STANDARDIZATION OF PACKAGE OF PRACTICES FOR LEAF CORIANDER (*Coriandrum sativum* L.) UNDER RAIN SHELTER

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(2018-12-030)

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THESIS

Submitted in partial fulfillment of the requirement for the degree of

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DEPARTMENT OF PLANTATION CROPS AND SPICES

COLLEGE OF HORTICULTURE

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THRISSUR – 680656 KERALA, INDIA

2020

DECLARATION

I, **Anjukrishna V. U. (2018-12-030)** hereby declare that this thesis entitled **Standardization of package of practices for leaf coriander (*Coriandrum sativum* L.) under rain shelter** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Anjukrishna V. U.
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Date: 16.09.2020

CERTIFICATE

Certified that this thesis entitled **Standardization of package of practices for leaf coriander (*Coriandrum sativum* L.) under rain shelter** is a record of research work done independently by **Mrs. Anjukrishna V. U. (2018-12-030)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

16/09/2020

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Date: 16.09.2020

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We, the undersigned members of the advisory committee of **Mrs. Anjukrishna V. U. (2018-12-030)**, a candidate for the degree of Master of Science in Horticulture with major field in Plantation Crops and Spices, agree that the thesis entitled **Standardization of package of practices for leaf coriander (*Coriandrum sativum* L.) under rain shelter** may be submitted by **Mrs. Anjukrishna V. U. (2018-12-030)**, in partial fulfillment of the requirement for the degree.

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Anjukrishna V. V.

Dedicated to my dear parents and my guide Dr. N. Mini Raj

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ABBREVIATIONS

MT	- metric ton
PGRs	- Plant Growth Reglators
GA_3	- gibberellic acid
NAA	- naphthalene acetic acid
$ml\ L^{-1}$	- milli litre per litre
$g\ L^{-1}$	- gram per litre
M	- molar
cm	- centimeter
$kg\ ha^{-1}$	- kilogram per hectare
kg	- kilogram
$t\ ha^{-1}$	- ton per hectare
%	- percentage
m^2	- meter square
h	- hours
$mg\ g^{-1}$	- milligram per gram
mg/100g	- milligram per 100 g
$mg\ kg^{-1}$	- milligram per kilogram
$g\ m^{-2}$	- gram per meter square
NaCl	- Sodium Chloride
N	- Nitrogen
P	- Phosphorous
K	- Potassium
P_2O_5	- Phosphorous Pentoxide
NPK	- nitrogen- Phosphorous- Potassium

Introduction

1. INTRODUCTION

Coriander (*Coriandrum sativum* L.) is one of the world's oldest spices whose use history traces back to 5000 BC. The word coriander is derived from a Greek word, *Korios* which means bed bug, because of the nasty smell of the immature green fruit. In many dishes the word is known for the dried seeds rather than to the whole plant and it is an inevitable seed and herbal spice in all cuisines world over. Coriander is a member of carrot family Apiaceae or Umbelliferae and is indigenous to Southern Europe and Mediterranean region. It is commonly known as *Dhania* in Hindi, *Kothamalli* in Tamil and *Malli* in Malayalam.

Coriander leaf is an important herbal spice. The widely accepted name of coriander leaves is *Cilantro*, a Spanish word. The immature coriander leaves are also called as Chinese Parsley. Fresh leaves are an important ingredient in Indian, Chinese and Thai dishes. The taste and flavour of leaves entirely differ from seeds as it has citrus overtones. The chemical constituents present in the leaves are responsible for its typical flavour and aroma.

Coriander leaves display an impressive nutritional profile, as it is high in proteins and dietary fibres, with negligible cholesterol and saturated fats. Besides, they are rich sources of vitamins and minerals like vitamin A, vitamin C, vitamin E, Zinc, Calcium, Magnesium, Iron and Phosphorus. Besides, the leaves also possess powerful antioxidants like carotenoids, flavonoids and anthocyanin which promote the anti-inflammatory and anti-microbial functions. Being a good source of antioxidants, coriander prevents the spoilage of cooked food.

Besides nutritional benefits, coriander is well known for its health benefits and medicinal properties too. It has got antimicrobial, antifungal, antioxidant, anti-hyperglycemic, anti-anthelmintic, diuretic, anti- anxiety, and metal detoxification properties.

Coriander cultivation is mainly concentrated in the tropics and sub tropics with remarkable cultivated area in Argentina, Myanmar, Spain, Turkey, Russia, Romania, France, Italy, Holland, Yugoslavia, and Mexico and to some extent in England and USA. India is largest producer of coriander seeds with 6, 26,547 ha area of and 7, 55,740 MT of production (DASD, 2020). It is mainly cultivated in Rajasthan, Madhya Pradesh, Andhra Pradesh, Gujarat, Tamil Nadu, and Karnataka.

Though coriander can be cultivated throughout the year, the demand for coriander leaves is high during summer. Production as well as quality of the produce highly depends on the seasonal variations. June - December is the best season for better grain yield in South Indian states, but for leaf purpose, it requires shade during hot periods.

Unlike its neighbours, Kerala takes lot of pride in its long list of spicy food that the state has to offer to its perpetually hungry tourists. Coriander is a demanded herbal as well as seed spice in Kerala cuisine. Though it is not a commercially cultivated crop, scattered cultivation for leaf purpose is seen in Wayanad and Idukki districts of Kerala. Even though coriander is a short duration spice crop, difficulty in year-round production is a limiting factor for the cultivation. In order to meet the daily requirements of consumers, possible avenues of its year-round production should be ensured.

Kerala is a high rainfall state with diverse agro climatic conditions. High rainfall and high relative humidity result in biotic stresses which inhibit the growth of herbal spices like coriander. Hence, protected cultivation will be the solution for this problem. The concept of rain shelter, the naturally ventilated polyhouse, will be ideal for the herbal spice production in Kerala.

Preliminary research conducted in the Department, on coriander for leaf purpose has identified few varieties suitable for Kerala conditions. But its cultivation methods have not been standardized. Therefore, the present study entitled "Standardization of package of practices for leaf coriander (*Coriandrum sativum* L.) under rain shelter" was undertaken. The study was carried out with the objectives of standardizing seed treatment, spacing, manurial schedule and harvest maturity of the crop under rain shelter during *rabi* season.

Review of literature

2. REVIEW OF LITERATURE

Herbal spices are integral ingredients in almost all cuisines world over. Coriander is an important seed as well as herbal spice crop known to mankind. In India, coriander cultivation is mainly confined to the states of Rajasthan, Madhya Pradesh and Andhra Pradesh. Young leaves as well as seeds have inexorable use in flavouring of different foods. Production technology or package of practices of coriander varies with the agro climatic conditions and a well outlined production practices improves its yield and quality.

The present study entitled **Standardization of package of practices for leaf coriander (*Coriandrum sativum* L.) under rain shelter** was carried out during two seasons of sowing *i.e.*, July – September and October – December with two varieties in order to evaluate the response of two varieties to different seed treatments, spacing, fertilizer application and harvest maturity in terms of yield and quality of leaves. The available literature related to these aspects have been included in this chapter. Literature on grain coriander, leaf coriander and related herbal spices are included under various sub heads.

2.1. EFFECT OF TIME OF SOWING ON GROWTH AND YIELD

All crops give maximum yield when grown under favourable season. Coriander can be grown throughout the year. But the leaf and grain yield are highly dependent on the growing conditions. Season of sowing plays a vital role in growth of coriander.

Manmadhan (1999) conducted studies on the performance of coriander in summer season under different shade levels and different sowing dates during March – May. The study revealed that maximum plant growth was recorded during May sowing whereas least was reported in April sowing.

A field trial conducted to evaluate the influence of time of sowing on performance of coriander plant in semi-arid Mediterranean climatic conditions reported that early December is the suitable sowing time for coriander in Mediterranean region and similar areas (Carrubba *et al*., 2006). They also suggested that sowing in early December helps to utilize the natural rainfall and perpetuate the vegetative phase and so maximum yield can be retrieved.

