

Off-season leafy coriander production

technology under shade net covered tunnels

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Leafy coriander production during off-season can be a boon for the poor and marginal farmers of the arid and semi-arid regions in the urban and peri-urban areas. Off-season leafy coriander production technology under shade net cover tunnels developed at ICAR-National Research Centre on Seed Spices reveals that 50% black and 90% green shade net covered tunnels gave 162.8 and 167.2 kg/100 m² coriander leaf yields with net returns of ₹ 9,817 and ₹ 9,693 during 2015, whereas during 2016 the yield levels were 101.4 and 106.0 kg/100 m² with net returns of ₹ 7,921 and ₹ 7,984 respectively. In the field demonstration at farmer's field, the technology is proven to yield higher returns and double income in comparison to open conditions.

Keywords: Coriander, High tunnel, Farmer's income, Off-season, Protected cultivation, Shade net, Walk-in tunnel

ARID and semi arid regions of India are known for their harsh climatic conditions especially in peak summers when the temperature shoots up to 47°C in many parts of the country. Main crops of these areas are wheat, mustard, gram and seed spices. All the crops are season based crops but the seed spices especially the coriander can be grown throughout the year for leafy purpose by adopting some protected cultivation technologies. Coriander is a *rabi* (winter) crop in Northern India, but demand for its green leaves is very high in summers with scanty supply, hence growing the coriander in summers (off-season) can fetch extra income to coriander growers. Efforts were made at ICAR-NRCS to enhance the income of farmer through off-season cultivation of Coriander. The shade net covered walk in tunnel technology is affordable and reliable and can help in improving farmer's prosperity in the region. The shade net covered walk in tunnel with 90% shading intensity (100 m² area) gave 167.2 and 106.0 kg leafy coriander yield with net returns of ₹ 9,693 and

₹ 7,984 during 2015 and 2016, respectively, which is 4.7 to 5.7 times higher than the open cultivation. Similar results were recorded for the 50% shade net covered walk in tunnel during off-season.

Coriander is a dual purpose (seed and leaves both), low volume, high value seed spice crop, grown by the poor and marginal farmers of arid and semiarid regions of the country. The green leaves of coriander are a natural source of minerals like calcium, phosphorus and iron as well as vitamin A, C, riboflavin and folic acid and have many antioxidant, anti-diabetic, anti-mutagenic and anti-spasmodic medicinal properties. The herb is also used to treat diseases such as digestive and respiratory disorders, infections of the urinary tract, rinsing of the kidneys etc. Looking to its demand in market, coriander is cultivated throughout the year; it can withstand high temperature to some extent and can be cultivated under ensured irrigation facilities during hot summers using protected structures.

The predominance of high temperature (38-46°C) and bright

sunshine (850-1200 kilolux) with long day length during the summer season is a typical phenomenon in Rajasthan and other parts of northern India. Because of the high incidence of biotic and abiotic stresses, it is very difficult to grow vegetables successfully in the summer season under open field environment. It is well known that extreme climate particularly high temperature with bright sunlight emitting more UV rays in the summer season which is not favourable to coriander plant development and growth resulting in very less or sometimes no yield due to leaf scorching. In harsh climatic conditions and at high temperature during the period of April to September, it is very difficult to grow off-season crops particularly coriander to survive in natural open conditions. High temperature encourage early bolting (flowering) in leafy coriander with stunted growth and pale colour. Hot summer months aren't suitable for coriander, while the demand during the hot season is very high for use as garnishing and flavouring agent in various cuisines. The pre-monsoon

season is, season of many social events and marriages in India and farmers/growers fetch high prices for their produce in the summer season. The prices of leafy coriander during off-season (March- September) are 4 to 5 times higher ranging ₹ 150-200/kg than the *rabi* season leafy coriander (₹ 15-20/kg), sometimes prices may be shoot-up as high as 10 times higher than the normal *rabi* season price due to meager supply and very harsh climatic conditions, low harvest and high demand. Protected cultivation in off-season (summer days) can therefore be a potential alternative for producers to manage natural climatic conditions that can affect coriander germination and leaf quality. Under protected cultivation, significant increases in yield along with enhancement of yield attributing characters are reported compared to open condition. Production of leafy coriander under the shade net covered tunnels has numerous benefits, including minimum use of pesticides, off-season production, delayed bolting, better productive period, superior quality and high earning per unit area. Microclimate regulation enables the production of higher quality produce which are free from insect-pest attack and chemical residue. Therefore, it is utmost necessary to improve the productivity of leafy coriander by adopting intensive cultivation under the shade

