



Package of Practices for Organic Cultivation of Garlic in Sikkim

*Sudip Kumar Dutta¹, Shaon Kr Das¹, TL Bhutia¹, Sital Yonzon¹, Urmila Karki¹, Prakash Chettri¹, Ashish Yadav¹, Ashok Kumar¹, Ram Dutta² and Vijay B Mahajan²

¹ICAR-RC NEH Region, Sikkim Centre, Gangtok, Sikkim-737102, India

²ICAR-Directorate of Onion and Garlic Research (DOGR), Rajgurunagar, Maharashtra-410505, India

*Corresponding Author's email: sudipiari@rediffmail.com

Garlic (*Allium sativum* L.) is a popular bulb crop cultivated in India and used as a spice or condiment. It is also a significant foreign exchange earner for India. Fresh and frozen garlic, dried garlic, dehydrated garlic flakes, dehydrated garlic powder, and garlic oil are all exported from India to Bahrain, Bangladesh, Germany, and Japan. Garlic is mostly grown in Gujarat, Madhya Pradesh, Orissa, Maharashtra, Uttar Pradesh, and Rajasthan. India is also now one of the exporters of garlic to Pakistan, Thailand, USA, Nepal and Malaysia, as well as the traditional market of Bangladesh. The distinctive, intense, and peculiar flavour of this genus, as well as its potential nutritional and medicinal qualities have drawn the attention of numerous plant physiologists, chemists, nutritionists, traditional practitioners, growers and researchers working on phytoremedies throughout the world. Garlic is thought to be a good source of volatile chemicals, which are responsible for the unique flavour and bioactive qualities of dry bulbs. Non-volatile substances with well-known pharmacological and therapeutic effects, such as amides, nitrogen oxides, phenolic compounds, particularly flavonoids, proteins, saponins and saponinins, as well as antioxidants, minerals (particularly P, K, and Se), and vitamins, are also abundant (especially vitamin C and vitamins of B complex) in garlic. Garlic bulbs generally consists of water (62-68%), carbohydrates (26-30%), proteins (1.5-2.1%) and energy content is around 140 kcal 100 g⁻¹ fresh weight.

North East India (Assam, Manipur, Mizoram, Nagaland, Meghalaya, Tripura, Arunachal Pradesh, and Sikkim) is one of India's biodiversity hotspots. This region's warm tropical temperature provides a good ecosystem for a diverse range of cultivated and wild edible *Allium* species. Sikkim is also no exception, the soil and climatic condition of Sikkim allows farmers for growing garlic at a small and medium scale. In Sikkim, October to February are relatively drier months. Therefore, one crop of garlic can be easily accommodated in those months. Short day varieties of garlic are suitable for Sikkim condition and long day crops can be grown under certain high-altitude areas. Sikkim farmers are mostly small and medium scale farmers and follow organic production practices. Sikkim has been declared organic state in the last decade and since then, organic farming is followed religiously throughout the state. Keeping in view the climatic conditions of Sikkim, ICAR RC NEH Region, Sikkim centre has popularized the cultivation of two varieties of garlic in the state viz. SG-01 (local garlic) and Bhima Purple from ICAR-DOGR, Pune, Maharashtra. Various other technological interventions are introduced to upscale the production and productivity of organic garlic in Sikkim which are discussed in the following sections.

Organic package of practice

Soil: In Sikkim, garlic grows best in well-drained, deep, humus-rich soil with a high potassium concentration that does not dry out rapidly in the summer. Garlic crops planted in sandy or loose soils produce lighter-weight bulbs and have poor storage quality. Garlic bulbs

cultivated in thick soils are distorted, and during harvest, bulbs are crushed and injured. In poorly drained soil, bulbs decay. Acidic soils are not conducive to clove growth. A pH of 5-7 is ideal for development and yield.

