The Pharma Innovation Journal 2021; 10(12): 2591-2594

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(12): 2591-2594

www.thepharmajournal.com
Received: 05-10-2021
Accepted: 15-11-2021

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Studies on conventional and organic production system on growth of garlic (*Allium sativum*)

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Abstract
A field experiment was conducted at Research farm, Dept. of Horticulture, M.G.C.G.V.V., Chitrakoot, and Satna (M.P.) during *Rabi* season of 2014-15 and 2015-16 to study the effect of conventional and organic production system on growth parameters of Garlic CV-Yamuna Safed-3 (G-282). The experiment was laid down in Factorial Randomized Block Design and replicated in three times. Each replication was comprised of 18 treatment combinations. The following treatment combinations involving three levels of Conventional Agriculture vis. Control-C_O, RDF (100% NPK @ 100:60:60 Kg ha^1) - C_1, 50% NPK (50:30:30 Kg ha^1) + FYM 5 t ha^1 - C_2 and six levels of Organic Production System i.e. Sowing on root days (according to moon) - O_1, Vermi compost @ 5 $t.ha^1$ -O_2, Treatment of cloves with Bijamrita for 5 minutes @ 10% - O_3, Irrigation with Jiwamrita at field preparation and with every irrigation 500 1 ha^1 - O_4, Panchagavya @ 3% Foliar application (30, 60 & 90 days after planting) - O_5, Vermi Wash @ 10% (30, 60 & 90 days after planting) - O_6 were given in G-282 of garlic variety.

Keywords: conventional production system, organic production system, garlic

Introduction
Garlic (*Allium sutivum* L.) belonging to the Alliaccae family, originated in Central Asia and Southern Europe, especially Mediterranean region. It is the most ancient cultivated vegetables giving pungency of the genus Allium and possess second rank among spice crop grown throughout India after onion which contributes 24.06% of world area and 9.48% of production. India, although rank second by area and production, is the lowest as far as productivity is concerned (5.08 t/ha). It is grown in large quantities in the states of Madhya Pradesh, Gujarat, Orissa, Rajasthan, Karnataka, Tamil Nadu, Maharashtra and Bihar.

Garlic has a variety of potent sulphur-containing compounds which are the reason for its characteristic pungent odour. Allicin, the vital compound among them, is known to have great anti-bacterial, anti-viral, anti-fungal and anti-oxidant properties. Garlic is also a reliable source of selenium. Allicin, along with other compounds like ajoene, alliin, etc. found in them also have an effect on the circulatory, digestive and immunological systems of our body and help in lowering blood pressure, detoxification, healing, etc.

It is evident from recent past that chemical farming has pushed up the agriculture production but it involved a heavy price on inputs to achieve production targets. Chemical fertilizers also jeopardized the environment through nitrate poisoning and exterminating the beneficial soil micro fauna by adversely altering the chemical and physical properties of soil and agriculture ceases to be sustainable. For sustainable production farmers should go for IPNS (Integrated Plant Nutrient System), under which they can adopt the use of other sources of plant nutrients to complement and supplement mineral fertilizers in order to maintain soil fertility and its physic-chemical properties, agriculture productivity and improving farmer's profitability through judicious and efficient use of mineral fertilizers, organic manures and bio-fertilizers to the extent possible. Use of Bio-enhancers is a new concept in organic agriculture. Bio enhancers are utilized to treat seeds/ seedlings, enrich soil and induce better plant vigour. If properly filtered, these could be potential tool for fertigation.

Materials and Methods
The present experiment was carried out in the Research Farm, Department of Horticulture, Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidyalaya, Chitrakoot, District-Satna (M.P.) during two consecutive *Rabi* season 2014-15 and 2015-16, respectively. The research work was conducted in the Factorial Randomized Block Design with three replications.