net protected cultivation during the summer season. This crop can be easily produced for the purpose of the green leaf by growing under protective structures / shade nets and one can generate more income. Green house, poly house and shade net house are some of the readily available options for the off-season production of the coriander, but these technologies are very costly and a few farmers can afford to adopt the technology due to the high cost and requirement of higher skills and knowledge. Hence, efforts were made at ICAR-NRCSS, Tabiji, Ajmer to overcome the precincts of off-season coriander cultivation. In this regard, shaded net covered walk-in tunnels and high tunnels were built indigenously with available resources, tested and validated through field trials. These structures are easy to install, affordable, user friendly and adopted easily by farmers with existing skills and expertise available with them. Walk-in tunnels and high tunnels are mainly the low cost protected structure prepared from Pre-galvanized (GI) pipe and covered with UV stabilized shade nets for the off-season leafy coriander production. In view of the above, the experiment was performed to optimize the shading intensity and colour of the shade net for production of leaf in the protected situation during most demanding but off-season (summer) for coriander. Green (50, 75 and

90% shading) and black, white and red colour shade net (50% shading) were tested and compared with open cultivation of the leafy coriander. After standardizing the off-season production technology for leafy coriander, the best technique was validated at farmer's field. The shade net covered walk-in tunnels and high-tunnel technology were also demonstrated to farmers at their fields to double farmer's earnings in the summer season for off-season leafy coriander production.

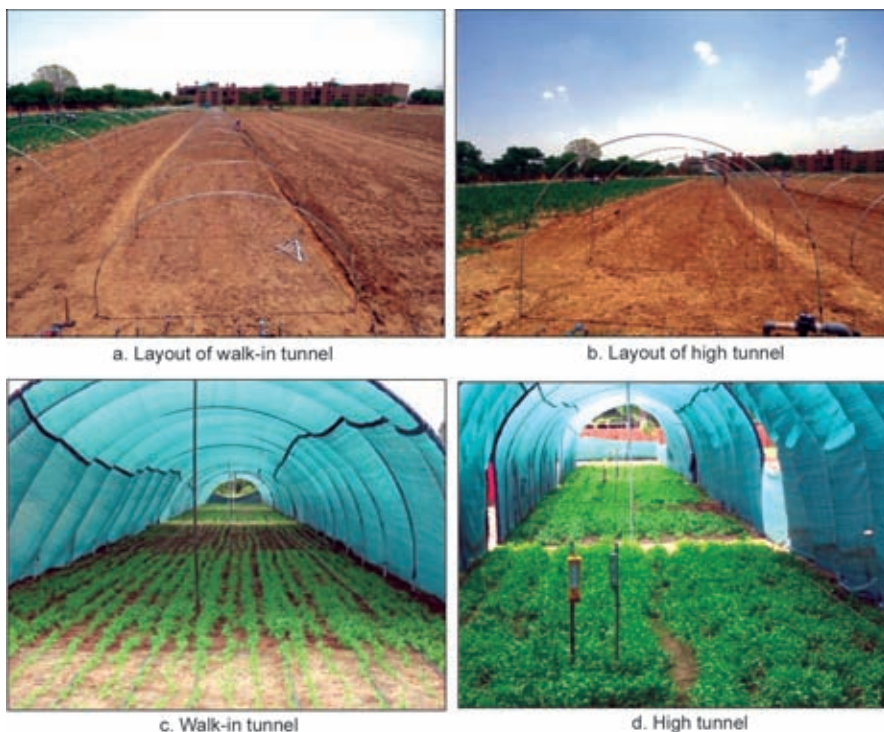
Major challenges to producing leafy coriander during the Off-season

1. Extreme weather is the biggest challenge in arid and semi-arid zones, only certain crops can survive in heat storms and harsh climatic conditions.
2. High radiation levels is a common phenomenon found in the region restricting the establishment of new crops in these areas.
3. Uneven and delayed onset of monsoon rains is one of the biggest challenges in the arid and semi arid regions.
4. The rhizospheric soil of the area is characteristically less productive with very poor organic carbon content (i.e. < 0.2% only) and sandy to sandy loam structure with limited water holding potential.
5. The extreme temperature, poor density of vegetation, higher rate

Table 1. Leafy coriander yield in shade net covered walk in tunnel (kg/100 m²), cost, net returns and B:C ratio during off-season

