

Microgreen farming

A new approach for nutrient rich greenfood for remote locations

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Microgreen production is a newfangled approach in green farming in which fresh green vegetable plants in tiny form i.e. 10-15 cm height are cultivated. These plants are consumed raw after harvesting without root, within 10-12 days of sowing. In this approach, certain vegetables seeds are grown in small plastic trays in soilless organic media. The trays are kept inside the mini-modular greenhouse in tier system to utilize the vertical space and to maintain the suitable environmental conditions for growing the plants. These small fresh green plants are rich source of necessary minerals, vitamins and other beneficial phyto-bioactive compounds for health than their counterpart. Self-growing and eating these small green plants can help to manage societal sickness and monotonous state of mind which are quite common in remote locations. Growing these nutritious plants is economical because the study conducted on different vegetable microgreens revealed that an average of 40-50 g yield/tray can be achieved with an average cost of seeds ₹ 6.30/tray. The vegetables like broccoli, red cabbage etc. have more expenditure i.e. about ₹ 32.0/tray as their seeds are costly but vegetables like pink radish, white radish, cabbage, cauliflower, turnip etc. have very low seed cost i.e. about ₹ 0.4 to 1.96/tray.

Key words: Harsh Physiography, Microgreen, Nutrition, Small Plant, Tray

QUANTITY of food is an important contributor to physical and mental well-being. Fresh green edible plants can make food nutritious by providing the essential minerals, vitamins and other phyto-nutrients. Deficiency of any of these may result in health problems. So, there is requirement of fresh vegetables and fruits in human diet. In extremely remote and harsh physiographic conditions, providing the conventional fresh vegetables and fruits all the time is not feasible. Keeping the aspect in view, Defence Institute of High Altitude Research (DIHAR) a constituted laboratory of Defence Research & Development Organization (DRDO) has developed new microgreen farming concept to provide fresh green small edible plants as nutrients rich supplement even to the soldiers at harsh physiographic conditions of

remote locations in Ladakh.

Origin of concept

Strategic concerns necessitate the Armed Forces to operate in extreme high altitude cold arid region over a prolonged period, in far-flung inhospitable terrain under inclement and hostile weather conditions of Ladakh. The harsh environment poses an adverse effect on the normal functioning of the body of soldiers due to low atmospheric pressure, depleted oxygen level, severe cold, high wind velocity, low relative humidity, high solar radiation etc. The physiological effect that soldiers experience in such locations contributes to rapid decline in physical and mental efficiency, and increased fatigue. Quality of food is an important contributor to physical and mental well-being, and thus results in high morale and operational

efficiency, especially in high altitude cold arid physiographic conditions.

In general the Indian Troops prefer and for fresh food as they do not like preserved/processed food much. Use of preserved food items may cause gastric problems, hypoxia, loss of appetite, high water retention, indigestion problems, deficiency of vitamins and minerals etc.

To overcome these complex health problems among the troops in these regions, microgreen technology was developed to fulfill the necessary minerals, vitamins and phyto-nutrients in an easiest way.

Nutritional importance: Phyto-minerals and vitamins

Fresh green plants are rich source of phyto-nutrients and minerals. Research suggests that such food may directly decrease the risk of cancer, diabetes, neurodegenerative diseases

and many other health problems. Vegetables of *Brassica* family which includes broccoli, brussels sprouts, cabbage, kale, red cabbage, knolkhol, mustard *etc.* are rich in minerals (cobalt copper, zinc, selamium), vitamins(K and E) and other phyto-nutrients.

Microgreen Technology

Selection of crops: Vegetable like white radish, pink radish, cabbage, red cabbage, leafy cabbage, mustard, broccoli, bunching fenugreek (*Methi*) have been found suitable for microgreen farming. Plants such as pea, beans, moong bean, cucumber, *etc.*, rich in phyto-nutrients have also evaluated and grown successfully.

