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RESEARCH ARTICLE

Impact of bioinoculants and fertilizers application on growth and yield performance of garlic (*Allium sativum* L.)

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Abstract

Bacillus spp. are soil-borne bacteria associated with plant roots, enhancing soil fertility, nitrogen availability, nutrient uptake by plants, and thus reducing the excessive application of chemical fertilizers. This study investigated the impact of bioinoculants (*Bacillus licheniformis* and *B. pumilus*), combined with varying doses of chemical fertilizers, on the growth and yield of the garlic cultivar 'Solan Selection.' The experiment followed a randomized complete block design with seven treatments and three replications, incorporating combinations of *B. licheniformis* and *B. pumilus* @ 10 mL/plant with 100 and 75% of the recommended doses of nitrogen and phosphorus, individual treatments of *B. licheniformis* and *B. pumilus* at 10 mL/plant and the recommended dose of fertilizers. The best growth was observed under treatment T_1 (100% recommended dose of N & P + *B. licheniformis* @ 10 mL/plant) with the shortest germination time, maximum number of leaves/plant, and quality parameters. Whereas the optimum yield traits *viz.,* fresh weight of bulb, number of cloves/bulbs, bulb yield/plot etc. were observed in treatment T_3 (100% recommended dose of N & P + *B. pumilus* @ 10 mL/plant). The combinations of 100% RDN & P with *B. licheniformis* and *B. pumilus* enhanced the growth, yield and quality of garlic under the mid hill zone of Himachal Pradesh, India.

Keywords: Garlic, Bioinoculants, *Bacillus licheniformis*, *B. pumilus*, Solan Selection

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Introduction

Garlic (*Allium sativum* L.), commonly known as lahsun, is a species within the genus *Allium* that belongs to the family Amaryllidaceae, originating from Central Asia, including regions such as India, Afghanistan, West China, and Russia (Panthee et al., 2006). Its cultivation requires a cold, moist environment during vegetative growth, bulb development and warm and dry conditions during the maturation phase. It flourishes in well-drained, fertile soils rich in organic matter with optimal growth temperatures ranging from 13 to 24°C. For bulbing, the optimal photoperiod is 10 to 12 hours for short-day varieties and 13 to 14 hours for long-day varieties. It is a rich source of volatile compounds that contribute to its characteristic flavour and bioactive properties, including anti-inflammatory, antibacterial, cardioprotective, anticancer, and antidiabetic effects (Yun et al., 2014; Martins et al., 2016). The composition of garlic cloves is primarily water (65%), carbohydrates (28%, mainly fructans), sulfur compounds (1–4%), proteins (2%), fibers (1.5%), and free amino acids (1–1.5%) (Pianezze, 2019). Soil harbours a wide variety of microbial communities, which include beneficial microorganisms that exhibit plant growth-promoting characteristics. These beneficial plant-associated microbes such as bacteria, fungi, and algae have positive effects on plants under various environmental stresses (Gouda et al., 2018; Tiwari & Lata, 2018). Various soil microorganisms like *Bacillus*, *Pseudomonas* and *Azospirillum* have been identified as suitable PGPR for crops due to their beneficial effects and tolerance to abiotic stress (Tiwari et al., 2016; Tiwari & Singh, 2017). Recently conducted studies on impact of various soil microorganisms *viz., Bacillus*, *Pseudomonas* and *Azospirillum* as PGPR on *Allium sativum* have resulted in enhanced growth and yield characteristics *viz.,* bulb diameter, growth of leaf and root, enhanced biomass and germination. While, it also enhanced various biochemical parameters such as phenolics, flavonoids, chlorophyll, sugar and protein content (Tariq et al., 2023). *Allium cepa* when treated with various rate of mineral fertilizer and soil microorganisms *viz., Azotobacter*, *Bacillus*, *Sphingobacterium* and *Burkholderia* resulted in increased growth, quality, biochemical and soil attributes (Tinna et al., 2020). Inoculation of soil microorganisms *viz., Azospirillum brasilense*, *Burkholderia ambiferia*, *Gluconacetobacter diazotrophicus* in seeds of *Allium cepa* resulted in increased plant height, dry matter, total chlorophyll and soil fertility (Pellegrini et al., 2021). *Bacillus* genus is a gram-positive, spore-forming, rod shaped bacteria which are obligate aerobes and due to their endospores forming ability, they are capable of surviving in various niches including extreme environmental conditions such as temperature, pH, and salinity and hence are widespread in nature (Govindasamy et al., 2010). *Bacillus* can enhance plant growth through direct and indirect mechanisms. Indirectly, *Bacillus* species helps to minimize the problems caused by phytopathogens, leading to improved plant health. (Ahemad & Kibret, 2014; Kamilova et al., 2015; Torres et al., 2020; Soni & Keharia, 2021). Directly, *Bacillus* spp. generates siderophores and phytohormones such as indole-3-acetic acid, cytokinin, and gibberellic acid which helps in the solubilization of phosphorus and other nutrients, which actively promote plant growth and enhance root volume (Ambawade & Pathade, 2015; Kashyap et al., 2019; Bavaresco et al., 2020; Zerrouk et al., 2020). *Bacillus pumilus* is a gram positive, spore-forming bacteria that is commonly found in various environments including marine water, sea sediments, and soil (Pudova et al., 2022; Yakovleva et al., 2022; Zhang et al., 2022). *Bacillus pumilus* is resistant to environmental stresses such as low nutrient availability, drought and UV radiation (Nicholson et al., 2000). *B. licheniformis* is a facultative anaerobic, gram-positive, rod-shaped, endospore-forming bacteria and is closely related to *B. subtilis* (Logan & De Vos, 2009). *B. licheniformis* has strong growth-promoting activity (Probanza et al., 1996). It was soon discovered that they are auxin producers (Gutierrez-Manero et al., 1996). Therefore, the current study was conducted to analyse the response of these soil microrganisms as PGPR in combination with chemical fertilizers on growth and yield performance of *Allium sativum*.