Climate: In Sikkim, garlic crops flourish in a wide range of climates. It cannot, however, withstand temperature extremes. In both summer and winter, it enjoys moderate temperatures. Extreme heat and prolonged drought are not favourable to bulb development. It is a frost-hardy plant that demands a cold, damp environment during growth and a somewhat dry climate once the bulb has matured. Long days and high temperatures are conducive to bulb formation. Temperature between 25 and 30 °C is optimum for bulb growth. Under Sikkim conditions, there are chances of frost damage during January-February. Hence, a spray of water in early morning hours is advisable. Garlic grown under low cost poly tunnels and shelters are free from frost damage. Low cost poly tunnels and shelters provide a suitable microclimate for production of cloves during winter months under Sikkim condition.

Garlic Variety: Given below in the table are high yielding garlic varieties which can be used for commercial garlic cultivation in Sikkim. The data has been generated through AINRPOG (All India Network Research Project on Onion and Garlic) trials over last three years (2022-2025) in Sikkim.

Sl.No.	Variety	TY (q/ha)	ABW (g)	NOC	AWC (g)	TI	PDI PB	PDISB
1.	Bhima Purple	97.2	23.03	20.67	8.80	1	1	0
2.	BhimaOmkar	92.7	24.00	21.13	9.27	1	0.33	0.33
3.	SG-01	110.7	24.66	22.80	9.53	1	0.33	0

TY = Total yield, ABW = Average bulb weight, NOC = Number of cloves/bulb, AWC = Average Weight (Based on weight of 50 cloves), TI = Thrips incidence, PDIPB= Plant disease index Purple blotch, PDISB= Plant disease index Stemphyllium blight

Propagation: Garlic is propagated vegetatively by planting cloves; more cloves are produced by planting larger cloves. The cloves should be virus-free.

Season of Garlic Planting: The season of garlic planting in Sikkim condition is 1st week of October to mid November. Late planting must be avoided as it may cause poor germination and slower seedling growth and early bolting.

Garlic Planting: Repeated ploughing should be done before adding well-decomposed FYM at a rate of 15 to 20 tonnes per hectare for soil preparation. For acid soil reclamation, lime should be applied @ 2 ton/ha once in two years. The use of borax at a rate of 10 kg/ha improves bulb size and crop yield. The optimal spacing is 15 cm × 10 cm, and the seed rate per acre is 500 to 600 kg of cloves.

Three methods are suitable for garlic sowing under Sikkim condition.

- Dibbling in raised bed: Fields are divided into small raised plots convenient for irrigation and seeds are dibbled 5-7.5 cm deep keeping their growing ends upward.
- Dibbling in raised bed with plastic mulching: Same as above, only polythene mulching is used additionally.
- Ridge planting: Ridges and furrows are made with hand hoe. The cloves are planted in the ridges with the growing end facing upward. Then the cloves are covered lightly with loose soil. Proper drainage system should be ensured in both the methods of planting.

Organic Nutrient Management: Application of well-decomposed farmyard manure (FYM) or compost @ 15 t/ha along with 200 kg neem cake and 100 kg/ha rock phosphate or vermicompost @ 5 t/ha is recommended through broadcasting and ploughing at the time of land preparation or as basal dressing by spreading over the beds or into the pits at the time of planting. Integrated application of FYM @ 8 t/ha and vermicompost @ 2 t/ha along with 200 kg neem cake and 100 kg rock phosphate/ha is the best option for sustainable onion and garlic production. Organic manure can also be applied along with bio-fertilizers like *Azospirillum* and *Bacillus* (Phosphate Solubilizing Bacteria) for better nutrition to the crop.

Besides, *Trichoderma viride* 5kg/ha mixed with *Azotobacter* 10kg/ha can also be applied along with organic manure as basal dose.

Irrigation: Prior to planting, the land should be lightly irrigated. Garlic crop can be irrigated by furrow irrigation, drip irrigation, and sprinkler irrigation. Irrigation is done every third to fourth day throughout the early stages. The frequency is lessened, and the irrigation is turned off when the crop matures.

