, be assumed that the plants growing in the plots with all main nutrients enjoyed a situation congenial for their growth and development. Similar results have been reported by Damse *et al.*, 2014, Patil *et al.*, 2007 [7], Verma, *et al.*, 2013 [10], Nainwal, *et al.*, 2015 [6], Sachin *et al*., 2017 [14], Tripathy *et al*., 2017, Kumar *et al*., 2019 [5] and Joshi *et al*., 2005 [3].

Interaction effect was significantly affected the number of leaves per plant. The significantly maximum number of

leaves per plant were recorded in treatment combination O_2 C_1 (FYM@ 15 t/ha + 100% RDF- N:P:K:S (100:60:60:45 kg NPKS/ha)) While, it was recorded lowest in treatment combination O_1C_1 (control + control) at all the stages during both the years. This may be due to application of major and minor nutrients, Indole Acetic Acid (IAA), Gibberlic Acid (GA_3) and Cytokinin through organic manure and chemical fertilizers, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the number of leaves plant^{-1}. These findings are in agreement with the findings of Damse *et al.*, 2014, Patil *et al.*, 2007 [7], Nasreen *et al.*, 2009, Nainwal, *et al.*, 2015 [6], Ram *et al*., 2017 [8] and Kumar *et al*., 2017 [4].

The data revealed that significantly maximum leaf area per plant (cm^2) were recorded in the treatment O_2 (FYM@ 15 t/ha) followed by O_3 (VERMICOMPOST@ 5 t/ha). While, the leaf area per plant (cm^2) was observed lowest in the treatment O_1 (CONTROL) at both the stages during both the years. The probable reasons for increased leaf area per plant (cm^2) may be due to cumulative effect of continuous supply of nutrients, vitamins and growth promoting substances present in FYM which ultimately lead to enhanced cell division. These results were in close conformity with the findings of Acharya and Kumar, 2018 [1] and Nainwal *et al.*, 2015 [6].

As regards to chemical fertilizers, the treatment C_2 (100% RDF- N:P:K:S (100:60:60:45 kg NPKS/ha)) was observed significantly maximum leaf area per plant (cm^2), however, minimum was observed in treatment C_1 (control) at both the stages during both the years. A proper supply of nitrogen, phosphorus, potassium and sulphur through inorganic fertilizers at their recommended doses might have led to formation of soil solution rich in almost all ions required to be essentially to the plants. It is again an established fact that among other things, the nutrients acquisition power of a plant greatly depends on the concentration of the ions in soil solution. It can therefore, be assumed that the plants growing in the plots with all main nutrients enjoyed a situation congenial for their growth and development. Similar results have been reported by Acharya and Kumar, 2018 [1] and Nainwal *et al.*, 2015 [6].

Interaction effect was significantly affected the leaf area per plant (cm^2). The significantly maximum leaf area per plant (cm^2) were recorded in treatment combination O_2 C_2 (FYM@ 15 t/ha + 100% RDF- N:P:K:S (100:60:60:45 kg NPKS/ha)) While, it was recorded lowest in treatment combination O_1C_1 (control + control) at both the stages during both the year. This may be due to application of major and minor nutrients, Indole Acetic Acid (IAA), Gibberlic Acid (GA_3) and Cytokinin through organic manure and chemical fertilizers, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the leaf area plant^{-1}. These findings are in agreement with the findings of Acharya and Kumar, 2018 [1] and Nainwal *et al.*, 2015 [6].

Table 1: Effect of organic and inorganic sources on plant height (cm), number of leaves per plant and leaf area per plant (cm^2) of garlic at 90DAS

Treatment Symbols	Plant height(cm)			Number of leaves per plant			Leaf area per plant(cm^2)		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled
C_1 O_1	50.50	56.70	53.60	6.33	6.67	6.50	121.67	123.33	122.50
C_1 O_2	60.67	62.00	61.33	10.03	10.40	10.22	148.33	150.00	149.17
C_1 O_3	56.30	60.80	58.88	9.03	9.30	9.17	145.00	145.00	145.00
C_1 O_4	56.40	60.40	58.40	8.60	9.00	8.80	141.33	142.00	141.67
C_2 O_1	53.67	59.00	56.33	7.73	8.10	7.92	130.67	132.00	131.33
C_2 O_2	64.33	65.00	64.67	10.83	11.20	11.02	164.67	166.33	165.50
C_2 O_3	62.27	63.50	62.88	10.40	10.80	10.60	158.33	160.00	159.17
C_2 O_4	59.50	61.50	60.50	9.33	9.70	9.52	146.33	148.00	147.17
C_3 O_1	54.33	59.70	57.02	7.93	8.30	8.12	136.33	138.00	137.17
C_3 O_2	63.50	64.00	63.75	10.67	11.00	10.83	160.33	162.00	161.17
C_3 O_3	61.70	63.00	62.35	10.33	10.70	10.52	157.33	159.00	158.17
C_3 O_4	58.37	61.00	59.68	9.13	9.50	9.32	145.33	147.00	146.17
C_4 O_1	53.00	58.80	55.90	7.23	7.60	7.42	129.33	131.00	130.17
C_4 O_2	61.23	62.40	61.82	10.23	10.60	10.42	153.33	155.00	154.17
C_4 O_3	60.27	61.90	61.08	9.63	10.00	9.82	147.67	149.00	148.33
C_4 O_4	55.23	60.00	57.62	8.23	8.60	8.42	138.33	140.00	139.17
SE(m)	0.723	0.405	0.478	0.180	0.196	0.134	1.970	1.685	1.042
$CD_{5\%}$	2.071	1.160	1.370	0.517	0.561	0.385	5.645	4.828	2.984

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