Ghobadi and Ghobadi (2010) conducted an experiment in Iran to evaluate the effect of four different times of sowing and plant densities on yield and yield components of coriander and recorded that 4th June sowing yielded highest grain yield.

Gujarat Coriander -2 is a suitable variety for leaf purpose when it is sown during third week of June (22nd June) in open field conditions, whereas sowing during first week of June resulted in lowest green yield. Date of sowing did not affect the chlorophyll content of leaves (Ragavbhai, 2011).

An experiment was conducted by Ghobadi and Ghobadi (2012) to find out the effect of late sowing on quality of coriander. The study was carried out in late spring (May and June) with four different sowing dates and plant densities which revealed that on late sowing seed and oil yield increased.

Randhawa and Singh (1991) cited by Nagpure (2013) stated that highest herbage yield, dry matter yield and oil yield was obtained when dill seeds were sown on 30th September.

Different dates of sowing tried in CO (Cr)-4 revealed that sowing of seeds on 15th October produced plants with maximum plant height at 30 days after sowing, flowering and at harvest. Likewise, highest number of primary and secondary branches were recorded in seeds sown on 15th October, whereas, highest essential oil percentage was recorded in plants sown on 1st October (Farooq, 2013).

Sharangi and Roychowdhury (2014) pointed out the effect of time of sowing and irrigation on phenology and yield of coriander. The study showed that time of sowing and irrigation had significant effect on growth and yield of coriander. Maximum seed and oil yield were recorded in early sown coriander.

Raj (2017) conducted studies on five coriander varieties to evaluate their performance during different times of sowing under different growing conditions. The study revealed that crop grown during July- September recorded highest number of leaves at harvest.

Namdev (2017) reported that sowing of coriander seeds during fourth week of June significantly increased the growth and yield of the plant such as maximum length of umbel, average weight of umbel $plant^{-1}$, seed yield $plant^{-1}$ in comparison to other sowing dates. Minimum plant height was observed when seeds were sown during first week of August.

A field trial conducted by Khali (2007) in fenugreek to evaluate the response of sowing time on growth and yield revealed that, crop sown in second week of March (11^{th} March) recorded higher values for growth parameters *viz*., plant height, plant spread, number of trifoliate leaves per plant and yield attributes.

The field trial conducted by Gawtham (2018) revealed that October sown coriander crop performed better and recorded high leaf area, leaf area index and chlorophyll content.

2.2. EFFECT OF GROWING CONDITIONS ON GROWTH, YIELD AND QUALITY

Climate plays a vital role in the quality and yield of seed as well as herb in coriander. Cultivation before or after its normal season is possible in coriander and off season production increases the demand of the crop.

Manmadhan (1999) conducted an experiment which involved five shade treatments with an unshaded control and three sowing dates *viz*., 1^{st} March, 1^{st} April and 1^{st} May. Growth parameters with respect to plant height, plant spread and leaf area recorded highest values under 50 per cent shade whereas least was recorded in polyhouse and unshaded control.

Ramaji (2011) conducted field trial on the influence of growing conditions on leafy vegetables during summer season and recommended that coriander and fenugreek grown under 75 per cent shade net was the best which gave maximum growth attributes. Maximum net return and benefit cost ratio was also obtained from fenugreek and coriander grown under 75 per cent shade.

Guha *et al.* (2013) reported the possibilities of protected cultivation of coriander in summer days which helped the farmers as an alternate method to control the external climatic factors which may affect the germination and yield.

Studies conducted by Rajasekar, *et al*. (2013) to evaluate the influence of weather and growing environments on vegetable growth and yield found that relative humidity was higher and light intensity was minimum inside the shade nets in winter and summer season. The results indicated that growing of coriander and other vegetables in shade nets will be more profitable irrespective of the season.

A fertilizer trial of off season coriander with five nitrogen doses under 50 per cent shade showed that nitrogen doses and shade level had significant role in green leaf yield in the arid and semi-arid conditions of Rajasthan (Lal *et al*., 2016).

Prakash (2018) investigated the influence of growing conditions on growth and yield of leafy vegetables and suggested that growing conditions had significant influence on all growth parameters of leafy vegetables such as amaranthus, beet leaf, coriander and fenugreek. The plants responded very well in polyhouse conditions compared to open filed. Among leafy vegetables, amaranthus showed better performance in all growth and yield parameters such as plant height, number of branches, number of leaves, fresh weight of the plants, fresh weight of the shoot, fresh weight of the root and yield per plot. Higher vitamin C content, maximum shelf life and less physiological loss in weight was observed in coriander.

Leaf area, leaf area index and total chlorophyll content were significantly higher in coriander grown under shade net when compared to open cultivation. Biochemical traits like iron content and calcium was also higher under shade net (Gawtham, 2018).

2.3. EFFECT OF SEED TREATMENTS ON GROWTH, YIELD AND QUALITY

Seed treatment plays a crucial role in enhancing germination, growth and yield. Plant growth regulators have various uses in spices especially in seed germination, fruit set, size manipulation of fruits and enhanced production. Seed treatment with plant growth regulators is one of the most popular methods that can be effectively used as a tool for improving the crop health.

Mishriky (1990) found that application of GA_3 at 20 or 50 mg L^{-1} in celery plants increased the plant height, plant weight, weight of petioles per plant, weight of leaves per plant and petiole weight to whole plant weight ratio.

Studies on effect of different plant growth regulators and their mode of application on growth, yield and quality of cv. Rcr-435 of coriander reported that soaking and spraying of 50 mg L^{-1} GA_3 yielded maximum plant height, number of green leaves per plant, number of branches per plant, number of umbels and umbellates per plant, biological yield, seed yield and harvest index. Maximum chlorophyll content and carotenoid content in leaves was observed in 50 ppm NAA applied through soaking and spraying whereas maximum essential oil yield was yielded in 25 mg L^{-1}NAA applied as soaking and spraying treatment (Verma, 2002).

All morphological characters of coriander such as plant height, number of leaves per plant, number of umbels per plant, number of primary and secondary branches per plant significantly increased with the increase in gibberellic acid concentration. But morphological characters were negatively impacted with the increase in level of ethrel (Panda *et al*., 2007).

Sharada *et al*. (2008) conducted an experiment to study the effect of growth regulators and their time of application on growth and yield of coriander. The study revealed that 1 ml L^{-1} triacontanol showed maximum plant height, more number of branches per plant and more number of umbellates per umbel, while, application of 10ppm Naphthalene Acetic Acid (NAA) increased seed yield and crop duration.

Hydro priming is one of the easiest and cheapest, non-chemical, harmless method which can be adopted for enhancing seed germination and vigour of aged coriander seeds (Rithichai *et al*., 2009). Fast germination and highest germination percentage was observed in hydro primed seeds than non-primed seeds.

Seed priming is an efficient method to overcome germination of coriander seed under salinity conditions. The substances used for priming and duration of priming are important. The germination percentage of primed seeds, under salinity stress was improved comparing to unprimed seeds and osmopriming with NaCl 4g L^{-1} was found to be the best osmopriming condition for improving the mean germination percentage in coriander cultivars (Fredj *et al*., 2013).

Seed priming of coriander seeds with aerated solutions of 0.13 M NaCl and $CaCl_2$ for 24 h was found to improve the emergence, growth and mineral parameters of coriander seedlings grown under salinity conditions (Aymen and Cheriff, 2013).

Shanu *et al*. (2013) reported that presoaking of coriander seeds in 1000 mg L^{-1} of thiourea for 4 hours followed by foliar spray at vegetative and flowering stage recorded higher plant height at 90 DAS, branches per plant, fresh weight and dry weight of leaves at 45 and 90 DAS. Application of thiourea significantly increased the seed yield parameters like umbels per plant and umbellates per plant. Application of thiourea resulted in enhanced photosynthetic efficiency, delaying leaf age and senescence.