Each replication was comprised of 18 treatment combinations. The following treatment combinations involving three levels of Conventional production system vis. Control-C_O, RDF (100% NPK @ 100:60:60 Kg ha^1) - C_1, 50% NPK (50:30:30 Kg ha^1) + FYM 5 t ha^1 - C_2 and six levels of Organic Production System i.e. Sowing on root days (according to moon) - O_1, Vermi compost @ 5 t.ha^1 -O_2, Treatment of cloves with Bijamrita for 5 minutes @ 10% - O_3, Irrigation with Jiwamrita at field preparation and with every irrigation 500 1 ha^1 - O_4, Panchagavya @ 3% Foliar application (30, 60 & 90 days after planting) - O_5, Vermi Wash @ 10% (30, 60 & 90 days after planting) - O_6 were given in garlic. The gross plot area was 5.76 m^2 and net plot area was 5.176 m^2. Crop was maintain with 15 cm row to row spacing and 10 cm plant to plant. The crop variety Yamuna Safed-3 (G-282) was used as test crop during both the years.

As per treatment combination a basal dose of well rotten farmyard manure @ 5 t ha^{-1}, and vermicompost @ 5 t ha^{-1} was incorporated in the soil before sowing. According to treatment combinations, nitrogen through urea, phosphorus through SSP (Single Super Phosphate), potash through MOP (Murate of Potash) and Sulphur was applied for better growth and proper nutrition of garlic.

Nitrogen was applied in three splits. The half amount of nitrogen with full doses of P_2O_5, K_2O and Sulphur were applied as basal, at the time of sowing. The remaining nitrogen was top dressed at 45 and 70 day after sowing. The three hoeing and weeding were done to check the weed in the crop at 15, 30 and 45 days after sowing. In order to protect the crop from thrips and fungal diseases the appropriate fungicides and insecticides were sprayed as and when needed. For establishment of the garlic crop, first irrigation was given just after sowing then subsequent irrigations were given as per the need of crop and soil conditions. Harvesting was done manually by hand digger when the top turn yellowish or brown colour and shown signs of drying up and bend over (neck fall stage). The harvested bulbs with tops were weighed and subjected to other observations.

During course of investigation the different growth parameters i.e. plant height (cm), Number of leaves plant^{-1}, length of leaves (cm^2), width of leaves (cm^2), stem girth (cm), fresh weight of plant (g), dry weight of plant (g) was recorded at harvest. The recorded data of different parameters were statistically analysed to find out overall total variability present in the material under study for each character and for all the populations.

The present experiment was carried out at Research farm department of horticulture, MGCGVV, Chitrakoot (M.P.) during the year Rabi 2014-15 (first year), 2015-16 (second year) with 18 treatment combinations. The observations on different aspects such as growth behaviour were recorded and statistically analysed. The findings of the investigations presented here.

Plant height (cm), Number of leaves per plant, Length of leaves (cm), Width of leaves (cm), Stem girth (mm), Fresh weight of plant (g) and Dry weight of plant (g) was recorded at harvest and presented in table 1 and 2. All the growth parameters were showed the significant effect of treatments individually and interaction effect as well. The data revealed that significantly maximum 72.189 cm plant height, 11.644 number of leaves plant^{-1}, 13.711 cm length of leaves, 8.267 cm width of leaves, 10.850 mm stem girth, 55.033 g fresh weight of plant and 4.734 was recorded in the treatment O_2-Vermicompost @ 5 t/ha while, the minimum 69.678 cm plant height, 9.372 number of leaves plant^{-1}, 9.844 cm length of leaves, 5.478 cm width of leaves, 8.639 mm stem girth, 53.844 g fresh weight of plant and 3.887 g dry weight per plant was recorded in the treatment O_1 (Sowing on root days according to moon) during pooled study.

As regards to chemical fertilizers, the treatment C_2 (100% RDF- N:P:K @ 100:60:60 kg NPK/ha) was observed significantly maximum 71.872 cm plant height, 10.925 Number of leaves plant^{-1}, 12.300 cm length of leaves, 7.128 cm width of leaves, 10.128 mm stem girth, 54.800 g fresh weight of plant and 4.381 g dry weight of plant while, the treatment C_0 (control) was observed minimum 69.011 cm plant height, 9.056 number of leaves plant^{-1}, 9.367 cm length of leaves, 5.372 cm width of leaves, 8.428 mm stem girth, 53.678 g fresh weight of plant and 3.846 g dry weight of plant under study.

