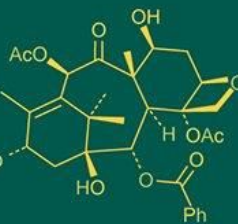
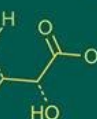
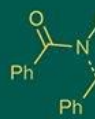
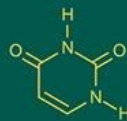
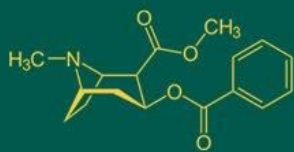


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Growth response of garlic (*Allium sativum* L.) by using organic and inorganic nitrogen sources in Jalandhar, Punjab

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Abstract

The research was carried out at the horticultural field, Department of Agriculture, Sant Baba Bhag Singh University, Khiala, Jalandhar during Rabi season 2023-24. The experiment was laid out in a Randomized Block Design with nine treatments and three replications. The findings revealed that among the various sources of organic and inorganic nitrogen applied, the plant height at 180 DAS in T4 -75% RDN through FYM + 25% RDN through urea showed significantly highest 82.06 cm and minimum in T0 is 70.22. The maximum numbers of leaves per plant 12.9 and lowest 9.06 and a leaves length of highest 61.76 cm and minimize 53.70 cm in T4 and T0 respectively. The Data of different treatments revealed that there was significant influence of different nitrogenous fertilizers and manures on the days to maturity of garlic bulb. It was noticed that application of 75% RDN through FYM +25% through urea (T4) was recorded the earliest to maturity (197.00 days) and late maturity 212.33 in T0. The research gap on finding of inorganic and organic sources of nutrients should be used in combination for improved biometric observations, viz. maturity of bulb.

Keywords: Garlic, growth attributes, organic and inorganic sources of nitrogen, recommended dose of nitrogen (RDN)

Introduction

Garlic (*Allium sativum* L.) also known as 'Lehsun', which originated from Central Asia, particularly elevated highland of Pamir and Tian Shan is considered as the primary centre of origin of garlic, however Caucasus and North Africa is considered as the secondary centre of origin (Mukhia *et al.*, 2023) ^[1]. Garlic is derived from the old English word "garleac" which means "spear leek". The 'gar' means spear (referring to spear shaped leaves) and "leac" means leek (Kshirsagar *et al.*, 2018) ^[2]. It is a member of the Allium genus in the Alliaceae family. The herb contains a variety of bioactive substances, such as phenols, enzymes, vitamins, minerals and substances containing sulphur. The edible underground stem of garlic is made up of numerous tiny bulbs known as cloves (Chotaliya and Kulkarni, 2017) ^[3]. It is utilized for both culinary and medicinal applications (Diriba *et al.*, 2013) ^[4]. One of the main active components of garlic that is thought to be responsible for many of its health advantages is allicin, a sulfur-containing molecule, which gives typical odor of fresh garlic (Hazra *et al.*, 2011) ^[5].

The total global production of garlic in 2022 was 29,149,438 metric tonnes, up marginally from 29,028,027 tonnes in 2021. China accounts 75% of the total world output at 21,337,798 tonnes and ranks first in production (FAO, 2024) ^[6]. Garlic is cultivated on 401 hectares throughout India with a production of 3277 Metric Tonnes in 2021. Major states like Madhya Pradesh, Rajasthan, Uttar Pradesh, Gujarat and Punjab are its home to growth in terms of area and output. Madhya Pradesh ranks first with 206101 ha area and 2122416 Metric Tonnes productions, whereas Punjab ranks fifth with 7888 ha area and 89855 Metric Tonnes productions in 2023 (NHB, 2023) ^[7].

Nutrients are essential for plant metabolism. It is generally recognized that the prolonged use of inorganic fertilizers has a negative impact on soil fertility, resulting in low crop production and quality. As a result, the combination of inorganic fertilizer and organic manures is capable of maintaining soil health, productivity and fertility (Priyanshu *et al.*, 2020) ^[9]. The primary goals and optimal application of organic fertilizers are to reduce environmental

contamination and save healthy foods. Garlic crops have recently gained popularity, in part due to the numerous health and nutritional benefits associated with garlic consumption (Rashwan *et al.*, 2018) ^[10]. Applying the necessary nutrients with chemical fertilizers alone may have a negative impact on soil health and result in yields that are not sustainable. In addition to benefiting the ecosystem and soil, organic farming also improves human health. Therefore, integrated plant nutrition farming is the greatest solution to get rid of all these negative consequences. The present research planned to evaluate the comparative effects of FYM and vermicompost in combination with urea on garlic growth under Punjab's agro-climatic conditions.