Materials and Methods

The experiment was conducted at Vegetable Research Farm, Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during *Rabi* season of 2023-24 (single season). The experimental site is located at Nauni, about 14 km from Solan, at an altitude of 1276 m amsl. lying at longitude of 77˚ 11′ 30′′ E and a latitude of 30˚ 52′ 30′′ N and falls in sub-humid, sub-temperate and mid hill zone of Himachal Pradesh, India. The local clonal variety Solan Selection developed by Department of Vegetable Science, UHF, Nauni, Solan was used for the study. The bulbs of 'Solan Selection' are creamish white in colour and have a diameter ranging from 3.5 to 5.5 cm, with 12 to 13 yellowish white cloves. The average yield of this variety ranges from 150 to 190 q/ha. The treatment details as shown in Table 1 consisted of seven treatments including T_1 (100% recommended dose of N & P + *B. licheniformis* @ 10 mL/plant), T_2 (75% recommended dose of N & P + *B. licheniformis* @ 10 mL/plant), T_3 (100% recommended dose of N & P + *B. pumilus* @ 10 mL/plant), T_4 (75% recommended dose of N & P + *B. pumilus* @ 10 mL/plant), T_5 (*B. licheniformis* @ 10 mL/plant), T_6 (*B. pumilus* @ 10 mL/plant) and T_7 (Recommended Dose of Fertilizer). The recommended dose of nitrogen (RDN) @ 500 kg/ha and phosphorus (RDP) @ 475 kg/ha was applied as per the "Package of Practices for Vegetable Crops", published by the Directorate of Extension Education, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (Anonymous, 2020). The experiment was set up in a randomized complete block design with three replications, resulting in 21 experimental plots. The spacing was 15 cm between rows and 10 cm between plants, with raised plots measuring 1.5 ×1.5 m. The garlic bulbs were sown in September, 2023 and were treated with bioinoculants (*B. licheniformis* and *B. pumilus*), then sown 3 to 4 cm deep in raised beds manually. The bioinoculants *viz., B. licheniformis* and *B. pumilus* were procured from the Department of Soil Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP, and were grown on nutrient agar medium,