Interaction effect was significantly affected all the growth parameters at harvest. The significantly maximum 73.933 cm plant height, 13.833 Number of leaves plant^{-1}, 18.333 cm length of leaves, 12.400 cm width of leaves, 14.017 mm stem girth, 56.450 g fresh weight of plant and 6.183 g dry weight of plant was recorded in treatment combination O_2C_2 (Vermicompost @5 t/ha + 100% RDF- N:P:K @ 100:60:60 kg NPK/ha) while, minimum 67.267 cm plant height, 8.683 Number of leaves plant^{-1}, 9.467 cm length of leaves, 5.100 cm width of leaves, 7.850 mm stem girth, 53.467 g fresh weight of plant and 3.777 g dry weight of plant was recorded in treatment combination O_1C_0 (Sowing on root days according to moon + control) during pooled study.

Results

Table 1: Effect of conventional and organic production system on plant height, number of leaves plant^{-1}, length of leaves and width of leaves of garlic (pooled basis)

Treatment	Plant height (cm)				Number of leaves plant^{-1}				Length of leaves (cm)				Width of leaves (cm)			
	C_0	C_1	C_2	M	C_0	C_1	C_2	M	C_0	C_1	C_2	M	C_0	C_1	C_2	M
O_1	67.267	71.233	70.533	69.678	8.683	9.850	9.583	9.372	9.467	10.133	9.933	9.844	5.100	5.767	5.567	5.478
O_2	70.433	73.933	72.200	72.189	9.483	13.833	11.617	11.644	8.467	18.333	14.333	13.711	5.533	12.400	6.867	8.267
O_3	68.033	71.333	70.867	70.078	8.817	10.083	9.750	9.550	9.267	10.333	10.067	9.889	5.200	5.833	5.667	5.567
O_4	70.233	71.700	71.533	71.156	9.283	11.017	10.683	10.328	9.733	13.000	12.333	11.689	5.433	6.733	6.400	6.189
O_5	69.133	71.467	71.267	70.622	9.150	10.417	10.217	9.928	9.667	11.000	10.000	10.222	5.700	6.067	5.900	5.889
O_6	68.967	71.567	71.300	70.611	8.917	10.350	10.150	9.806	9.600	11.000	10.467	10.356	5.267	5.967	5.867	5.700
M	69.011	71.872	71.283		9.056	10.925	10.333		9.367	12.300	11.189		5.372	7.128	6.044	
	SE (m)		CD$_{5\%}$		SE(m)		CD$_{5\%}$		SE(m)		CD$_{5\%}$		SE(m)		CD$_{5\%}$	
C	0.116		0.334		0.208		0.600		0.257		0.742		0.307		0.887	
O	0.082		0.236		0.147		0.424		0.182		0.525		0.217		0.627	
C x O	0.200		0.579		0.360		1.039		0.445		1.285		0.532		1.536	

Table 2: Effect of conventional and organic production system on stem girth, fresh weight of plant and dry weight of plant of garlic at harvest (pooled basis)

Treatment	Stem girth (cm)				Fresh weight of plant (g)				Dry weight of plant (g)			
	C_0	C_1	C_2	M	C_0	C_1	C_2	M	C_0	C_1	C_2	M
O_1	7.850	9.117	8.950	8.639	53.467	54.167	53.900	53.844	3.777	3.967	3.917	3.887
O_2	8.850	14.017	9.683	10.850	53.833	56.450	54.817	55.033	3.903	6.183	4.117	4.734
O_3	8.083	9.217	9.083	8.794	53.600	54.300	54.000	53.967	3.803	3.973	3.960	3.912
O_4	8.717	9.550	9.483	9.250	53.800	54.683	54.700	54.394	3.880	4.100	4.073	4.018
O_5	8.650	9.450	9.383	9.161	53.700	54.633	54.450	54.261	3.863	4.037	4.010	3.970
O_6	8.417	9.417	9.283	9.039	53.667	54.567	54.367	54.200	3.850	4.023	3.997	3.957
M	8.428	10.128	9.311		53.678	54.800	54.372		3.846	4.381	4.012	
	SE(m)		$CD_{5\%}$		SE(m)		$CD_{5\%}$		SE(m)		$CD_{5\%}$	
C	0.150		0.433		0.153		0.441		0.114		0.328	
O	0.106		0.306		0.108		0.312		0.080		0.232	
C x O	0.260		0.751		0.265		0.764		0.197		0.568	

Discussion

The present study was conducted to determine the effect of different conventional and organic production system on growth of garlic. During the course of discussion an effort has been made to establish relationship between various growth parameters was recorded and statistically analysed on the basis of the two years pooled findings. An endeavour has been made to explain the possible reason of variability obtained due to different treatment combinations. Wherever, necessary findings of other workers have also been quoted to support the results of the present investigation.