Material and Methods

The experiment location is in the trans-gangetic Agro-climate zone of India, in the central plains of Jalandhar, Punjab, at longitude 75° 48'51"E and latitude 31° 25'14"N at an elevation of 228 meters above mean sea level in Rabi season. This region's climate is semi-arid and subtropical, with very hot temperatures in the summer and cold weather in the winter. The typical daily temperature gradually decreases from October to January, reaching as low as 6 °C to 16 °C, and then gradually increases from February to April, reaching as high as 23-35 °C in April. Frost occurs on occasion throughout December and January. The average annual rainfall ranges from 70 to 125cm. It prefers Garlic cloves sprout optimally at temperatures between 10–15.6 °C.

This encourages the cloves to break dormancy and start growing. The formulations and information on nitrogen sources used, including urea, farm yard manure and vermicompost, for different treatments. The field experiment Plot size 3m x 3m = 9m², Total area 270 m² and Spacing 7.5cm x 15 cm was conducted with Nine treatments with three replications were included in the Randomized Block Design (RBD) in trial setup in field.

Table 1: Treatments details

Treatment no.	Treatment
T0	100% RDF (Control)
T1	100% RDN through FYM
T2	25% RDN through FYM + 75% RDN through urea
T3	50% RDN through FYM + 50% RDN through urea
T4	75% RDN through FYM + 25% RDN through urea
T5	25% RDN through VC + 75% RDN through urea
T6	50% RDN through VC+ 50% RDN through urea
T7	75% RDN through VC + 25% RDN through urea
T8	100% RDN through Vermicompost

* RDF- Recommended dose of fertilizers, FYM- Farm Yard manure, VC- Vermicompost, RDN -Recommended dose of nitrogen

For this research work, the Neeli Dhari cultivar used it is a long day variety. The bulbs are pinkish in color and diameter range of 3.5 to 5.5 cm having 13-16 yellowish white cloves. The plant growth habit is straight, wider dark green and erect leaves. Plant height is 90-95 cm and number of leaves varies from 10-14. Before planting the garlic cloves, the experimental field was carefully prepared by harrowing and ploughing. Debris from the previous crop was removed. Wooden planks were used to level the land. Plots and water channels were prepared in accordance with the layout. Add the required amount of FYM at 20 t/ha were added to all treated plots. The required quantity of NPK-

100:50:50 is added in all treated plots. The required quantity of clove @ 518 kg/ha for experimental area was worked out and sowing of cloves at 15 cm x 20cm between plants and rows was carried out in the first week of October -2023. Nitrogen was applied at a rate of 100 kg per hectare during the experiment. A basal dose of 50 kg phosphorus hectare in the form of SSP (containing 16% P₂O₅) was applied based on the treatments. Potash at 50 kg per hectare in the form of murate of potash (KCl) with 60% K₂O was administered as a base dosage to the plots according to the treatments. The nitrogen was applied as per the treatment at split dose whereas P and K were applied as a basal dose. Harvesting was done manually by hand pulling method when the plant top turn yellowish or brown color and shown signs of drying up and bend over (neck fall stage).The crop was harvested after complete maturity on 210 days.



a) Sowing



b) Germination



c) Field view



d) Tagging



e) Weeding

Fig 1: Pictorial presentation of garlic growth

Observations recorded and analysis

In order to evaluate the effect of different treatments on growth parameters nutrient content and their uptake and soil fertility status after crop harvest following observations were recorded during the course of investigation. Five plants were randomly selected and tagged from each net plot of different treatments. The details of the techniques employed for recording different types of observation are as follows: Growth attributes similar to Plant height 30, 60, 90, 120, 150 and 180 DAP (in cm), No. of leaves per plant 30, 60, 90, 120, 150 and 180 DAP (in cm), Leaf length (in cm) and Maturity days of bulbs.

Data for all characters under consideration were statistically analyzed for accurate interpretation. OPSTAT analysis of variance software was utilized for the Randomized Block Design (RBD). The treatment differences were assessed using the F' test at a 5% level of significance based on the null hypothesis. Standard errors (S.E.±) were obtained for each case, and the Critical Difference (C.D.) was calculated at a 5% level of probability to compare the two treatments.

Results and Discussion

Plant height (cm)

The plant's height is a significant factor in determining more foliar area, which results in a higher yield. Taller plants are also considered more desirable because this characteristic has a positive and direct association with larger photosynthetic area as a result better yield and productivity. However, plant height is a genetically determined trait that is impacted by nutrition availability as well as cultivar. An application of organic and inorganic sources of nitrogen gave significant results in terms of growth attributes. Plant height varied from range 70.22 – 82.06 cm. Data recorded for plant height revealed that maximum plant height (82.06 cm) was recorded in treatment T4 at 180 days While, minimum plant height (70.22 cm) was recorded in treatment T0 (100% RDF Control). Increase in plant height record in T4 (75% RDN through FYM+ 25% RDN through urea) as affected by the combined application of organic and inorganic fertilizers and observed that 25% RDF + 75% N through FYM produced highest plant height, number of leaves, lowest bolting percentage and smallest neck thickness. Organic manure stimulates plant growth and nutrient absorption by activating living organisms that require nitrogen for multiplication. As a result, organic manure plays an important role in garlic growth and development Mujadidi *et al.*, 2020. Organic manure enhanced availability of nutrients and production of some growth promoting substances that might have caused cell elongation and multiplication. Further, nitrogen might have increased the chlorophyll content of leaves and resulted in increased synthesis of carbohydrates, which in turn has influenced cell elongation and multiplication Eragegowda *et al.*, (2018)^[13].