Climate: Below 10°C temperature, seeds of different varieties selected for microgreen plant do not germinate. Under low light intensity, seedlings become weak and bended. Low humidity lowers the growth; continuously high humidity may lead to the fungal growth on the growing plant. Therefore, adequate environmental conditions are required to obtain optimum quality and quantity of the small green plants of different varieties. Main climatic requirement for growing of small plants of different varieties as microgreens are-

Temperature: 18-25°C

Light Intensity: 12000-16000 Lux

Humidity: 60-75%

Growing media: The seeds of

vegetables can be grown in mixture of cocopeat, vermiculite, perlite and vermin-compost. The mixture of cocopeat, vermiculite and perlite in 5:2:1 ratio has been found suitable experimentally. The macro and micro nutrients present in this medium released slowly, therefore, same media can be re-used 6-8 times for growing of small green plants, after sterilization.

Seed quality: Since it is a new technology, specific varieties need to be developed. Use of hybrid seeds is not cost effective so they are not recommended and the seeds treated/pelleted by different chemicals are also not suitable for microgreen farming. A number of suitable varieties of untreated seeds like radish mino early, radish Chinese pink, cabbage golden acre, cauliflower maghi, Pusa broccoli, *etc.* were evaluated successfully.

Preparation of trays: The soilless media is filled in the plastic trays of 30 cm length, 24 cm breadth and 7 cm depth were found suitable to grow the small green plants of almost all the varieties. About 4-5 cm thick layer of the media should be filled in a tray (Fig. 1) and 500 g mixture is required for filling up a tray. This media should be wet well before sowing of the seeds. It absorbs almost 1 liter water/tray.

Sowing of seeds: Small sized seeds of crops like cabbage, radish, fenugreek, turnip, *etc.* can be sown in the rows

about 2.0-2.5 cm apart and large seeds such as peas, beans, *etc.* may be sown in the rows made at 3 cm distance (Fig. 1b). The seeds should be sown at proper depth, general small size seeds can be sown at 0.5 cm depth and large size at 1.0-1.5 cm depth. Just after sowing, seeds should be covered by a thin layer of wet media followed by a very light misting of water.

Seed rate and spacing: Seed rate depends on size of the seeds and on germination percentage. For small sized seed crops like cabbage, broccoli, mustard, *etc.* almost 3-4 g/tray seed is sufficient. About 8-10 g seed/tray is required for medium sized seed crops like radish and fenugreek. Almost 25 g for moong bean and 80 g seeds for chickpeas is needed for sowing of one tray. The seeds commercially available in the market have almost 80% germination percentage.

Sowing time: Seeds may be sown at any time as per requirement. Stumps/roots of previous crops should be properly removed from the trays to re-use of the trays. The media should be exposed to sunlight for drying before filling up in the trays. Properly dried growing media can be reused.

After sowing, the trays are kept inside the specially designed microgreen farming unit (Fig. 2) in tier system. To maintain optimum temperature, the structure can be