Fenugreek seeds treated with *Trichoderma viride* gave earliest germination, highest plant height, number of branches per plant and number of leaves per plant at harvest. Maximum number of pods per plant, number of seeds per pod, highest test weight of seed, highest seed yield per plant and seed yield per hectare were recorded in seeds treated with *Trichoderma viride* being on par with the seeds treated with bavistin (Lal *et al*., 2013).

A field trial conducted by Ogbuehi *et al.* (2013) to assess performance of groundnut by hydro priming of seed for different durations revealed that 24 hours hydro priming gave highest percentage emergence, plant height, leaf area and number of leaves.

Mahajan *et al*. (2013) suggested that cumin seeds treated with *Trichoderma harzianum*, *Aspergillus versicolor*, carbendazim and captan performed well in field conditions with higher seed germination, higher plant survival, lower number of plants with cumin wilt infection and blight as compared to all other treatments and control.

Haokip *et al.* (2016) suggested that among different plant growth regulators, GA_3 50 ppm increased plant height, number of primary and secondary branches per plant, number of umbels per plant, number of umbellates per umbel, seed yield, oleoresin and essential oil and minimum number of days to 50 per cent flowering in coriander than all other treatments.

Bano *et al.* (2016) suggested that phytohormone plays an important role in growth and development of aromatic plants. It can also control the primary and secondary metabolites present in the aromatic plants.

Field trial on evaluation of the impact of pre- soaking and foliar application of plant growth regulators on growth and yield of coriander conducted by Yugandhar *et al*. (2017) reported that maximum percentage of germination was recorded with presoaking in 75 mg $L^{-1}GA_3$. Higher concentrations of both cycocel 250 mg L^{-1} and 75 mg $L^{-1}GA_3$ significantly influenced the growth and yield parameters.

Seed soaking and spraying at leaf stage were found to be the right combination of gibberellic acid application to improve the biological yield of coriander whereas, seed soaking followed by spraying at leaf stage and 50 per cent flowering stage yielded good quality coriander seeds (Kumar, 2017).

Nguyen *et al*. (2019) suggested that use of plant growth regulators is one efficient solution of improving the yield of sugar cane and sugar content. They also found that application of 150 mg L^{-1} GA_3 increased the yield by 19.94 per cent and sugar content by 2.21 per cent.

2.4. EFFECT OF SPACING ON GROWTH, YIELD AND QUALITY

Crop spacing is about number of plants per unit area. Spacing can be defined as the distance between one plant to another plant or one row to another row. Overfilling of plants in unit area cause competition between plants for light, nutrients and water which leads to reduction in terms of yield and quality. In coriander also, the plants should be well spaced to maximize the herb yield.

Plant height, number of compound umbels per plant and seed yield increased as the distance between the plants increased whereas, medium spaced plants produced higher seed yield per acre, as reported by El-Gengaihi and Abdallah (1978).

Sharma and Prasad (1990) conducted a study with bold and small seeded fennel cultivars with three row spacing and three seed rates. The highest yield was recorded in bold seeded cultivars with row spacing 30 cm and sowing rate of 40 kg ha^{-1}.

Narayan (1994) found that row spacing of 20 cm decreased weed dry matter content compared to the crop raised with row spacing of 40 cm, in coriander. But yield parameters such as plant height, number of branches, seed weight $plant^{-1}$ and harvest index were best in 40 cm row spacing.

In *Anethum graveolans* L, Randhawa *et al.* (1996) reported that seed yield decreased with increase in row spacing. Closer spacing with 30 and 45 cm gave maximum seed yield than wider row spacing with 60 cm whereas, a closer spacing of 10 cm between plants gave maximum yield than wider spacing.

Ahmad *et al.* (2004) evaluated the effect of different sowing seasons and row spacing on seed production of fennel and concluded that a row spacing of 40 cm recorded maximum morphological characters like plant height, seed weight per umbel, and seed yield whereas, minimum yield was recorded in 70 cm spacing. Significantly higher seed yield was obtained from Autumn sown plant with row spacing of 40 cm.

Kumar *et al*. (2007) reported the effect of closer spacing (20 x 20 cm) with a combination of nitrogen dose (80 kg ha^{-1}) on plant height in coriander. Seed yield per ha was maximum under 30 x 20 cm spacing when applied with 80 kg ha^{-1} N. According to Pawar *et al.* (2007) a spacing of 30 x 10 cm gave maximum plant height and yield per hectare in coriander while, a spacing of 30 x 20 cm yielded highest number of leaves per plant, number of primary branches per plant, number of secondary branches and fresh weight of the plant.

Vasmate *et al*. (2008) studied the effect of spacing and organic manure on seed yield of coriander during *rabi* season. Among different spacing treatments, 30 x 20 cm resulted in maximum number of leaves per plant, height of the plant, number of umbels per plant and number of umbellates per plant while, number of seeds per umbellate, test weight , germination percentage and maximum seed yield were recorded in spacing of 30 x 10 cm.

Nath *et al*. (2008) conducted a field experiment with three sowing dates, four levels of nitrogen and three spacings in coriander. Wider spacing of 30 x 20 cm and 30 x 30 cm were found to be acceptable in all characters except seed yield which was higher at a closer spacing of 30 x 10 cm.

Sowing of dill seeds at 50 x 10cm could increase seed yield by 42.65 per cent compared to the yield obtained in 40 x 10 cm spacing (Umesh *et al*., 2016).

Planting density had significant effect on the quality of essential oil extracted from fennel seed (Khorshidi *et al*., 2009). The highest essential oil was obtained in low density planting. Highest percentage of anethole was recorded in the 40 x 25 cm spacing.

A combination of 40 x 10 cm spacing with 75 kg ha^{-1} of phosphorous and without cutting leaves in coriander resulted in maximum seed yield which was on par with the treatment combination of 40 x 10 cm spacing with 50 kg ha^{-1} phosphorous without leaf cutting. Maximum green leaf yield was observed in the treatment combination of 75 kg ha^{-1} phosphorous with 20 x 20 cm spacing and cutting of leaves at 30^{th} and 50^{th} day after sowing (Nandal *et al*.,2010).

Nejad (2011) conducted a field trial to determine the effect of planting dates and row spacings on yield of dry land and irrigated cumin (*Cuminum cyminum* L.) and reported that seed yield and essential oil was inversely proportional to the row spacing. Maximum seed yield and essential oil yield were obtained in two irrigations adopted with 20 cm spacing.

A trial of coriander to find out the response of row spacing and phosphorus indicated that maximum number of umbels per plant and 1000 seed weight were obtained in 45 kg ha^{-1} phosphorus at 45 cm spacing whereas, maximum seed yield was obtained when 45 kg ha^{-1} phosphorus was applied at a row spacing of 25 cm (Jan *et al*., 2011).

Fruit yield of fennel was significantly influenced by the plant spacing, planting date and their interaction (Al-Dalain *et al*., 2012). Early planting significantly recorded high fruit yield with highest number of branches per plant and number umbels per plant. Early planting with 30 cm plant spacing was found to be acceptable in fennel for biological yield and higher fruit set.

Naruka *et al*. (2012) evaluated the influence of spacing and nitrogen levels on growth, yield and quality of ajwain and documented that wider spacing of 45 x 30 cm significantly increased primary and secondary branches, fresh weight per plant at harvest and number of umbellates per plant. Quality determining factors *viz*., chlorophyll and carotenoid content of leaves and essential oil of seed were also maximum under 45 x 30 cm spacing, whereas plant height, biological yield per ha and seed yield per hectare were maximum in 45 x 10 cm spacing.

Sowing of fennel seeds during the first week of October (October 7) at 50 cm spacing and spraying of yeast 5 g L^{-1} resulted in high vegetative growth and seed yield plant^{-1} whereas, oil yield was maximum in plants sown in first week of October at 35 cm spacing and spraying of active dry yeast at the rate of 5 g L^{-1} (Selim *et al*., 2013).

