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Effect of Integrated Organic and Inorganic Fertilizer on, Growth of Garlic (*Allium sativum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Field experiments were conducted under loamy sand soil during *rabi* seasons of 2022-23 and 2023-24 at the Horticulture farm, S.K.N. College of Agriculture, Jobner. The experiment comprised of 28 treatment combinations of organic manures, inorganic fertilizer in main plot and 4 levels of foliar application through organic manures. The treatments with their symbols are described as under (100% RD of N through inorganic fertilizers (V_1), 75% Inorganic fertilizers+ 25% vermicompost (V_2), 75% Inorganic fertilizers+ 25% poultry manure (V_3), 75% Inorganic fertilizer + 25% FYM (V_4), 50 % Inorganic fertilizer + 50% vermicompost (V_5), 50% Inorganic fertilizer + 50% poultry manure (V_6), and 50% Inorganic fertilizer + 50% FYM (V_7), were assigned to main plots

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and four levels of organics (Control (O_0), Vermiwash (O_1), *Panchgavya* (O_2), and Cow urine (O_3), in sub plots and replicated thrice in split plot design. Garlic variety 'G-282' was used as a test crop. On the basis of two years result, application of 100 % inorganic fertilizer and foliar spray of *Panchgavya* was proved the most superior treatment combination in garlic representing the significantly higher growth parameter plant height of garlic at 60 and 90 days, number of leaf at 60 and 90 days and chlorophyll content.

Keywords: Garlic; growth; plant height; chlorophyll.

1. INTRODUCTION

"Garlic (*Allium sativum* L.), is an important bulb crop widely used as a spice or condiment. It's one of the major members of Alliaceae family and known by various local names in different parts of India. In India, it is commonly known as Lahsun. It is originated from central Asia and later on spread to Mediterranean region" [1].

It has higher nutritive value than other bulbs crops. It is especially rich in protein, carbohydrate and ascorbic acid. About 142 calories of energy can be obtained from 100 g of garlic. Garlic contains 59 percent moisture, 6.4 g protein, 1469 kcal energy, 0.5 g fats, 33.1 g carbohydrates, 1.5 g fiber, 181 mg Ca, 153 mg P, 1.7 mg Fe, 17 mg Na, 401 mg K, 0.08 mg riboflavin, 0.25 mg thiamine, 0.06 mg nicotinamide and 10.8 mg ascorbic acid per 100 g of edible portion [2]. Garlic is used in flavouring of foods, preparing chutneys, pickles, curry powder, tomato ketchup, etc.

A colorless, odorless, water-soluble amino compound known as alliin is present in uninjured cloves of garlic. On injury of the cells, an enzyme, alliinase comes in contact with alliin and causes breakdown into sulphur containing product allicin (diallyl thiosulfate) which gives typical odour of fresh garlic. Diallyl disulfide possess the true garlic odour [3]. Garlic also possess antibacterial, antibiotic, antitumor, antiviral, antifungal, anticandidal, antimycotic, antithrombotic, fibrinolytic, hypoglycemic, cytotoxic and lipid lowering properties [4].

"Although, the crop is commercially important but the harvest from garlic is very low in India. Among the many constraints for low productivity of garlic imbalanced nutrition is the main limiting factor. The continuous and imbalanced use of fertilizer is adversely affecting the sustainability of agricultural production besides causing environmental pollution. Looking at the high nutrient requirement of different varieties and hybrids of garlic, farmers often use inorganic fertilizers as they provide quick supply of nutrients to the plants. Use of chemical fertilizers has pushed up the agricultural production. However, among major nutrients nitrogen is lost in soil through leaching or to the atmosphere because of denitrification" [5]. Organic manure (poultry manure, FYM, vermicompost, etc.) Badal et al*.,* [6] use also results better yield of garlic crops as they acts as a store house of several macro, micro and plant growth regulators which are released during the process of mineralization to release plant nutrients present in the soil it increases the fertilizer use efficiency [7,8]. *Panchagavya*, an organic product is the potential source to play the role for promoting growth and providing immunity in plant system. *Panchagavya* is a bio promoter with a combination of five products obtained from the cow *viz;* dung, urine, milk, curd and ghee [9].