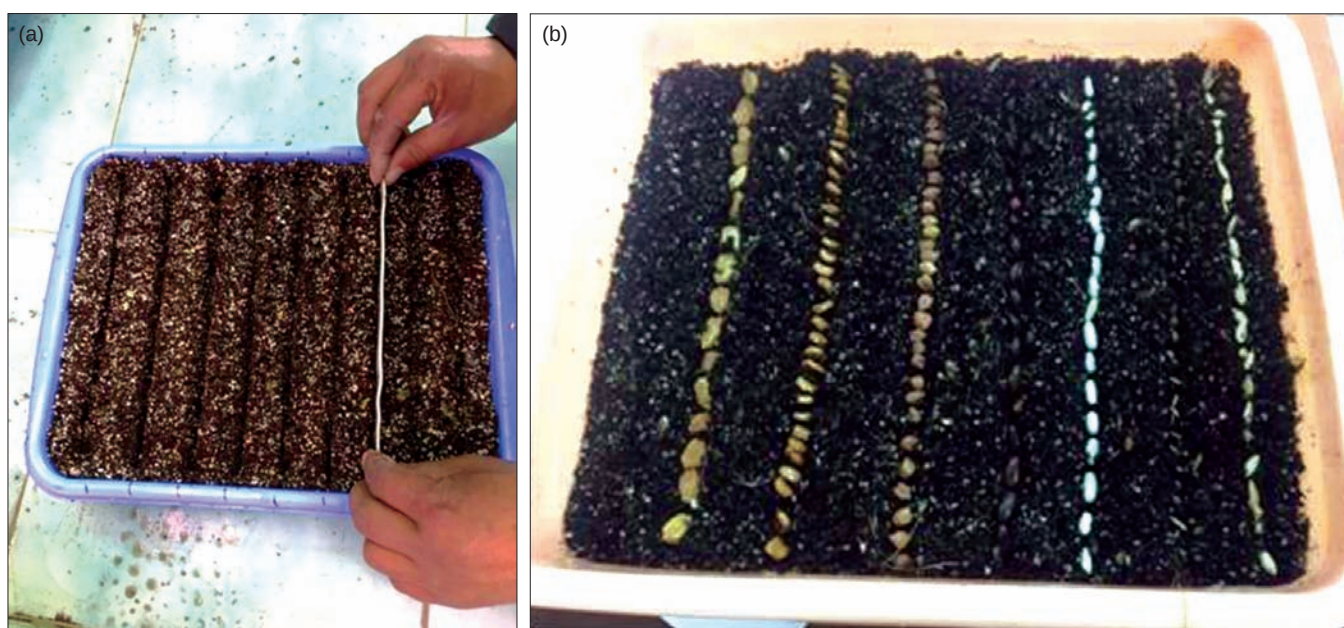


Fig. 1. (a) Preparation of media tray for seed sowing (b) Tray after seed sowing



Fig. 2. Microgreens production unit

kept in living place (room, huts, bunker) or in a mini-modular green house, where temperature, humidity and light intensity can be managed manually.

Modular mini greenhouse

The modular mini-greenhouse for incubation of trays has been designed at the laboratory (DIHAR) to grow the small fresh green edible plants especially for the harsh climatic conditions of remote locations. Vertical space is used in the structure in which the trays are kept in tier system for maximizing the production per unit area. The structure is covered by a transparent plastic/poly-carbonated sheet as cladding material which allows the light to go inside for photosynthesis and heat generation. Window/gate system has been given lengthwise on one side of the unit. The cladding material and window system help to regulate the climatic parameters in manual/passive mode.

Small microgreen farming unit of



Fig. 3. Storage after harvesting

size 1 m length, 0.5 m width and about 1.5 m height made of stainless steel/aluminum framing and shelves may be accommodated in the shelter. Total 30 trays (30 × 24 × 07 cm size of each tray) can be placed at a time on 05 shelves inside the unit, which will be sufficient to provide nutritious fresh plants for 4-6 persons. Warming of the shelter by any heating device is necessary in low temperature conditions.

However, this structure was designed for troops for keeping it inside the bunker where it can be managed easily. The structure can also be modified according to the need of production either for commercial or personal uses.

Irrigation

According to the humidity level, water can be sprayed as per requirement. Misting can also be done when the upper layer of the mixture shows symptoms of dryness. About 50 ml water per tray is required for one time misting. Drinking water should be used for watering the trays.

Growth and harvesting

Based on the variety of vegetable and temperature, germination starts within 2-4 days of sowing. Plants of

some varieties of radish, cabbage, *etc.* get ready for harvest after 8-12 days of optimum environmental conditions. Crop like fenugreek takes 15-20 days to attain optimum size for harvesting. The small plants should be harvested at optimum stage because early harvesting adversely affects the yield and delayed harvesting may deteriorate the nutritional value of the produce. In average ambient conditions; small seed sized crops yield 30-40 g of fresh plants/tray, medium seed sized crops yield 50-60 g/tray and large seed sized crops yield 100-150 g/tray.

Storage and uptake of green plants

After harvesting, green plants are washed gently in clean water. Green plants are to be kept in porous and airy pots to drain out the water properly (Fig. 4). Closed container may deteriorate the quality because of highly perishable food stuff. After that it can be stored at 4°C temperature.

The produce can be consumed whole, as salads or after cutting in small pieces. It can be used for dressing the cooked food like vegetables, dal, chicken, meat, *etc.* It can also be served with dry fruits.