Treatment	Leafy coriander yield (kg/100 m ²)Annual				Crop cost of tunnel (₹)	Total production cost (₹)	Gross cost (₹)	Net returns (₹)*	% higher returns (₹)	B:C return than open	ratio
	I crop	II crop	III crop	Total							
2015											
90% Green	50.6	57.4	59.2	167.2	3521	961	4482	14175	9693	470	2.2
75% Green	45.9	47.8	46.0	139.8	3084	961	4045	12099	8054	373	2.0
50% Green	42.8	44.0	43.7	130.5	3011	961	3972	11275	7303	329	1.8
50% Black	48.9	56.3	57.7	162.8	3011	961	3972	13789	9817	477	2.5
50% Red	22.8	34.5	32.3	89.7	3084	961	4045	7392	3347	97	0.8
50% White	13.5	40.2	37.8	91.5	3011	961	3972	6986	3014	77	0.8
Open condition	9.3	11.4	10.6	31.3	-	961	961	2662	1701	0	1.8
2016											
90% Green	52.6	53.6	-	106.0	3521	961	4482	12466	7984	574	1.8
75% Green	46.8	45.9	-	92.7	3084	961	4045	10904	6859	479	1.7
50% Green	40.8	39.9	-	80.7	3011	961	3972	9488	5516	366	1.4
50% Black	49.9	51.5	-	101.4	3011	961	3972	11893	7921	569	2.0
50% Red	22.7	33.5	-	56.2	3084	961	4045	6463	2418	104	0.6
50% White	35. 9	38.9	-	74.9	3011	961	3972	8757	4785	304	1.2
Open condition	8.7	9.7	-	18.4	-	961	961	2145	1184	0	1.2

*Sale price of leafy coriander (per kg) I crop, II crop and III crop was ₹ 125, ₹ 80 and ₹ 55 during 2015 and ₹ 130 and ₹ 105 during 2016



(a to d) Different types of tunnels for Off season vegetable/ leafy coriander production

of evapo-transpiration (≥ 25.0 mm/day), high wind speed, and frequent dust storms raises the risk of severe damage to crop.

Existing protected cultivation technology

The different types of protective structures for crop growth vary from basic arrangements such as rain shelters, shade structures, mulches, row covers, low tunnels, high tunnels, naturally ventilated green house and climate regulation greenhouse systems.

Types of tunnels for off season production

In traditional agronomic methods, the crops are cultivated / raised in the open field under natural climatic conditions where the crops are more prone to abrupt changes in environment, due to which the consistency, yield of a particular crop may be affected and may be reduced. Low tunnels, walk-in tunnels and high tunnels are used to provide optimal regulated environments throughout the season, irrespective of the outside natural conditions. These tunnels have variety of advantages and applications, like advancing or delaying of the crops, growing of vegetables, floriculture, planting material for acclimatization. Such

low-cost systems can be dissembled, transported over the entire farm, and work with the land contours.

Walk-in tunnels (WIT): Walk-in tunnel usually made up of GI pipes and covering material used is polythene/ shade net, usually semi-circular from top, square or elongated in shape. WT are lower in height (6-7' from centre) compared to high tunnels (10-12' from centre). Owing to better sunlight and ventilation, walk-in tunnels have higher yields than low tunnels. The tunnel is most preferable to grow high value vegetables and spices. If the covering material is poly sheet during winters, the inside area warms up because of heat penetration by solar radiation. During off-season (summer), shade net of different shading intensities is used as the covering material to eliminate harsh effects of direct sunlight, UV and high temperature. In these tunnels, temperature, humidity and ventilation can be controlled by keeping the end walls open fully or partially as per need. Walk-in tunnels can be used to provide a higher/low temperature and/or humidity than that which is available in the environment but can also protect crops from intense heat, bright sunlight, winds, hailstones, and cold and hot waves.

High tunnels (HT): The high tunnel is a walk-in, hoop or gothic-shaped, pipe frame structure covered with UV stabilized plastic film (in winter) and with a shade net (in summer). High tunnels are simple greenhouse-like structures, without the greenhouse's extensive heating and cooling systems. Primarily they rely on natural solar heating and ventilation. Galvanized iron pipes (GI pipes) are the standard material used for posts and hoops. Posts are driven into the ground about 0.5 m deep to support the hoops. The ground posts are sometimes extended 0.5 to 1.0 m above ground, to get a higher ridge and better ventilation depending on the season and crop. Open ends of the tunnel should be wide enough to allow a small tractor to reach in the tunnel for field preparation and other agronomic operations. Keeping open end walls as open doors facilitate the ventilation which is more crucial during off season due to high temperature.