2. MATERIALS AND METHODS

Field experiments were conducted under loamy sand soil during *rabi* seasons of 2022-23 and 2023-24 at the Horticulture farm, S.K.N. College of Agriculture, Jobner. The experiment comprised of 28 treatment combinations of organic manures, inorganic fertilizer in main plot and 4 levels of foliar application through organic manures under sub plots. The treatments with their symbols are described as under (100% RD of N through inorganic fertilizers (V_1), 75 % Inorganic fertilizers+ 25 % vermicompost (V_2), 75 % Inorganic fertilizers+ 25 % poultry manure (V_3), 75 % Inorganic fertilizer + 25 % FYM (V_4), 50 % Inorganic fertilizer + 50 % vermicompost (V_5), 50 % Inorganic fertilizer + 50 % poultry manure (V_6), and 50 % Inorganic fertilizer + 50 % FYM (V_7), were assigned to main plots and four levels of organics (Control (O_0), Vermiwash (O_1), *Panchgavya* (O_2), and Cow urine (O_3), in sub plots and replicated thrice in split plot design.

2.1 Plant Height (cm)

Plant height was recorded at 60 days and 90 days after planting of cloves. Five plants were

randomly selected in each plot and tagged. Plant height was measured from the ground level to the top of the highest leaf. The meter scale was used to measure the height in cm.

2.2 Number of Leaves Per Plant

The number of fully grown, green and photosynthetically active leaves per plant were counted at 60 and 90 DAP. Five tagged plants and their mean values were computed and presented.

2.3 Total Chlorophyll Content of Leaves (mg/g) at 60 DAP

Total chlorophyll content in leaves was estimated with the method as recommended by Arnon [10]. Sample of 50 mg fresh leaves were homogenized with 5 ml of 80 per cent acetone in a mortar with pestle. Then this aliquot was taken and centrifuged for 10 minutes at 2000 rpm and made the final volume to 10 ml. clear supernatant solution was taken. Absorbance of clear supernatant was measured at 663 nm and 645 nm on spectronic-20 spectrophotometer. The amount of chlorophyll present in the extract was calculated using the following equations:

Chlorophyll (a) mg/g tissue = $12.7(A_{663}) – 2.69 (A_{645})$ x V/1000 x W

Chlorophyll (b) mg/g tissue = $22.9(A_{645}) – 4.68(A_{663})$ x V/1000 x W

Total Chlorophyll mg/g tissue = $20.2(A_{645}) + 8.02 (A_{663})$ x V/1000 x W

Where,

A = Absorbance at specific wave length

V = Final volume of chlorophyll extract in 80% acetone

W = Fresh weight of tissue extracted

Analysis for chlorophyll content was made at 60 days after planting

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

Application of 100% RD of N through inorganic fertilizers significantly increased the plant height, number of leaf and chlorophyll content of garlic at 60 and 90 days after planting growth attributes

Table 1. Effect of integrated nutrient management on plant height at both stage of garlic

Treatments	Plant height (cm)					
	60 DAS			90 DAS		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
Application of organic and inorganic source						
V_1	36.57	38.05	37.31	54.93	57.57	56.25
V_2	34.87	36.18	35.53	52.95	53.98	53.46
V_3	35.49	36.81	36.15	53.72	55.52	54.62
V_4	31.58	32.73	32.15	47.36	49.01	48.19
V_5	30.74	32.09	31.42	45.95	46.53	46.24
V_6	31.00	32.32	31.66	46.80	48.64	47.72
V_7	28.21	29.47	28.84	42.90	44.69	43.79
SEm+	**0.88**	**0.92**	**0.64**	**1.35**	**1.38**	**0.97**
CD (P = 0.05)	**2.51**	**2.63**	**1.86**	**3.87**	**3.94**	**2.82**
CV (%)	**9.32**	**9.39**	**9.36**	**9.52**	**9.39**	**9.46**
Application of organics						
O_0	28.45	29.86	29.16	43.45	45.01	44.23
O_1	35.00	36.26	35.63	52.45	53.89	53.17
O_2	35.65	36.89	36.27	53.10	54.75	53.93
O_3	31.45	32.79	32.12	47.92	49.75	48.84
SEm+	**0.47**	**0.49**	**0.42**	**0.70**	**0.72**	**0.64**
CD (P = 0.05)	**1.33**	**1.39**	**1.19**	**2.00**	**2.05**	**1.79**
CV (%)	**6.56**	**6.55**	**8.25**	**6.52**	**6.47**	**8.23**

Treatments key (V_1:V_2:V_3:V_4:V_5:V_6:V_7 and O_0:O_1:O_2:O_3)

Table 2. Effect of integrated nutrient management on number of leaves per plant at both stage of garlic