An experiment conducted by Farooq (2013) to evaluate the effect of row spacing in coriander indicated that among different row spacings adopted in CO (Cr)-4 variety, 15 x 15 cm spacing recorded significantly highest plant height at 30 days after sowing, flowering and at harvest. Row spacing of 30 x 15 cm recorded higher number of primary and secondary branches at 30 days after sowing and at harvest. Maximum number of leaves per plant at 30 days after sowing, at flowering and at harvest was recorded in 22.5 x 15 cm spacing.

According to Rana *et al*., (2015), row spacing at 45 cm recorded incomparably higher leaf yield than spacing at 30 cm and 60 cm in fenugreek. While wider spacing at 60 cm showed higher test weight of leaves than lower spacings. A combination of spacing at 45 cm and one leaf cutting at 60 days after sowing yielded maximum seed yield per hectare. The same row spacing of 45 cm was suitable for cumin which led to higher seed yield per hectare (Singh and Amin, 2015). A spacing of 45 x 30 cm significantly increased plant height, fresh weight per plant, dry weight per plant, seed yield, straw yield, chlorophyll content and carotenoid content in ajwain (Muvel *et al*., 2015).

Plant height and yield attributing characters like seed yield increased when fenugreek plants were sown at a spacing of 30 x 10 cm whereas, number of trifoliate leaves, number of pods and plant spread were found higher in a spacing of 30 x 30 cm (Khali, 2017).

A field trail in coriander with five nitrogen doses and three row spacing by Diwan Maida (2018) concluded that among three different row spacings, 50 x 10 cm recorded the highest growth characters *viz*., number of branches, total biomass production of the plant on dry weight basis (g), days taken to 50 per cent flowering, days taken to maturity and yield attributes *viz*., umbels per plant, umbellets per plant, seeds per umbel and test weight (g). Maximum seed yield per hectare was recorded in 30 x10 cm spacing with 90 kg ha^{-1} nitrogen.

Parameters such as plant height, number of umbels per plant, fresh weight of plants and dry weight of plants decreased with denser plant population in fennel (Jakhar *et al*., 2019).

2.5. EFFECT OF FERTILIZER ON GROWTH, YIELD AND QUALITY

For sustainable yield and quality, crop must be provided with nutrients for the growth and metabolism. Fertilizers are the natural or manufactured substances applied to the soil, or plant tissues for improving the growth and yield. Soil nutrient management is a crucial factor to maintain constant production as well as the health of the soil.

Rao *et al.* (1983) conducted studies on fertilizer application in coriander and reported that application of nitrogen increased the plant height and oil yield without affecting the quality of oil. The response of plant to both 50 kg and 100 kg N application did not vary significantly.

According to Bhati (1990), application of nitrogen at the rate of 30 kg ha^{-1} significantly increased the number of umbels per plant, biological yield, seed yield, net profit and benefit cost ratio in cumin. Application of nitrogen as top dressing 30 days after sowing recorded higher number of umbels per plant, biological yield, seed yield and benefit cost ratio compared with basal application. Application of phosphorus increased number of umbellates per umbel, seed yield, and 1000 seed weight when compared with no phosphorus application.

A field trial was undertaken to study the response of three cultivars of coriander *viz.*, Sakaleshpur Local, Bulgarian and Rc-41 to different levels of vermicompost in comparison with inorganic fertilizers which indicated that application of vermicompost significantly increased the herbage yield and seed yield which was comparable to inorganic fertilizers (Vadiraj *et al*., 1998). Herbage yield recorded highest value in Rc-41 at 60 days after sowing when 15 t ha^{-1} vermicompost was applied whereas seed yield was maximum in plants treated with 20 t ha^{-1} vermicompost.

The study conducted by Kumar (2000) revealed that there was significant increase in plant height and crop dry matter accumulation with the increase in application of nitrogen from 0- 90 kg ha^{-1} whereas the essential oil and protein content was maximum at 60 kg ha^{-1} compared to control and other treatments.

Studies have also ascertained that application of a combination of nitrogen 75 per cent through organic (FYM) and 25 per cent through inorganic (Urea) were at par with a combination of 50 per cent through organic and 50 per cent through inorganic which significantly increased the height of the plant, number of branches per plant, dry matter, leaf area index and crop growth rate in all growth stages except the initial stages in coriander (Yadav, 2005).

Both green leaf yield and seed yield of coriander were highly influenced by the increase in nitrogen application. Leaf yield increased with the increase in levels of nitrogen and number of cuttings. Maximum herbage yield was obtained in 90 kg nitrogen per ha with two leaf cuttings, whereas higher seed yield was related with 90 kg nitrogen per ha without leaf cutting (Tehlan and Thakral, 2008).

The application of farm yard manure, poultry manure, vermicompost, neem cake and diammonium phosphate gave significant increase in the yield attributes of coriander, but the application of 75 per cent recommended dose of nitrogen through vermicompost and 25 per cent recommended dose of nitrogen through diammonium phosphate gave increase in the number of pods per plant under loamy sand soils (Yadav, 2010).

Field experiment conducted by Singh (2011) to study the influence of vermicompost and chemical fertilizers on growth, seed and oil yield and quality of coriander indicated that combination of 7.25 t ha^{-1} and 25 per cent recommended NPK at the rate of 25:12.5:12.5 kg ha^{-1} produced highest biomass, seed and oil yield compared to organic manure and no fertilizer or manures. This indicated that 75 per cent of NPK requirement can be met by the application of vermicompost without loss in yield.

Foliar spray of urea at different concentrations had significant influence on growth of coriander. Foliar spray of 2.5 per cent urea could be beneficial for coriander leaf production under multicut system (Sharangi *et al*., 2011).

Nitrogen is an essential element for the synthesis of protein and chlorophyll. Naruka *et al*., (2012) suggested that among four levels of nitrogen *viz*., 0, 20, 40, 60 kg nitrogen per ha, 60 kg nitrogen showed better growth, yield and quality attributes like essential oil and carotenoid content of ajwain at 60 and 90 days after sowing.

Field experiment conducted by Mehta *et al.* (2013) to study the influence of varying levels of irrigation and nutrients on growth, profitability and productivity of coriander revealed that higher growth parameters, yield parameters and net return were obtained by the application of 50 kg ha^{-1} N and 25 kg ha^{-1} P_2O_5.

A field experiment in coriander to investigate the effect of varying levels of nitrogen and sulphur on growth and yield by Patel *et al.* (2013) revealed that seed yield, plant height, number of branches $plant^{-1}$, number of umbels and umbellates $plant^{-1}$ and straw yield improved with the application of 80 kg ha^{-1} nitrogen. Among the different levels of sulphur, 30 kg ha^{-1} significantly improved the growth and yield parameters.

The nitrogen dose of 80 kg ha^{-1} in coriander given as half dose of N as basal and half N as topdressing at 30 days after sowing recorded maximum plant height, number of leaves, single plant weight, plant weight m^{-2} and foliage yield ha^{-1} closely followed by 60 kg ha^{-1} with the same application method (Moniruzzaman *et al*., 2014).

A field trial conducted in Bangladesh during *rabi* season to determine the requirement of nitrogen (N), phosphorous (P), potassium (K), and sulphur (S) of coriander variety BARI-Coriander-1 for seed yield revealed that highest yield was recorded in moderate application of 70 kg ha^{-1} of N, 50 kg ha^{-1} P, 30 kg ha^{-1} of K and 20 kg ha^{-1} S. This fertilizer combination was found to be best for coriander cultivation in Grey Terrace Soil of Amnura Soil Series under AEZ-25 of Bangladesh (Yousuf *et al*., 2014).

A research trial to evaluate yield and growth response in coriander to water stress and P fertilizer application revealed that increase in water supply and P fertilization increased plant height, number of umbels per plant and seed yield (Hani *et al.*, 2015). A field experiment conducted to study the performance of coriander cultivars under different levels of sulphur and zinc in semi-arid conditions reported that RCr-436 performed best with high magnitude of growth parameters and chlorophyll content at 50 days after sowing, yield attributes and application of 40 kg sulphur ha^{-1} increased higher seed yield (Meena, 2015).