Table 1: Details of treatment combinations of fertilizers and bioinoculants

Treatments	*Treatment details*
T_1	100% recommended dose of N & P + *B. licheniformis*@10 mL/plant
T_2	75% recommended dose of N & P + *B. licheniformis*@10 mL/plant
T_3	100% recommended dose of N & P + *B. pumilus*@10 mL/plant
T_4	75% recommended dose of N & P + *B. pumilus* @10 mL/plant
T_5	*B. licheniformis* @10 mL/plant
T_6	*B. pumilus*@10 mL/plant
T_7	RDF

respectively and all these cultures were maintained at 4°C in a refrigerator in the Department of Vegetable Science, UHF, Nauni, Solan. Sub-culturing of cultures was done once in a fortnight and was inoculated at 25 ± 1°C. *B. licheniformis* and *B. pumilus* were multiplied on nutrient broth medium. A loop full of each bacterial antagonist was transferred aseptically into test tubes containing 5 mL of sterilized nutrient broth separately and incubated at 27 ± 1°C for 48 hours. Further, 10 mL of the broth cultures (48 hours old) containing about 10^8 cfu/mL was added in field soil at the root zone of each plant. The experimental fields were ploughed three times and well harrowed to prepare the soil. Fertilizers *viz.,* nitrogen, phosphorus and potassium were applied through calcium ammonium nitrate (CAN) (25% N_2), single super phosphate (SSP) (16% P_2O_5) and muriate of potash (MOP) (60% K_2O) as a basal dose at the time of sowing. Weed control was carried out by hoeing and shallow earthing up. Harvesting took place in the month of May and harvested bulbs were then cured and sun-dried for 10 days, with the leaves folded over the bulbs to protect them from sunburn. After a week of drying, the necks and roots were trimmed. The yields obtained from the plot were then weighed and recorded after curing. Post harvesting observations for all growth and yield attributes were recorded from 10 randomly selected plants in each replication, and the B:C ratio was also calculated.

Statistical analysis

The statistical analysis was carried out for each observation using MS-Excel and OPSTAT software packages. The data for different traits were analyzed in accordance with randomized complete block design (Factorial) as suggested by Panse & Sukhatme (2000).

Results and Discussion

Growth characteristics

The data for germination days presented in Table 2 were statistically significant and revealed that garlic seeds were able to germinate earlier as compared to the control when bioinoculants were combined with chemical fertilizers. However, the minimum time taken for germination (8.00 days) (Table 2) was observed in treatment T_1 (100% recommended dose of N&P + *B. licheniformis* @10 mL/plant) as compared to treatment T_7 (RDF), which observed maximum time for germination (13.66 days). Tariq et al. (2023) established that garlic cloves, when inoculated with *Bacillus cereus* and other bacterial strains at 10^8 CFU/mL, enhanced germination percentage and early growth characteristics in garlic. Rattan (2023) also confirmed that the combination of 100% NPK+ FYM+ PSB improved germination rates in *Pisum sativum*. The data for plant height were statistically significant and are shown in Table 2, which revealed that treatment T_3 with 100% recommended dose of N & P+*B. pumilus*@ 10 mL/plant resulted in the maximum

Table 2: Effect of chemical fertilizers in combination with bioinoculants on germination (days), plant height (cm), number of leaves, diameter of bulb

Treatments	*Growth parameters*			
	Germination (days)	*Plant height (cm)*	*Number of leaves*	*Diameter of bulb (cm)*
T_1	8.00	80.50	10.33	4.82
T_2	9.66	79.58	9.33	4.93
T_3	9.33	82.33	9.66	4.73
T_4	9.50	81.41	9.00	4.70
T_5	12.33	77.29	8.33	4.09
T_6	11.00	75.35	8.16	4.25
T_7	13.66	66.81	6.33	3.92
SE (m) ±	0.57	0.65	0.37	0.07
$CD_{(0.05)}$	1.78	2.05	1.16	0.23

plant height of 82.33 cm. Whereas, the minimum plant height (66.81 cm) was recorded under treatment T_7 (RDF)). Results for plant height have been supported by a previous study conducted by Tariq et al. (2023), which revealed that shoot length and root growth in garlic were enhanced under the inoculation of garlic with *B. cereus*. This was validated by Agake et al., (2022), who reported significant enhancement in weight and shoot length by *B. pumilus* inoculation. The number of leaves per plant ranged between 6.33 and 10.33 (Table 2), which was statistically significant. The highest number of leaves per plant (10.33) was recorded in treatment T_1 (100% recommended dose of N & P + *B. licheniformis* @ 10 mL/plant) as compared to lowest number of leaves per plant (6.33) under the treatment T_7 (RDF). The results were in accordance with the study conducted by Tariq et al., (2023) which also reported increased growth and number of leaves by inoculation of garlic cloves with *B. cereus*. Integrated nutrition management may have promoted vegetative growth, resulting in increased leaf count and enhanced photosynthetic activity (Dhaker et al., 2017). Combined application of bioinoculants and fertilizers reduced the days to maturity, which ranged between 212.66 and 219.33 days, as shown in Table 3. The minimum crop maturity duration (212.66 days) was observed in treatment T_3 (100% recommended dose of N & P + *B. pumilus* @ 10 mL/plant). Whereas, maximum days to maturity per plot were recorded in treatment T_7 (RDF) with 219.33 days. The results of the present study were consistent with a recently reported study by Priyanshu et al., (2019) and Desta et al., (2021) who revealed that bioinoculants promotes early growth and reduces physiological maturity duration. The early maturity under *B. pumilus* and *B. licheniformis* in combination with chemical fertilizers enhanced nitrogen and phosphate solubilization, balanced hormonal assisted growth and increased photosynthetic efficiency.