Treatments	Number of leaves per plant					
	60 DAS			90 DAS		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
Application of organic and inorganic source						
V_1	6.12	6.57	6.34	7.67	7.96	7.82
V_2	5.87	6.29	6.08	7.32	7.64	7.48
V_3	6.03	6.41	6.22	7.53	7.91	7.72
V_4	5.55	5.97	5.76	6.96	7.30	7.13
V_5	5.27	5.66	5.47	6.47	6.92	6.69
V_6	5.34	5.77	5.56	6.57	6.99	6.78
V_7	4.86	5.23	5.04	6.05	6.39	6.22
SEm±	**0.13**	**0.14**	**0.10**	**0.17**	**0.19**	**0.13**
CD (P = 0.05)	**0.38**	**0.40**	**0.28**	**0.50**	**0.53**	**0.37**
CV (%)	**8.32**	**8.16**	**8.24**	**8.70**	**8.88**	**8.80**
Application of organics						
O_0	4.91	5.30	5.11	6.22	6.59	6.41
O_1	5.89	6.25	6.07	7.25	7.61	7.43
O_2	6.01	6.39	6.20	7.49	7.85	7.67
O_3	5.50	6.00	5.75	6.80	7.16	6.98
SEm±	**0.09**	**0.09**	**0.08**	**0.12**	**0.13**	**0.10**
CD (P = 0.05)	**0.27**	**0.27**	**0.22**	**0.34**	**0.37**	**0.29**
CV (%)	**7.72**	**7.25**	**8.68**	**7.86**	**8.24**	**9.34**

Treatments key (V_1:V_2:V_3:V_4:V_5:V_6:V_7 and O_0:O_1:O_2:O_3)

Table 3. Effect of integrated nutrient management on chlorophyll content in leaves of garlic

Treatments	Chlorophyll content (mg/g)		
	2022-23	2023-24	Pooled
Application of organic and inorganic source			
V_1	1.226	1.253	1.240
V_2	1.174	1.204	1.189
V_3	1.194	1.226	1.210
V_4	1.115	1.132	1.124
V_5	1.013	1.049	1.031
V_6	1.041	1.059	1.050
V_7	0.972	0.981	0.976
SEm±	**0.026**	**0.028**	**0.019**
CD (P = 0.05)	**0.074**	**0.079**	**0.055**
CV (%)	**8.13**	**8.48**	**8.31**
Application of organics			
O_0	0.941	0.968	0.955
O_1	1.182	1.206	1.194
O_2	1.222	1.248	1.235
O_3	1.075	1.095	1.085
SEm±	**0.020**	**0.020**	**0.016**
CD (P = 0.05)	**0.058**	**0.058**	**0.046**
CV (%)	**8.42**	**0.154**	**9.46**

Treatments key (V_1:V_2:V_3:V_4:V_5:V_6:V_7 and O_0:O_1:O_2:O_3)

like plant height (37.31cm and 56.26 cm), number of leaf (6.34 cm and 7.82 cm) chlorophyll content (1.24 cm) of garlic followed by 75 % Inorganic fertilizers+ 25 % poultry manureand75 % Inorganic fertilizers+ 25 % vermicompost. These findings clearly reflected that nutrient

management through organic manure and inorganic fertilizer played a significant role in enhancing the growth attributes of garlic. Improvement in plant growth attributes (plant height, number of leaves per plant and chlorophyll content) with the treatment, might be due to the fact that poultry manure, vermicomposting [11], FYM as organic source of nitrogen not only improves plant nutrients but also improve the physical condition of soil in respect of granulation, friability and porosity, which in turn provide a balanced nutritional environment favorably both in the soil rhizosphere and the plant system [12]. Application of urea inorganic fertilizer is considered one of the indispensable mineral nutrients for growth and development of plants, as it is the basis of the fundamental constituents of all living matters [13]. Foliar application of *Panchgavya* being at par with foliar application of vermiwashand significantly increased the plant height, number of leaf and chlorophyll content as compared to rest of the treatments [14]. Moreover the presence of growth enzymes in *Panchagavya* might have favored rapid cell division and elongation and increased the activities of beneficial microorganisms in soil by application of FYM which ultimately resulted into production of growth promoting substances and improved nutrient availability for longer period and thus, beneficial effects on growth parameters plant height, number of leaves per plant, and chlorophyll content of garlic. Similar findings have been reported by Kumar et al*.* [15], Verma et al*.,* [16] and Javiya, [17].

4. CONCLUSIONS

On the basis of two years result, application of 100 % inorganic fertilizer and foliar spray of *Panchgavya* was proved the most superior treatment combination in garlic representing the significantly higher growth parameter plant height, of garlic at 60 and 90 days, number of leaf, at 60 and 90 days and chlorophyll content.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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