Troop that are posted at remote locations are given dry fruits as



Fig. 4. (a) Freshly harvested radish (b) Ready to eat after washing (c) Serving with dry fruits

Table 1. Growth parameters, yield and economics of microgreen production of few Vegetables

Crop	Test wt./wt. of 1,000 seeds (g)	No. of rows/ tray	No. of seeds/ row	Seed qty. (in g/ tray)	Days taken	Microgreen wt./ tray (g)	Seed cost/ tray (₹)
Radish (White)	14.31	12	78-80	14	08	40.32	1.96
Radish (Pink)	8.54	12	70-80	8.25	09	42.33	1.28
Cabbage	3.83	12	90-100	4.25	14	49.2	3.40
Cauliflower	3.75	12	90-100	4	12	45.7	3.40
Broccoli*	3.45	12	90-100	3.80	12	56.16	32
Knol-khol	3.11	12	90-100	4	11	44.12	7.25
Fenugreek	12.79	12	70-80	12.50	10	54.4	3.6
Turnip	1.52	12	90-100	1.80	08	26.00	0.4
Chickpea	171.24	10	30-35	80	12.5	125	8.05
Moong bean	42.52	10	50-60	25	09	92.16	5.1

*The cost mentioned for broccoli is of hybrid seeds due to unavailability of non hybrid seeds

special ration scale. Blending these dry fruits with fresh green plants may provide them good nutrients package for maintaining their optimum operational efficiency.

Plant disease and bio-safety

Bio-safety is a crucial aspect in microgreen farming as small green plants are eaten raw. As they are grown in moderate care, no severe pathogen attack was observed during the study, but sometimes a white fungal type growth on the media may be seen (Fig. 5) due to excess moisture for long period. Fungus isolated and identified as *Rhizopus* sp., causes plant diseases like seedling rot, seedling blight, damping and soft rot. The disease may influence the quantity and quality of the green plants grown under microgreen farming.

Therefore, certain precautions are helpful to control the fungal growth, such as use of disease free healthy seeds, sterilization of the media and tools by sun drying/autoclave technique, avoid excess moisture during cropping period, removal of all the stumps of the previous crop before re-use of the media, and diseased plants should be removed properly during cultivation. The general sanitation in and around the microgreen growing unit should be maintained. The seeds should not be planted too deep as etiolated seedling

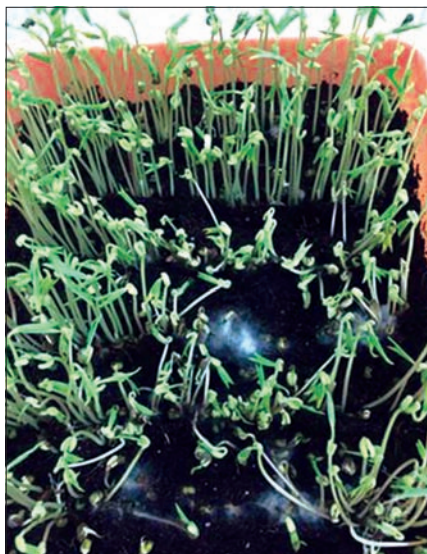


Fig. 5. *Rhizopus* sp. infestation during microgreen production

are highly susceptible to the pathogens.

Economics

Microgreen growing unit with plastic trays may be considered as fixed cost to this farming. The media may be reused up to two years by adding small quantity of organic fertilizers time to time. The seed is main recurring cost for this technology. As hybrid seeds are expensive, their use is not cost effective and it will add only extra bearing cost, so the hybrid and pelleted/chemically treated seeds are not recommended for the microgreen

farming.

In microgreen production, the modular mini greenhouse, trays, media and water spray cost may be considered as fixed cost and the seed cost may be considered as variable cost which depends upon crop and its variety.

The cost of single unit of stainless steel modular mini greenhouse is ₹ 12,800, in which almost 30 trays of size 30 × 24 × 7 cm can be kept in tier system and the cost of one tray is ₹ 60 at average. The 500 g media costs about ₹ 16.25/tray and seed cost/tray is stated in table 1.

Future scope

Overall in terms of economics, nutrition, and commercial production, microgreen farming has a bright future. Although the concept originated mainly for remote locations, it can be easily adopted in household to fulfill the daily nutritional requirements of the family. The module of microgreen production should also be popularized among household, hotel industry, independent restaurants, and localized food hubs to grow their own green salads and nutrition rich quality edible plants.

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Krishi Unnati Yojana

The *Krishi Unnati Yojana*, a central sector scheme, is envisaged as umbrella programme for focusing on food security, by merging schemes on Soil-health Card, Integrated Scheme on Agricultural Co-operation and Agricultural Marketing, National Mission on Agriculture Extension, Horticulture Development, Price Stabilization Fund, National Mission on Sustainable Agriculture and other programmes.