Table 3: Effect of chemical fertilizers in combination with bioinoculants on fresh weight of bulb (g), number of cloves per bulb, days to maturity

Treatments	*Growth parameters*		
	Fresh weight of bulb (g)	*Number of cloves per bulb*	*Days to maturity*
T_1	57.40	13.33	213.67
T_2	55.86	12.67	214.67
T_3	58.87	14.00	212.66
T_4	57.50	12.00	216.00
T_5	52.78	11.67	217.67
T_6	51.66	12.33	218.00
T_7	47.27	10.33	219.33
SE (m) ±	0.55	0.59	0.95
$CD_{(0.05)}$	1.70	1.84	2.97

Yield characteristics

The data for diameter of bulb was statistically significant and ranged between 3.92 to 4.93 cm as shown in Table 2. Treatment T_2 (75% of the recommended dose of N & P + *B. licheniformis* @ 10 mL/plant) recorded the highest bulb diameter of 4.93 cm as compared to treatment T_7 (RDF) with lowest bulb diameter of 3.92 cm. The enhancement in diameter of garlic bulb was significant under bioinoculants in the present study is in line with findings of Tajamul Mansoor et al., (2025), which observed the highest bulb diameter (5.37 cm) in the treatment consisted of 75% RDF + Vermicompost + biofertilizers (PSB + KSB + *Azotobacter*). Similar effect of chemical fertilizers in combination with bioinoculants on bulb diameter was reported by Eragegowda et al., (2018). The fresh weight of the bulb revealed significant enhancement in all the treatments as compared to the control (RDF) @ T7, as shown in Table 3. The maximum fresh weight of bulb (58.87 g) was recorded in treatment T_3 (100% recommended dose of N & P along with *B. pumilus* @ 10 mL/plant) as compared to treatment T_7 (RDF) with minimum fresh weight of bulb (47.27 g). Findings for fresh weight of bulb in the present study are in close agreement with findings of Tajamul Mansoor et al., (2025), which observed optimum fresh weight of bulb (44.00 g) under application of 75% RDF + Vermicompost + biofertilizers (PSB + KSB + *Azotobacter*). Similar results were observed by Abdel-Razzak et al., (2013) under the treatment of bio-inoculants on garlic fresh bulb weight. The data for the number of cloves per bulb were statistically significant and presented in Table 3. The maximum number of cloves per bulb (14.00) was observed in treatment T_3 (100% recommended dose of N & P along with *B. pumilus* @ 10 mL/plant). Whereas minimum number of cloves per bulb were recorded in treatment T_7 (RDF) with 10.33 cloves per bulb. These results were in alignment with the findings of Das et al., (2020), who observed the highest number of cloves per bulb of garlic in a similar treatment involving NPK (100%), vesicular arbuscular mycorrhiza (VAM), *Azospirillium* and potassium solubilizer as compared to the control. Also correlated with the findings of Tajamul Mansoor et al., (2025), which observed that number of cloves per bulb increased under application of 75% RDF + Vermicompost + biofertilizers (PSB + KSB + *Azotobacter*). It is evident from statistically significant data for bulb yield per plot as shown in Table 4 that highest yield per plot of 4.75 kg/plot was recorded under treatment T_3 (100% recommended dose of N & P + *B. pumilus* @ 10 mL/plant). Whereas, minimum bulb yield per plot (3.20 kg/plot) was recorded in treatment T_7 (RDF). These results are supported by the findings of Singh & Singh (2017), who reported that the application of *Azotobacter* and phosphate-solubilizing bacteria (PSB) not only facilitates the availability of atmospheric nitrogen and soil phosphorus to plants but also promotes plant growth and bulb yield through the release of hormones and nutrients. Similar observations have been documented by Eragegowda et al., (2018) and Tesfaye & Bayih (2024) in garlic, who revealed direct relationship between NPK supply and bulb yield *via* application of bioinoculants. The data for projected yield per hectare was statistically significant and shown in Table 4 which revealed that treatment T_3 with 100% recommended dose of N & P+*B. pumilus*@ 10 mL/plant resulted in the highest projected yield per hectare (168.88 q/ha). Whereas, the minimum projected yield per hectare (114.01 q/ha) was recorded under treatment T_7 (RDF). These findings are consistent with those reported by Das et al., (2014), who observed improvements in growth and yield attributes in garlic through the combined application of chemical fertilizers and biofertilizers. These results for projected yield per hectare are in line with findings of Tajamul Mansoor et al., (2025), which observed that yield per hectare (3.60–8.24 t/ha) increased under application of 75% RDF + Vermicompost + biofertilizers (PSB + KSB + *Azotobacter*).