A field experiment conducted by Singh (2015) to study the effect of nutrient supplementation through organic manures such as vermicompost and FYM in coriander revealed that combination of FYM 15 t ha^{-1}+full recommended dose of 50:40:30 kg ha^{-1} NPK was the best one which improved growth attributes of coriander and there was 105.26 per cent increase in yield over control.

Rakib *et al.* (2015) suggested that foliar spray of planofix and urea can be used for maximum production of foliage in coriander. They also found that growth parameters *viz.*, plant height, plant spread, leaf length, leaves per plant, biomass yield, biomass yield m^{-1} were found maximum in foliar application 10 ppm planofix at 20 and 30 days after sowing.

Plant growth in terms of height of the plant, number of leaves and seed germination of off-season coriander under shade net were significantly influenced by the application of nitrogen to a certain level. Yield parameters like total leaf yield was maximum at 60 kg ha^{-1} nitrogen. (Lal *et al*., 2016).

Response of coriander to different levels of potassium and sulphur was studied by Solanki *et al.*, (2017) and they suggested that among the levels of potassium and sulphur, 40 kg ha^{-1} boosted the growth parameters and yield parameters.

Sanwal *et al.* (2017) found that combined application of vermicompost 2.5 t ha^{-1} with 40 kg ha^{-1} N and 20 kg ha^{-1} significantly increased the yield and quality parameters of coriander. The combination increased the seed, stover and biological yield of coriander.

Effect of organic fertilizers on growth and yield of coriander studied by Ahmad *et al.* (2017) revealed that highest number of leaves $branch^{-1}$, highest leaf area and minimum days taken to harvest were recorded in plants applied with poultry manure. Minimum number of days taken for germination was recorded in plants applied with compost.

Souri *et al.* (2018) conducted field trial to determine the effects of manure based urea pellets on growth, yield and nitrate content of coriander, garden cress and parsley plants. Results showed that application of manure based urea pellets in low and high compactness caused different plant responses in three leafy vegetables. Plant growth and biomass production increased in plants given urea or low compact urea pellets.

Singh *et al.* (2018) reported the influence of irrigation and nutrition on growth and yield of coriander. Four irrigations at 25, 50, 75, 100 days after sowing along with nitrogen 75 kg ha^{-1} and phosphorous 62.5 kg $ha^{-1}$was recommended for higher productivity and profitability of coriander during winter season.

2.6. GROWTH, YIELD AND QUALITY AS INFLUENCED BY HARVEST MATURITY

The widely accepted form of coriander is immature leaves and seed. The typical flavour, aroma and appearance are always associated with the maturity. Shelf life, essential oil content, chemical constituents *etc.* are determined by harvest maturity. Harvesting at correct stage yield quality produce. Stage of harvesting is an important factor while cultivation.

Marotti *et al.* (1993) reported that dry matter yield of pepper mint progressively increased from early to late stages of growth ranging from 16.9 per cent to 32 per cent and high quantity and quality oil was obtained from the plants harvested at full blooming stage.

Micromineral contents in commonly consumed green leafy vegetables such as amaranthus, hibiscus, and palak at three different stages of maturity were estimated by Khader and Rama (1998) and suggested that among three different stages of maturity, consumption of green leafy vegetables of 15 and 30 days age potentially ensured the availability of minerals present in leaves. The study revealed that the plants matured from 15 days to 30 days increased the minerals like iron and manganese whereas level of zinc and copper got depleted as crop matured.

Dhanasekar *et al*., (2000) conducted a study to determine the optimum harvesting stage of coriander for leaf purpose. The study revealed that irrespective of seasons significant yield in stem and leaves was recorded from 25 to 35 days after sowing. There was a decline in all growth parameter after 45 days.

Badi *et al*. (2003) evaluated the influence of spacing and harvesting time on herbage yield and quality and quantity of oil in thyme. The study suggested that maximum dry and fresh herbage yield and oil yield were obtained from the leaves harvested at beginning of blooming stage.

Telci *et al*. (2006) found that brown fruit, in fruit development stage was suitable for harvest in coriander and harvesting at early as well as late stages caused yield losses and lower linalool content.

Singh and Malhotra (2007) suggested that harvesting stage plays a major role in detaining the flavour which adds to the quality. Coriander crop grown exclusively for green leaves is harvested after 35-40 days of sowing and for green fruit, crop is harvested the when seeds are green and have attained full size. Delay in harvesting causes splitting and shattering of seeds.

Rameezani *et al*., (2008) observed the changes in essential oil content of aerial parts of coriander during four phenological stages. The study pointed out that essential oil yield remarkably increased on maturation process. Essential oil content of coriander was maximum at unripe green fruit stage followed by brown ripe fruits.

Saidi *et al*. (2010) conducted study in cowpea to evaluate the effect of leaf harvest initiation time and frequency on nitrogen content in tissue and productivity of dual purpose cowpea during four seasons. The study revealed that leaf vegetable yield in cowpea was found maximum when the leaf harvesting was initiated 3 weeks after emergence compared to two and four weeks after the emergence of crop. The study also suggested that leaf harvesting at seven days interval produced higher yield than biweekly harvest.

A harvesting frequency of fourteen days interval produced higher leaf fresh mass and dry mass in hydroponically grown mustard spinach (*Brassica juncea)* compared to harvesting frequency of seven days due to longer period given for leaf development (Maboko, 2013).

An experiment comprising of seven dates of sowing and three harvest treatments suggested that two harvests can be recommended as a general agronomic practice to get maximum green leaf in coriander (Guha *et al*., 2014).

Materials and methods

3. MATERIALS AND METHODS

The present study entitled "Standardization of package of practices for leaf coriander under rain shelter" was carried out in the Department of Plantation Crop and Spices, College of Horticulture, Kerala Agricultural University, Thrissur during 2019- 2020. The details of materials and methods followed in the study are given below.

3.1. EXPERIMENTAL SITE AND CLIMATE

The experimental plot laid out in the Plantation and Spice farm, College of Horticulture, Kerala Agricultural University, Thrissur, which is located at an elevation of 22.25m above mean sea level, 10º 31'N latitude and 76º 13' E longitude. The agro meteorological data recorded during the research period are presented in Appendix 1.

3.2. EXPERIMENTAL MATERIAL

Two genotypes of coriander as given below were used for the study.

1. CO (Cr-4) – a dual purpose coriander variety collected from the Department of Plantation Crops and Spices, Tamil Nadu Agricultural University, Coimbatore.
2. Theni Local – a local variety of coriander collected from Theni, Tamil Nadu.

3.3. DESIGN AND LAYOUT OF EXPERIMENT

All the experiments were carried out in two seasons *viz.*, July-September and October- December under rain shelter. The study comprised of four experiments.

Experiment No.1: Standardization of seed treatments

Experiment No.2: Standardization of spacing

Experiment No.3: Standardization of fertilizer schedule

Experiment No.4: Standardization of harvest maturity.

Package of practices as given below was followed in all the experiments, wherever applicable.

Plot size : $1m^2$

Seed rate : 10 kg ha^{-1}

Spacing : 20 cm x 15 cm

Seed treatment: Splitting + soaking in water for 12 h

Manuring : 600 kg ha^{-1} Lime + 5t ha^{-1} FYM +
20:10:10 kg ha^{-1} NPK (basal);
10 kg ha^{-1} N: 20 DAS (top dressing)

Harvest : 45 DAS (days after sprouting)

3.3.1. Experiment No.1: Standardization of seed treatment

The experiment was laid out with five seed treatment methods in three replications to evaluate effect of different treatments on the growth of coriander (Fig.1). Two plant growth regulators were used *viz.*, NAA and GA_3. A control was maintained by splitting the seeds alone.