Table 2: Effect of organic and inorganic nitrogen on Plant height (cm) of Garlic cv. Neeli Dhari

Treatments	Plant height (cm)					
	Days after sowing					
	30	60	90	120	150	180
T0	23.26	31.53	46.7	55.2	65.43	70.22
T1	25.33	40.13	54.50	61.33	71.70	76.09
T2	24.33	37.16	52.76	58.86	68.36	72.88
T3	25.56	43.06	58.4	65.43	75.80	80.63
T4	25.73	45.93	61.50	68.36	76.43	82.06
T5	23.56	33.53	47.30	56.60	66.36	71.59
T6	24.01	33.6	49.36	58.66	67.73	72.37
T7	25.43	39.16	56.56	62.60	73.23	78.45
T8	24.80	34.11	53.63	59.03	68.63	73.74
S.Em.±	0.44	0.64	0.85	0.79	0.53	0.71
C.D.(p=0.05)	1.34	1.96	2.57	2.39	1.61	2.15

*RDF: Recommended dose of fertilizers, RDN: Recommended dose of Nitrogen, FYM: Farm yard manure, VC: Vermicompost, means of three replications

Number of leaves per plant

The number of leaves on a plant is an important characteristic that is closely related to leaf area and yield. The number of leaves per plant increases photosynthesis yield and as a result returns. Garlic is a bulbous plant; the edible part is the underground bulb, not the entire crop. Although photosynthates produced in the leaves are eventually deposited in the bulb (sink). So there is a direct relationship between leaf number, photosynthates produced in the leaves and carbohydrates stored in the bulbs.

The range for number of leaves per plant varied from 9.06-12.93. Maximum number of leaves per Plant (12.93) was recorded in treatment T4 (75% RDN through FYM+ 25% RDN through urea). Whereas, minimum number of leaves per plant (9.06) were recorded by treatment T0 (100% RDF Control) which was statistically at par with treatment T5 (25% RDN through FYM+75% RDN through urea) recording 9.23 leaves per plant. Integrated nutrition management may have promoted vegetative development, which in turn increased the number of leaves and increased photosynthetic activity Dhaker *et al.*, (2017). The solubilization effect of plant nutrients caused by the addition of farm yard manure as well as the chelating effect of metal ions can manure as well as the chelating effect of metal ions can be attributed to increase uptake of NPK (Damse *et al.*, 2014).

Table 2: Effect of organic and inorganic nitrogen on number of leaves per plant of Garlic cv. Neeli Dhari

Treatments	Number of leaves per plant					
	Days after sowing					
	30	60	90	120	150	180
T0	2.56	4.63	6.96	7.70	8.01	9.06
T1	3.26	5.93	7.86	9.23	9.06	10.10
T2	3.60	5.23	7.46	8.70	8.83	9.96
T3	3.46	6.96	8.56	9.83	10.06	12.11
T4	4.26	7.23	9.16	10.6	11.30	12.93
T5	2.66	4.86	7.90	7.80	8.16	9.23
T6	3.40	4.96	7.36	8.50	8.50	9.36
T7	3.43	6.93	8.43	9.26	9.51	11.93
T8	3.16	5.63	7.63	8.16	8.96	10.12
S.Em.±	0.22	0.31	0.32	0.35	0.38	0.35
C.D.(p=0.05)	0.68	0.94	0.97	1.08	1.16	1.06

*RDF: Recommended dose of fertilizers, RDN: Recommended dose of Nitrogen, FYM: Farm yard manure, VC: Vermicompost, means of three replications

Leaf length (cm)

The data pertaining to leaf length recorded at different crop growth stages (30, 60, 90, 120, 150 and 180) days after sowing (DAS) is presented in Table 4.3. Leaf length varied from 53.70 - 69.44 cm. Data recorded for leaf length revealed that maximum leaf length (73.33cm) was recorded in treatment T4 (75% RDN through FYM+ 25% RDN through urea) which was statistically at par with treatment T3 (50% RDN through FYM +50% RDN through urea) and T7 (75% RDN through VC+25% RDN through urea) recording plant height of 69.04 cm and 67.45 cm respectively.