Materials needed for shade net covered walk-in and high tunnels

To cover 100 m² area, for walk-in tunnels, 22 pieces of 0.6 m length GI pipe of 3/4" OD are required to make posts for side wall of the tunnels. For high tunnels, the height of these pieces for side walls should be 1.5 m eleven pieces of GI pipes of 1/2" OD with 6.0 m length are required to be bended in semi circle shape for raising the hoops on the post. To give stability to the tunnel, two pieces of GI pipes of 1/2" OD with 3.5 m length for walk-in tunnels and 4.5 m length for high tunnels are also required. One end of these pipes needed to be weld with 1.0" U shaped MS (mild steel) strip to grid the end wall pipes of the hoops and give extra support and stability to the end wall hoops. Shade nets are available in many colours and have different shading intensities ranging from 25% to 90%, may vary crop to crop and season to season.

Steps for installation of shade net covered walk in tunnels and high tunnels

1. Site selection and land preparation

- and layout of the area.
2. Drive in ground posts/ holes in soil using hammer and rebar
3. Installation of ground posts (side wall) with GI pipes and raising hoops.
4. Trench digging
5. Shade net attachment

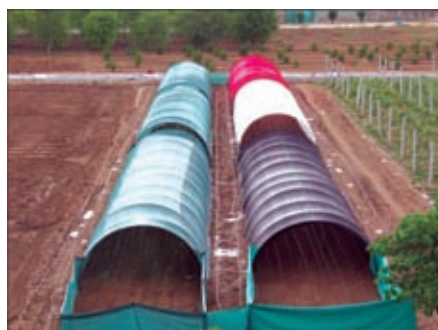
Agronomical practices for the off-season leafy coriander production

Delayed (late) bolting variety like AGCr-1, having faster growth and profuse biomass production habit is advisable for off-season leafy coriander production. Higher seed rate (500 g/100 m² area) is recommended which facilitate more number of plants per unit area resulting competition within the plants to boost growth and height.

Before sowing, split the seed in two halved then treat with 1.0 g bavistan. Broadcast the seed uniformly and mix it in the soil for faster germination. For the off-season production, coriander is sown from late March until early September. To achieve a constant supply of leaves throughout the summer, batch sowing in small amount is more profitable.

For irrigation, install the 10 drip lines at 0.3 m spacing with drippers at 0.3 m interval with 2.1 litre/hr water discharge rate. After sowing, operate the drip irrigation till the full area gets saturated with the moisture. Four days interval irrigation for 1/2 hour is required after germination. In addition, 2.0-2.5 kg/m² well decomposed farmyard manure, inorganic fertilizer were applied following standard management practices. Nitrogen, phosphorus and potassium at the rate 6:4:2 kg/100 m² were also applied with one third of nitrogen along with full doses of phosphorus and potassium as basal and rest nitrogen was top dressed twice at fortnight interval after plant establishment.

Thrips incidence was observed at



e. Different coloured shade net covered tunnels



f. Field operation under high tunnels



g. Crop view under different colored shade net covered walk-in tunnels



h. Green shade net covered walk-in tunnels at farmers field

Off season leafy coriander production under different coloured shade net and shading intensity covered walk-in and high tunnels

early stage of the crop which can be controlled by need based spray. The crop is ready for harvest before bolting, within 50-55 days after sowing, if the plant harvested by uprooting, one cycle of the crop will take 50-55 days. If harvested by cuttings, crop will ready to harvest in 25-30 days after first cutting. To enhance the keeping quality, uprooting is more advantageous than cutting. The market rate (price) of leafy coriander shoots maximum during May to June, hence planning should be done accordingly.

Standardization of different colour shade nets: Experiments were conducted at ICAR-NRCSS farm, Ajmer and field demonstrations were conducted at nearby farmer's fields to overcome the limitations of off-season cultivation of coriander through scientific and agronomical interventions. Application of green colour shade net with 90% shading intensity or black colour shade net with 50% shading intensity were

equally effective for higher leafy coriander biomass production. Cumulative yield of three cycles of crop produced was 167.2, 162.8, 139.8 kg/100 m² biomass of green leafy coriander under 90% Green, 50% Black and 75% Green shade net which is 5 to 6 times higher than the yields of open condition (31.3 kg/100 m²) during off season of 2015, same trend was observed in 2016 too. Maximum BC ratio (2.5 and 2.0) and net returns (₹ 9817 and ₹ 7921) were recorded with 50% Black shade net, during 2015 and 2016 respectively, followed by 90% Green shade net covered walk-in tunnel with minimal margins. If compared to open/natural conditions, the yield and net returns were 4.7 to 5.7 times more with off-season shade net covered walk in tunnel covered with 50% black or 90% green shade net followed by 75 to 50% green nets.

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