Table 1. Details of experiment No. 1: Standardization of seed treatments

Treatments	Seed treatment methods
T_1	splitting of seeds (control)
T_2	splitting + soaking in water (12 h)
T_3	splitting + soaking in water (24 h)
T_4	splitting + soaking in 50 mg L^{-1} GA_3 (8 h)
T_5	splitting + soaking in 20 mg L^{-1} NAA 8 h

3.3.2. Experiment No.2: Standardization of spacing

The experiment was laid out with three row x plant spacings (Fig. 2). Plant densities varied with the treatments. Details of the treatments are given below

Table 2. Details of experiment No. 2: Standardization of spacing

Treatments	Spacing
T_1	30 cm x 10 cm (33 plant m^{-2})
T_2	20 cm x 10 cm (50 plants m^{-2})
T_3	10 cm x 10 cm (100 plants m^{2})

3.3.3. Experiment No.3: Standardization of fertilizer schedule

Eleven different treatments were laid out in completely randomized design with two replications (Fig.3). Treatments included different doses of manures and fertilizers. Well decomposed farm yard manure and vermicompost were collected from the Department of Plantation Crops and Spices, College of Horticulture, Thrissur. Straight fertilizers *viz.*, urea, rock phosphate and muriate of potash were used as sources of nitrogen, phosphorus and potassium respectively. Basal dose of

T_1V_1	T_2V_1	T_3V_1	T_4V_1	T_5V_1
T_5V_1	T_4V_1	T_4V_1	T_2V_1	T_3V_1
T_3V_1	T_1V_1	T_5V_1	T_1V_1	T_4V_1
T_1V_2	T_2V_2	T_3V_2	T_4V_2	T_5V_1
T_2V_2	T_5V_2	T_4V_2	T_3V_2	T_1V_2
T_5V_2	T_2V_2	T_1V_2	T_3V_2	T_4V_2

Fig. 1. Layout of Experiment No. 1: Standardization of seed treatments

T_1V_1	T_2V_1	T_3V_1	T_1V_2	T_2V_2
T_3V_2	T_1V_1	T_2V_1	T_3V_1	T_1V_2
T_2V_2	T_3V_2	T_1V_1	T_2V_1	T_3V_1
T_1V_2	T_2V_2	T_3V_2		

Fig. 2. Layout of Experiment No. 2: Standardization of spacing

T_7V_1	T_1V_1
$T_{11}V_2$	T_8V_1
T_4V_2	$T_{11}V_1$
T_9V_2	T_8V_2
T_5V_2	T_3V_1
T_2V_1	$T_{10}V_2$
T_6V_1	T_5V_1
T_9V_1	T_2V_2
T_3V_2	T_4V_1
$T_{10}V_1$	T_7V_2
T_6V_2	T_4V_2

T_9V_1	T_1V_2
$T_{11}V_1$	T_5V_2
T_7V_1	T_3V_2
T_2V_2	T_8V_1
T_4V_2	$T_{10}V_2$
T_3V_1	T_9V_2
$T_{10}V_1$	T_2V_1
T_7V_2	T_3V_1
T_4V_1	$T_{11}V_2$
T_6V_1	T_8V_2
T_1V_1	T_6V_2

Fig. 3. Layout of experiment No. 3: Standardization fertilizer schedule

R_1	
R_2	T_4V_1
R_3	
R_1	
R_2	T_3V_1
R_3	
R_1	
R_2	T_2V_1
R_3	
R_1	
R_2	T_1V_1
R_3	

R_1	
R_2	T_4V_2
R_3	
R_1	
R_2	T_3V_2
R_3	
R_1	
R_2	T_2V_2
R_3	
R_1	
R_2	T_1V_2
R_3	

Fig. 4. Layout of Experiment No. 4: Standardization of harvest maturity

Plate 1. Overview of experimental plots in rain shelter

fertilizer was applied before sowing. A control was maintained without any nutrient application. Details of the treatments are given below.

Table 3. Details of experiment No. 3: Standardization of fertilizer schedule

Treatments	Fertilizer doses
T_1	Control
T_2	5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal); 10 kg ha^{-1} N : 20 DAS* (top dressing)
T_3	5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal); 1 per cent Urea: 20 DAS*(foliar)
T_4	5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal); 1.5 per cent Urea: 20 DAS* (foliar)
T_5	5 t ha^{-1} FYM (basal); 19:19:19 :15, 30 DAS* (foliar)
T_6	5 t ha^{-1} FYM (basal)
T_7	2.5 t ha^{-1} vermicompost+20:10:10 kg ha^{-1} NPK (basal); 10 kg ha^{-1} N: 20 DAS *(top dressing)
T_8	2.5 t ha^{-1} vermicompost+20:10:10 kg ha^{-1} NPK (basal); 1 per cent urea:20 DAS* (foliar)
T_9	2.5 t ha^{-1} vermicompost+20:10:10 kg ha^{-1} NPK (basal); 1.5 per cent urea:20 DAS* (foliar)
T_{10}	2.5 t ha^{-1} vermicompost (basal);19:19:19 :15, 30 DAS* (foliar)
T_{11}	2.5 t ha^{-1} vermicompost (basal)

*DAS – Days after sprouting

3.3.4. Experiment No.4: Standardization of harvest maturity

The experiment consisted of four different harvesting days after the germination of seeds (Fig.4). Few plants were left uncut in the plot for observing flowering and fruit set.

Table 4. Details of experiment No. 4: Standardization of harvest maturity

Treatments	Harvesting days
T_1	40 DAS*
T_2	45 DAS*
T_3	50 DAS*
T_4	60 DAS*

*DAS: Days after sprouting

3.4. CULTURAL OPERATIONS

General package of practices recommended by Tamil Nadu Agricultural University (TNAU), Coimbatore was followed in the study.

3.4.1 Land preparation

The experimental plots inside the rain shelter was levelled and all weeds and pebbles removed. Raised beds of $1m^2$ area were taken.

3.4.2 Manures and fertilizers

While making beds, lime was applied to balance the acidity of soil. Well powdered FYM was applied after 10 days and mixed with soil. Basal dose of fertilizers was applied by broadcasting over the beds.

3.4.3. Sowing

The seeds were split into two halves by rubbing them against a rough surface. The split seeds were soaked in water for 12 hours. The seeds were taken out and allowed to drain the water from the seeds. The seeds were sown in lines taken in the raised beds, they were covered with thin layer of soil. Irrigation was given by rose can.

3.4.4. Intercultural practices

The excess seedlings were thinned out after one week of germination for maintaining the desired plant to plant spacing. Fifty plants were maintained in each bed except for the spacing experiment. Regular weeding was done by hand. Plants were irrigated daily. Monitoring for pest and disease incidence was carried out regularly and control measures adopted as and when required.

3.4.5. Harvesting

Harvesting was done when the serrated leaf emerged in fifty per cent of the total plant population. The plants were uprooted and washed to remove all soil and dirt. .

3.5. OBSERVATIONS RECORDED

Five plants were selected randomly in each replication and labelled. Morphological observations were recorded from the labelled plants.

3.5.1. Morphological observations

Morphological observations were taken at 30 days after germination and at the time of harvest.

3.5.1.1 Days to seed germination

Days to seed germination was recorded by counting the days for 50 per cent of the seed germination and expressed in days.

3.5.1.2. Days to first leaf emergence

It was recorded by counting days for first leaf emergence in fifty percent of the total plant population and expressed in days

3.5.1.3. Days for second leaf emergence

Days for second leaf emergence in fifty percent of the total plant population was counted and expressed in days.

3.5.1.4. Days for third leaf emergence

It was done by counting days for third leaf emergence in fifty percent of the total plant population and expressed in days.

3.5.1.5. Plant height (cm)

Five plants were selected randomly and height of the plant was measured from ground level to the tip of the plant at 30 days after sprouting and at the time of harvest. The value was expressed in centimeters.

3.5.1.6.Number of leaves

Five plants were randomly selected and number of leaves was counted at 30 days after sprouting and at the time of harvesting and expressed as number.