While, minimum leaf length (53.70 cm) was recorded in treatment T0 (100% RDF Control) which was statistically at par with treatment T5 (25% RDN through VC +75% RDN through urea) noticing 57.93 cm leaf length.

An increase in leaf length was observed in treatment (T4) might be due to enhanced availability of nutrients and production of some growth promoting substances that might have caused cell elongation and multiplication. Further, nitrogen might have increased the chlorophyll content of leaves and resulted in increased synthesis of carbohydrates, which in turn has influenced cell elongation and multiplication and hence accelerated the vegetative growth (Das *et al.*, 2014 & Amare and Mamo (2020) ^[20, 15].

Table 3: Effect of organic and inorganic sources of nitrogen on leaf length (in cm) of Garlic cv. Neeli Dhari

No. of Treatments	Leaf length (cm)					
	Days after sowing					
	30	60	90	120	150	180
T0	18.53	26.08	40.02	48.07	51.58	53.70
T1	20.62	36.02	50.56	54.42	61.90	63.29
T2	20.42	34.42	46.39	51.08	59.72	61.28
T3	21.53	38.17	55.74	58.24	67.89	69.04
T4	22.07	40.47	56.02	61.76	68.15	69.44
T5	19.73	28.04	42.31	49.08	56.93	57.93
T6	20.29	31.62	43.08	51.02	57.93	58.52
T7	21.52	37.30	51.41	55.21	65.14	67.45
T8	20.52	35.57	48.02	52.78	60.93	61.74
S.Em.±	0.56	0.21	0.23	0.25	0.28	0.35
C.D.(p=0.05)	1.71	0.64	0.71	0.78	0.86	1.07

*RDF: Recommended dose of fertilizers, RDN: Recommended dose of Nitrogen, FYM: Farm yard manure, VC: Vermicompost, means of three replications

The least leaf length (53.70 cm) was recorded in T0 100% RDF (control), which could be attributed to inadequate and imbalance nutrients to the plants. The results of this study are in agreement with the findings of Singh *et al.*, (2023) ^[16] and Gashaw, (2021) ^[17].

Maturity days of bulbs

The garlic crop is ready to harvest when the plant tops dry out and collapse. Maturity is indicated by the weakening of

the main stem above the bulb and the yellowing of 75% of the leaves. The price of a commodity is greatly determined by its maturity timing, particularly in Indian markets. Early maturity is a desirable attribute since it yields a favorable price. Number of days to harvest is also an important character as it indicates the earliness of the crop. Early maturity is a desirable trait since it fetches good returns to the growers. Singh *et al.*, (2014) ^[21] & Meena *et al.*, 2015 ^[22].

Table 4: Effect of organic and inorganic sources of nitrogen on maturity days of bulbs in garlic cv. Neeli Dhari

Treatments		Days of maturity of bulbs
T0	100% RDF (Control)	212.33
T1	100% RDN through FYM	202.33
T2	25% RDN through FYM + 50% RDN through urea	207.33
T3	50% RDN through FYM + 50% RDN through urea	198.33
T4	75% RDN through FYM + 25% RDN through urea	197.01
T5	25% RDN through VC + 75% RDN through urea	210.33
T6	50% RDN through VC+ 50% RDN through urea	208.33
T7	75% RDN through VC + 25% RDN through urea	201.33
T8	100% RDN through vermicompost	205.66
S.Em.±		1.4
C.D.(p=0.05)		4.26

*RDF: Recommended dose of fertilizers, RDN: Recommended dose of Nitrogen, FYM: Farm yard manure, VC: Vermicompost, means of three replications

Data projected on different treatment revealed that there was significant influence of different nitrogenous fertilizers and manures on the days to maturity of garlic bulb. It was noticed that T4 (75% RDN through FYM+25% RDN through urea) was the earliest to mature (197.00 days) which was at par with T3 (50% RDN through FYM + 50% RDN

through urea (198.33 days), T7 (75% RDN through VC+ 25% RDN through urea) (201.33 days). Whereas, T0 (100% RDF control) was noticed to be late matured treatment (212.33 days). The result is confirmation with findings of Sachin *et al.*, (2017) ^[18] & Abate & Bizuayehu, 2023 ^[23].

Conclusion

Garlic is a commercial crop and it has various medicinal values. According to the results, 75% RDN through FYM +25% RDN through urea proved to be a significantly superior treatment for growth and FYM provides slow-releasing nutrients, improving soil health, enhancing organic-matter and promoting long-term soil fertility. It also improves soil aggregation stability, aeration and water holding capacity as well as increased accessibility of mineralized nutrients and organic carbon for their growth and continued cellular development. The urea provides an immediate source of nitrogen for plant growth. This combination helps optimize nutrient availability, increases crop yield and reduces the environmental impact compared to using solely chemical fertilizers.

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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 writing or editing of this manuscript.

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