It is evident from the data presented in table 1 and 2 that significantly maximum plant height (cm), Number of leaves plant^{-1}, length of leaves (cm), width of leaves (cm), stem girth (mm), fresh weight (g) of plant and dry weight (g) of plant was recorded in the treatment O_2- Vermicompost @ 5 t/ha at harvest during pooled study. While, the plant height was observed lowest in the treatment O_1 (Sowing on root days according to moon). Vermicompost has the nutrient and was able to release these nutrients for garlic plant competitively faster than FYM. Higher dose of Vermicompost 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 cation exchange capacity and water holding capacity. The probable reasons for increased Length and width of leaves (cm) may be due to cumulative effect of continuous supply of nutrients, vitamins and growth promoting substances present in vermicompost which ultimately lead to enhanced cell division (Acharya and Kumar, 2018 and Nainwal *et al.*, 2015) [1, 6]. It can also supply all the necessary nutrients require for plant growth i.e. height, number of leaves plant^{-1}. The beneficial effect of vermicompost on yield attributes might be attributed to its ability of sustains availability of nutrient throughout the growing season. The increased balanced C: N ratio might have increased the synthesis of carbohydrates with ultimate improvement in neck thickness. The probable cause may be due to increased availability of nitrogen and phosphorus leads to increased fresh and dry weight of plant. Similar results have been reported by Damse *et al.*, 2014, Acharya and Kumar, 2018, Nainwal, *et al.*, 2015, Ali *et al*., 2018, Sachin *et al*., 2017, Tripathy *et al*., 2017 and Kumar *et al*., 2019 [1, 6, 2, 4, 8, 5]. As regards to chemical fertilizers, the treatment C_2 (100% RDF- N:P:K @ 100:60:60 kg NPK/ha) was observed significantly maximum plant height, maximum number of leaves plant^{-1}, Number of leaves plant^{-1}, length of leaves (cm), width of leaves (cm), stem girth (mm), fresh weight (g) of plant and dry weight (g) of plant at harvest during pooled study. However, minimum was observed in treatment C_0 (control). 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 plays 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. 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. The application of NPK favored the metabolic and auxin activities in plant and ultimately resulted in increased neck thickness. The increase in fresh and dry weight of plants was due to application of major and minor nutrients, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the plant growth ultimately fresh weight of plant. The findings are in close harmony with the result of Verma *et al*., 2013 [9], Nainwal, *et al.*, 2015 [6], Sachin *et al*., 2017, 2017 [4, 8] and Kumar *et al*., 2019 [5].

Interaction effect was significantly affected the plant height, maximum number of leaves plant^{-1}, Number of leaves plant^{-1}, length of leaves (cm), width of leaves (cm), stem girth (mm), fresh weight (g) of plant and dry weight (g) of plant at harvest during investigation. All the growth parameters was significantly recorded in treatment combination O_2C_2

(Vermicompost @5 t/ha + 100% RDF- N:P:K @ 100:60:60 kg NPK/ha) While, recorded lowest in treatment combination O_1C_0 (Sowing on root days according to moon + control) at harvest under study. 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, number of leaves plant-, length of leaves, width of leaves. The higher stem girth was recorded due to increased supply of major plant nutrients which are required in larger quantities for growth and development of plants. Nitrogen accelerates the development of growth and reproductive phases and protein synthesis, thus promoting yield attributing characters. These findings are in agreement with the findings of Damse *et al.*, 2014, Nainwal, *et al.*, 2015 [6], Ram *et al*., 2017 [7] and Kumar *et al*., 2017 [4, 8].

Acknowledgement: Authors of this article

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