3.5.1.7.Crop duration

Crop duration was recorded by counting the days from sowing to harvest and expressed as days.

3.5.1.8 Green leaf yield per plant (g)

Green leaf yield per plant was taken at the time of harvest by pulling out five plants at random and weighing after removing the roots. The value was expressed as g/plant.

3.5.1.9. Biomass yield per plant (g)

Randomly selected five plants were weighed at the time of harvest and expressed as grams per plant (g).

3.5.1.10. Number of primary branches

Number of primary branches on the main stem were recorded at the time of harvest. The value was expressed as number.

3.5.1.11. Number of secondary branches

Number of secondary branches on the primary branches were recorded at the time of harvest. The value was recorded as number.

3.5.1.12.Days to emergence of serrated leaf

The days for the emergence of serrated leaf was recorded. Average was taken and expressed as number of days.

3.5.1.13.Days to flowering

Days for flowering was calculated by counting days from sowing to the flowering and expressed as days.

3.5.1.14.Days to fruit set

Randomly selected plants are tagged and the days for fruit set was recorded by counting the days from flowering to the fruit set. Fruit set was identified by the drying of flower and bulging of the fruit.

3.5.1.15.Days to fruit maturity

Maturity of the fruit was recorded by counting the required days for the maturation of the fruit from the sowing date.

3.5.1.16.Seed yield per plant

Ten plants were selected randomly and seeds were harvested from each plant and weighed separately. The average weight of the seeds was expressed as grams.

3.5.1.17.Seed yield per plot

The total seed obtained from each plot was weighed and expressed as grams.

3.5.2. Biochemical analysis

The biochemical analysis like chlorophyll, vitamin C and volatile oil of fresh leaves were done at the time of harvest.

3.5.2.1. Chlorophyll content

The chlorophyll content of the leaf sample was estimated by DMSO method suggested by Hiscox and Israelstam (1979). Coriander leaves were harvested and 0.25 g of fresh coriander leaves was taken in test tubes. Fifteen millilitre of Dimethyl sulfoxide (DMSO) was added to the test tube and incubated at 60° C for 30 minutes, till the coriander leaves becomes colourless. The solution was then made upto 25 ml using DMSO and optical density measured by using spectrophotometer under 645 nm and 663 nm Chlorophyll a, chlorophyll b and total chlorophyll was calculated by using the following formula. Data on chlorophyll content of variety CO-4 during October – December is unavailable.

$$\text{Chlorophyll a (mg g}^{-1}\text{)} = 12.7(A_{663}) - 2.69\,(A_{645}) \times \frac{V}{1000 \times W}$$

$$\text{Chlorophyll b (mg g}^{-1}\text{)} = 22.9\,(A_{645}) - 4.68\,(A_{663}) \times \frac{V}{1000 \times W}$$

$$\text{Total chlorophyll (mg g}^{-1}\text{)} = 20.2\,(A_{645}) - 8.02\,(A_{663}) \times \frac{V}{100 \times W}$$

A: Absorbance at specific wavelength

V: Final volume of the chlorophyll extract in DMSO

W: Fresh weight of the leaf

3.5.2.2. Vitamin C content

Ascorbic acid content in leaves was estimated by using volumetric method (Rao and Deshpande, 2005). Dye solution was prepared by dissolving 42mg Sodium bicarbonate into a small volume of distilled water and then dissolving 52 mg of 2, 6-dichlorophenol indophenol in it and making it up to 200 ml. Stock solution of ascorbic acid was prepared by dissolving 100mg ascorbic acid in 100 ml of 4 per cent oxalic acid solution in a standard flask. A working standard of ascorbic acid was prepared by dissolving 10 ml of standard ascorbic acid solution to 100 ml of 4 per cent oxalic acid. Five ml of the standard solution was pipetted out into a conical flask and 10 ml of 4 per cent oxalic acid was added and titrated against dye solution (V_1). The end point was judged by the appearance of light pink color which persisted at least for 5 seconds. In a similar manner, the extract of coriander leaves (5g) was prepared by using 4 per cent oxalic acid and it was made up to 100 ml and was centrifuged. Five ml of the supernatant was pipetted out, 10 ml of oxalic acid was added and titrated against the dye (V_2).

Total ascorbic acid present in the sample is calculated by using the following formula

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Dye factor} \times V_2 \times 100\ \text{ml} \times 100}{V_2 \times \text{aliquot taken} \times \text{weight of the sample}}$$

3.5.2.3. Volatile oil

Volatile oil present the coriander leaves was extracted using Clevenger apparatus (Clevenger, 1928). Coriander leaves were harvested and 100 grams of leaves chopped finely and fed into the round bottom flask attached to the Clevenger apparatus. A condenser also fitted to the top of Clevenger apparatus to condense the steam. 300 ml distilled water was added to the leaf sample. The sample was heated gently upto a temperature of 70 – 80°C for 150 minutes until all of the oil has been extracted. The oil was collected in the graduated tube of the Clevenger apparatus, cooled and collected in a vial. A pinch of anhydrous sodium sulphite was added to the oil extracted to remove the excess moisture. The volume of oil was expressed as percentage of oil present in 100 g of leaf sample.

$$\text{Volatile oil (\%)} = \frac{\text{Volume of oil collected (ml)}}{\text{Total weight of sample (g)}} \times 100$$

3.5.2.4. Soil nutrient analysis

Soil analysis was done to identify the soil nutrient profile of the experimental plot prior to planting and presented in Table 5.

3.5.3. Pest and disease incidence

During the investigation incidence of pest and incidence if any was recorded and appropriate control measures were adopted as and when required.

3.5.4. Weather parameters:

Data on mean temperature (°C), rainfall (RF), relative humidity (RH) and sunshine hours during the crop period was collected from the Department of Agricultural Meteorology, College of Horticulture, Vellanikkara and monthly mean value of all the parameters worked out and presented in Appendix I.

3.5.5. Statistical analysis

The recorded data were statistically analyzed by using OPSTAT and Online Package software.

Table 5. Soil nutrient status of experimental plot

Parameters	Sample	
	Quantity	**Remarks**
pH	6.9	Neutral
Electrical conductivity (dSm^{-1})	0.20	Normal
Organic Carbon (%)	1.89	High
Available phosphorus (kg ha^{-1})	77.64	High
Available Potassium (kg ha^{-1})	454.61	High
Available Calcium (mg kg^{-1})	2671	Sufficient
Available Magnesium (mg kg^{-1})	209	Sufficient
Available Sulphur (mg kg^{-1})	45	Sufficient
Micronutrients		
Available Iron (mg kg^{-1})	50.9	Sufficient
Available Manganese (mg kg^{-1})	68.1	Sufficient
Available Zinc (mg kg^{-1})	7.1	Sufficient
Available Copper (mg kg^{-1})	3.8	Sufficient
Available Boron (mg kg^{-1})	0.82	Sufficient

Results

4. RESULTS

Coriander (*Coriandrum sativum* L.) is an important functional food which is not only rich in nutrition, but also known for its medicinal value. It is a widely grown herb and commonly used seed as well as herbal spice in India. The agroclimatic conditions in Kerala is suitable for coriander cultivation but, the proper knowledge on cultivation practices is the bottle neck for its successful production. The present study entitled **Standardization of package of practices for leaf coriander (*Coriandrum sativum* L.) under rain shelter** was undertaken during July 2019 to March 2020 with four experiments and two varieties. Data pertaining to the effect of seed treatments, spacing, fertilizer schedule, harvest maturity and season on growth, yield and quality of coriander were analysed separately. The results obtained from the study are described experiment wise in the following pages.

4.1. STANDARDIZATION OF SEED TREATMENTS

This experiment was done to identify suitable seed treatment method to enhance the germination, growth and herbage yield of coriander. Field experiment was carried out during July – September and October- December under rain shelter. The influence of seed treatments including water as well as different plant growth regulators on successive stages of growth of two coriander varieties namely CO-4 and Theni Local are presented hereunder.