Table 4: Effect of chemical fertilizers in combination with bioinoculants on bulb yield per plot (kg), yield per hectare (q)

Treatments	*Yield parameters*	
	Bulb yield per plot (kg)	*Projected yield per hectare (q)*
T_1	4.54	161.53
T_2	4.24	150.87
T_3	4.75	168.88
T_4	4.32	153.71
T_5	3.79	134.75
T_6	3.72	132.26
T_7	3.20	114.01
SE (m) ±	0.04	9.76
$CD_{(0.05)}$	0.85	30.40

Table 5: Effect of chemical fertilizers in combination with bioinoculants on moisture percentage of bulb (%), dry matter content of bulb (%)

Treatments	*Quality parameters*	
	Moisture percentage of bulb (%)	*Dry matter content of bulb (%)*
T_1	66.14	41.40
T_2	65.52	37.59
T_3	65.84	40.23
T_4	64.23	35.73
T_5	61.48	31.70
T_6	59.05	33.76
T_7	55.49	31.58
SE (m) ±	0.27	0.58
$CD_{(0.05)}$	0.86	1.82

Quality characteristics

The individual and combination of bioinoculants with chemical fertilizers revealed significant enhancement in moisture percentage of bulb as presented in Table 5. The maximum moisture percentage of bulbs, with 66.14% was observed in treatment T_1 (100% recommended dose of N & P + *B. licheniformis* @ 10 mL/plant) as compared to treatment T_7 (RDF) with minimum moisture percentage of 55.49%. These observations are in line with the study conducted by Priyanshu et al., (2019), in which the combined application of bioinoculants with chemical fertilizer increased the moisture content to 62.62% in garlic bulb. This might be due to the assimilation of a higher content of nutrients supplied by the sources of nutrients in terms of nitrogen, phosphorus, sulfur and biofertilizers, which play an important role in increasing growth, succulence and turgidity in plant cells. Data for dry matter content of bulb was computed as per standard method which was statistically significant and shown in Table 5. The application of treatment T_1 (100% recommended dose of N & P + *B. licheniformis* @ 10 mL/plant) resulted in the highest dry matter content of bulbs (41.40%).

Table 6: Effect of chemical fertilizers in combination with bioinoculants on benefit cost ratio

Treatment	*Bulb yield (q/ha)*	*Cost of cultivation (₹)*	*Gross return (₹)*	*Net return (₹)*	*B:C ratio*
T_1	161.53	4,85,568	1938360	1452795	2.99
T_2	150.87	4,72,101	1810440	1338339	2.83
T_3	168.88	4,85,568	2026560	1540992	3.17
T_4	153.71	4,72,101	1844520	1372419	2.90
T_5	134.75	4,32,015	1617000	1184985	2.53
T_6	132.26	4,32,015	1587120	1155105	2.32
T_7	114.01	4,63,200	1368120	904920	1.92
$CD_{(0.05)}$	30.40	-	-	-	0.63

Whereas treatment T_7 (RDF) recorded lowest dry matter content of bulb (31.58%). When bioinoculants are applied together with chemical fertilizers, the dry weight of the bulb increases more than their individual applications. Singh et al., (2017) found that using 100% recommended dose of fertilizer (RDF) along with *Azotobacter* + PSB also enhanced the bulb's dry weight. These bioinoculants provide essential macro and micro-nutrients for plants, which are known to affect enzymatic changes during crop growth, ultimately contributing to quality improvement. These findings are supported by previous studies on garlic by Gamit et al., (2019), Meena et al., (2019) and Shumbulo et al., (2026).