Intercultural Operations: Garlic is a densely planted crop, and field should be kept weed free in the initial establishment stages. Manual hand weeding is generally followed in organic farming; moreover, hoeing improves the crop immediately before bulb development by loosening the soil and resulting in a set of larger and more compact bulbs.

Harvesting: Garlic crops mature in about 130-150 days, depending on cultivar, soil, and season under Sikkim condition. When the tops turn yellowish and show signs of drying and bending, the crop is ready for harvesting. Early harvesting produces low-quality bulbs that cannot be stored for extended periods of time. Bulbs are carefully removed and cleaned, leaves are knotted at the top and kept in shade for one week before storage.

Yield: Garlic yields 70 to 120 quintals per hectare under organic farming in Sikkim, depending on a number of factors such as variety, season, and soil richness.

Storage of Garlic: Garlic may be kept in well-ventilated rooms for a reasonable amount of time. Knot the garlic leaves and hang them with support in well-ventilated rooms. Well-cured garlic can be kept at room temperature for up to eight months.

Diseases and pests

- **Cultural Practices:**

- ✓ **Crop Rotation:** Avoid planting alliums in the same field for at least two years to disrupt pest cycles.

- ✓ **Field Sanitation:** Remove and destroy crop residues after harvest.

- ✓ **Physical Barriers:** Install yellow and blue sticky traps for monitoring and mass trapping of adult thrips. Use two rows of maize as a barrier crop around onion plots to block thrips.

- **Biological/Organic Controls:**

- ✓ **Bio-agents:** Use soil applications of *Trichoderma harzianum* and neem cake against anthracnose and purple blotch diseases.

- ✓ **Botanical Pesticides:** Neem oil and garlic extracts are used for pest control. Spray *Beauveria bassiana* (10g/L) for managing cutworms.

- ✓ **Seed Treatment:** Use *Trichoderma* bio-fungicide as a seed/clove treatment.

Purple blotch and *Stemphylium* blight: The initial signs of the disease are little, water-soaked lesions that quickly turn into white centres on leaves or seed stalks. These lesions become larger, consolidate, turn zonal, and expand uphill and downward in favorable conditions. Use of healthy cloves, crop rotation with non-related crops is the only measures to control this disease in organic farming. *Stemphylium* blight symptoms and management are similar as purple blotch.

Thrips: When they are in great numbers, they can be seen feeding on exposed leaf surfaces as well as in the protected inner leaves close to the bulb and under the leaf folds. The scarring of leaves caused by their feeding might be severest on green onions. The effective photosynthetic area may be reduced by severe scarring, and foliar diseases may be introduced. Thrips are frequently found being consumed by natural enemies such as lacewings, tiny pirate bugs, and predaceous mites. Thrips are found in all the garlic growing areas in Sikkim conditions. Sprays of the formulations of spinosad, azadirachtin, and entomopathogenic fungi such as *Beauveria bassiana* are acceptable for use on organically certified crops.

Harvesting and post-harvest

- **Harvesting:** Harvest when the tops fall over and the bulbs are mature, typically 3-4 months after planting.

- **Post-harvest:** Dry bulbs well in shade and store them in a cool, dry place with good air circulation to prevent storage rot.

Economics of garlic cultivation

In Sikkim, under field conditions, the yield of garlic ranged from 92.0 to 96.0 q/ha. The average variable cost varied from 140560.00 (Rs./ha) to 145600.00 (Rs./ha). Per kg cost of selling garlic cloves was kept Rs. 60.00/kg. The average gross Income (Rs./ha) varied from 555600.00 to 562800.00. The average net income (Rs./ha) ranged from 411900.00 to 420440.00. In all the three years the cultivation of garlic recorded benefit:cost ratio (B:C) of more than three with a range of 3.87 to 3.99.