Economics

The study evaluated the effect of chemical fertilizers combined with bioinoculants on the benefit-cost ratio in garlic cultivar Solan Selection. Table 6 unveiled that the highest garlic bulb yield (168.88 q/ha) was observed under 100% recommended dose of N & P + *B. pumilus* @ 10 mL per plant. This treatment also observed the highest B:C ratio (3.17) and net return of Rs. 1540992.

Conclusion

The result of the present study concluded that the treatment T_3 100% recommended dose of N & P + *B. pumilus* @10 mL/plant was superior for yield parameters including fresh weight of bulb, number of cloves/bulb, bulb yield/plot, yield/ha and recorded the highest gross income (Rs 20,26,560/ha), net income (Rs 15,40,992/ha) and benefit-cost ratio (3.17). Whereas, treatment T_1 consisting of 100% recommended dose of N & P + *B. licheniformis* @ 10 mL/plant was optimum for growth parameters including germination time, number of leaves/plant and quality parameters *viz.,* dry matter content and moisture percentage of bulb. Therefore, the combined effect of bioinoculants and chemical fertilizers improved growth, yield and quality characteristics in garlic under mid hill conditions of Himachal Pradesh.

Declaration of Competing Interests

The authors declared that they have no competing interests concerning the work reported in this research article.

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सारांश

बैसिलस प्रजाति के बैक्टीरिया मिट्टी में पाए जाते हैं और पौधों की जड़ों से जुड़े होते हैं। ये मिट्टी की उपजाऊ क्षमता, नाइट्रोजन की उपलब्धता और पौधों द्वारा पोषक तत्वों के अवशोषण को बढ़ाते हैं, जिससे रासायनिक उर्वरकों का अत्यधिक इस्तेमाल कम होता है। इस अध्ययन में लहसुन की 'सोलन सिलेक्शन' किस्म की वृद्धि और पैदावार पर बायो-इनोक्युलेंट्स (बैसिलस लिचेनिफॉर्मिस और बैसिलस प्यूमिलस) और रासायनिक उर्वरकों की अलग-अलग मात्राओं के संयुक्त प्रभाव की जांच की गई। प्रयोग में 'रैंडमाइज्ड कम्प्लीट ब्लॉक डिज़ाइन' का पालन किया गया, जिसमें सात ट्रीटमेंट और तीन रेप्लिकेशन शामिल थे। इनमें बैसिलस लिचेनिफॉर्मिस और बैसिलस प्यूमिलस (10 मिली/पौधा) को नाइट्रोजन और फास्फोरस की अनुशंसित मात्रा के 100: और 75: के साथ मिलाकर इस्तेमाल किया गया; साथ ही बैसिलस लिचेनिफॉर्मिस और बैसिलस प्यूमिलस (10 मिली/पौधा) के अलग-अलग ट्रीटमेंट और उर्वरकों की अनुशंसित मात्रा का भी उपयोग किया गया। सबसे अच्छी वृद्धि ट्रीटमेंट टी1 (नाइट्रोजन और फास्फोरस की 100: अनुशंसित मात्रा $ बैसिलस लिचेनिफॉर्मिस/10 मिली/पौधा) में देखी गई, जिसमें अंकुरण का समय सबसे कम था और प्रति पौधा पत्तियों की संख्या व गुणवत्ता के मानक सबसे अच्छे थे। वहीं, पैदावार से जुड़े सबसे अच्छे गुण, जैसे बल्ब का ताजा वजन, प्रति बल्ब कलियों (क्लोव्स) की संख्या, प्रति प्लॉट बल्ब की पैदावार आदि, ट्रीटमेंट टी3 (नाइट्रोजन और फास्फोरस की 100: अनुशंसित मात्रा $ बैसिलस प्यूमिलस/10 मिली/पौधा) में देखे गए। भारत के हिमाचल प्रदेश के मध्य पहाड़ी क्षेत्र में, नाइट्रोजन और फास्फोरस की अनुशंसित मात्रा के 100: के साथ बैसिलस लिचेनिफॉर्मिस और बैसिलस प्यूमिलस के संयोजन ने लहसुन की वृद्धि, पैदावार और गुणवत्ता को बढ़ाया।