Economic analysis of organic garlic cultivation (variety 'Bhima purple') during the *rabi* season

Economic parameter	Year		
	2022	2023	2024
Yield (q/ha)	93.5	92.6	93.8
Average variable cost (Rs./ha)	140560	143700	145600
Average selling price of cloves (Rs./kg)	60.00	60.0	60.0
Average gross Income (Rs./ha)	561000	555600	562800
Average net income (Rs./ha)	420440	411900	417200
Benefit:cost ratio (B:C)	3.99	3.87	3.87

How Sikkim farmers are taking interest in adopting garlic cultivation

- Farmers are interested to grow garlic inside low cost poly tunnels and shelters.
- Easily cultivated by farmers.
- Garlic seeds can be stored easily by farmers.
- Garlic is popular as ethno-medicine.
- Garlic is used in making post-harvest products.
- High market price due to organic production.
- Adapted in various altitudes of Sikkim.
- Can be grown under kitchen garden in most of the households.

Problems faced by Sikkim farmers

- Heavy rainfall damage: early onset of rain and late season monsoon.
- Hailstorm damage.
- High yielding variety seed availability.
- Wild animals: Fox, monkey, peacock, wild boar.
- Knowledge about package of practices.
- Insufficiency of organic nutrients.
- Insufficiency of organic pest and disease control.
- High moisture content in bulbs during harvesting and poor storage capacity.
- Less sunshine hours during harvesting.
- Insufficiency of irrigation facilities during dry winter seasons.

Suggestions for better implementation

- Low-cost shelters and poly tunnels.
- Timely high yielding variety seed availability.
- Fencing against wild animals.
- Training and demonstration about organic package of practices.
- Supplementation of concentrated organic nutrients.
- Training on organic pest and disease control.
- Artificial drying and curing facility for High moisture content in bulbs during harvesting and poor storage capacity.
- Provision of irrigation facilities through *Jalkunds* and natural streams during dry winter seasons.

Summary

The production and productivity of garlic in North-eastern states in general and Sikkim in particular are very low compared to many other states. The soil and climatic condition of Sikkim allows farmers for growing garlic at a small and medium scale. Unawareness of farmers about improved varieties, climate, soil and agro-techniques, diseases and pest damaging the crops and their control measures as well as post-harvest management are though main reasons, inadequate market support is also responsible for limiting the production and productivity indirectly. ICAR RC NEH Region, Sikkim centre has popularized the cultivation of two varieties of garlic in the state viz. SG-01 (local garlic) and Bhima Purple from ICAR-DOGR, Pune, Maharashtra. In raised bed and low-cost poly tunnels and shelters garlic can be easily managed. In addition, weed infestation is greatly reduced and clove development is enhanced because of mulching, raised bed thus benefitting the farmers economically. Study has observed that there are possibilities of increasing area and production of garlic in the state of Sikkim.



Cultivation of local garlic varieties at farmers terraces in Sikkim.



Cultivation of garlic in raised beds at farmers field in Sikkim.



Cultivation of garlic in raised beds under low-cost shelters

References

1. Ashish Yadav, A. Y., Avasthe, R. K., & Dutta, S. K. (2018). Sikkim organic horticulture: scope, challenges and prospects. *Progressive Horticulture*, 50(1/2): 82-91
2. Bhattarai, N. K., Deka, T. N., Chhetri, P., Harsha, K. N., & Gupta, U. (2013). Livelihood improvement through sustainable large cardamom cultivation in North Sikkim. *International Journal of Scientific and Research Publications*, 3(5), 1-4.
3. Das, S. K., Dutta, S. K., Bhutia, T. L., Laha, R., & Mishra, V. (2022). Potential of Integrated Organic Farming System (IOFS) Model to Enhances Farmer's Profitability in Sikkim. *Biofoca Research Today*, 4(11), 760-763.
4. Avasthe, R. K., Pradhan, Y., & Bhutia, K. (2014). Handbook of organic crop production in Sikkim. *Sikkim Organic Mission, Govt. of Sikkim and ICAR Research Complex of NEHR, Sikkim Centre, Gangtok*, 161-172.