Details of season of sowing, seed treatments, and its notations are given below.

T_1 : splitting of seeds (control)

T_2 : splitting + soaking in water (12 h)

T_3 : splitting + soaking in water (24 h)

T_4 : splitting + soaking in 50 mg L^{-1} GA_3 (8 h)

T_5 : splitting + soaking in 20 mg L^{-1} NAA (8 h)

S_1 : July – September

S_2 : October – December

4.1.1. Days to germination

The data on days to germination of both the coriander varieties presented in Table 6 revealed that pre-sowing treatments had significant effect on days to sprouting and germination started within six days after sowing. In variety CO-4, seeds sprouted earlier in T_3 (6.63), T_4 (6.33) and T_5 (6.33) which was on par with T_2 (6.83). Delayed germination was recorded in control (7.17). In variety Theni Local, earliest sprouting of seeds occurred in T_4 (6.00) which was on par with T_3 (6.17) and T_5 (6.50). Delayed sprouting was observed in control (7.33).

The individual effect of season of sowing and the interaction effect of seed treatments and season of sowing were non-significant in both the varieties.

4.1.2. Days to leaf emergence

Days taken for first, second and third leaf emergence was recorded and mean values are presented in Table 7a and Table 7b.

4.1.2.1. Days to emergence of first leaf

The emergence of first leaf in variety CO-4 was not affected by the seed treatment methods followed before sowing whereas, in variety Theni Local, it was significant. In variety Theni Local, earliest emergence of first leaf was observed in T_4 (10.50) which was on par with T_3 (10.83) and T_5 (11.00). Delayed emergence was observed in control (12.00).

Season of sowing also had significant effect on first leaf emergence in variety Theni Local whereas, it was non-significant with respect to the variety CO-4. Earliest emergence of first leaf was observed during October – December (10.86) compared to July – September (11.40).

Interaction effect of seed treatments and season of sowing was non-significant on first leaf emergence in both the varieties.

Table 6. Effect of seed treatments and season on germination of coriander varieties

Variety	Treatments / Seasons	S_1	S_2	Mean
CO-4	T_1	7.00	7.33	7.17^{a}
	T_2	6.67	7.00	6.83^{ab}
	T_3	6.33	6.33	6.33^{c}
	T_4	6.33	6.33	6.33^{c}
	T_5	6.33	6.33	6.33^{c}
	Mean	6.53	6.67	
	CD (Season)	NS		
	CD (Treatments)	0.62		
	CD (Season x Treatments)	NS		
	CV	7.82		
Theni Local	T_1	7.00	7.67	7.33^{a}
	T_2	6.67	6.67	6.67^{b}
	T_3	6.00	6.33	6.17^{b}
	T_4	6.00	6.00	6.00^{bc}
	T_5	6.33	6.67	6.50^{b}
	Mean	6.40	6.67	
	CD (Season)	NS		
	CD (Treatments)	0.54		
	CD (Season x Treatments)	NS		
	CV	6.84		

Table 7a. Effect of seed treatments and season on emergence of leaves in coriander variety CO-4

Treatments/ Season	First leaf			Second leaf			Third leaf		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	11.33	11.33	11.33	16.67	15.67	16.17[a]	21.00	20.33	20.67[a]
T_2	11.00	11.33	11.17	16.33	15.33	15.83[ab]	20.33	20.00	20.17[b]
T_3	10.67	10.67	10.67	15.67	14.67	15.17[b]	20.00	19.00	19.50[c]
T_4	10.67	10.67	10.67	15.67	14.67	15.17[b]	20.00	19.00	19.50[c]
T_5	11.00	11.00	11.00	16.67	15.00	15.83[ab]	20.67	19.67	20.17[b]
Mean	10.93	11.00		16.20[a]	15.07[b]		20.40[a]	19.60[b]	
CD (Season)	NS			0.42			0.28		
CD (Treatments)	NS			0.66			0.44		
CD (Season x Treatments)	NS			NS			NS		
CV	5.26			3.63			1.82		

Table 7b. Effect of seed treatments and season on emergence of leaves in coriander variety Theni Local

Treatments/ Season	First leaf			Second leaf			Third leaf		
	S_1	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**
T_1	11.67	12.33	12.00^{a}	17.00	17.33	17.17^{a}	21.67	21.67	21.67^{a}
T_2	11.67	11.00	11.33^{ab}	16.33	16.67	16.50^{b}	21.33	21.67	21.50^{a}
T_3	11.33	10.33	10.83^{bc}	16.33	16.00	16.17^{b}	20.67	21.00	20.83^{b}
T_4	11.00	10.00	10.50^{bc}	16.00	16.00	16.00^{b}	20.33	21.00	20.67^{b}
T_5	11.33	10.67	11.00^{bc}	16.67	16.33	16.00^{b}	21.00	21.33	21.67^{a}
Mean	11.40	10.86		14.67	16.47		21.00	21.33	
CD (Season)	0.44			NS			NS		
CD (Treatments)	0.70			0.66			0.58		
CD (Season x Treatments)	NS			NS			NS		
CV	5.18			3.32			2.28		

4.1.2.2. Days to second leaf emergence

The second leaf emergence in both the varieties was dependent on seed treatment significantly. In CO-4, earliest second leaf emergence was found in T_3 and T_4 (15.17) which was on par with T_2 and T_5 (15.83). Delayed emergence was found in control (16.17). In variety Theni Local, earliest second leaf emergence was observed in T_4 and T_5 (16.00) which was on par with T_3 (16.17) and T_2 (16.50).

Season of sowing significantly influenced the second leaf emergence in CO-4 whereas it was independent in variety Theni Local. Second leaf emerged earlier during October – December in variety Theni Local (15.07) compared to July – September (16.20).

The interaction effect was non-significant regarding second leaf emergence in both the varieties. Second leaf emerged within 14.67 to 16.67 days in CO-4 and 16.00 to 17.33 days in Theni Local.

4.1.2.3. Days to third leaf emergence

The seed treatments had significant influence on third leaf emergence in both the varieties and it varied from 19.50 to 20.67 days in variety CO-4 and 20.67 to 21.67 days in variety Theni Local. In variety CO-4, earliest emergence of third leaf was recorded in T_3 and T_4 (19.50) whereas, in variety Theni Local it was found in T_4 (20.67) and this was on par with T_3 (20.83). In CO-4, delayed emergence was recorded in control (20.67). In Theni Local, third leaf emergence was late in control as well as T_5 (21.67).

The influence of season of sowing on third leaf emergence was found significant in CO-4 whereas, in Theni Local, days taken for third leaf emergence did not vary significantly between the seasons. In CO-4, third leaf was noticed within 19.60 days in the October- December crop compared to 20.40 days during July- September.

Interaction of seed treatments and season of sowing was not significant on third leaf emergence in both the varieties.

4.1.3. Plant height

Growth of the coriander plants was recorded in terms of plants height at 30 DAS and at the time of harvest. The statistically analysed data on plant height are presented in 8a and Table 8b.

4.1.3.1. Plant height at 30 DAS

Height of the plants in both the varieties at 30 DAS was influenced by seed treatments significantly. In variety CO-4, tallest plants were observed in T_3 (17.21 cm) which was on par with T_4 (16.99 cm) whereas in variety Theni Local, tallest plants were found in T_4 (13.41 cm) and this was on par with T_3 (12.93 cm). Short statured plants of CO-4 and Theni Local were observed in control and T_2 respectively. i.e., in CO-4, plant height recorded in control was 14.98 cm whereas in Theni Local, plant height recorded in T_2 was 11.88 cm which was statistically similar to the results given by T_5 (12.09 cm) and control (12.09 cm).

Season of sowing also had significant effect on plant growth in both the varieties. Variety CO-4 sown during October – December (19.40 cm) produced taller plants than the crop sown during July – September (12.96 cm). Similar effect was also found in variety Theni Local. Tallest plants were observed during October – December (13.28 cm) whereas, short statured plants were observed during July – September (11.66 cm).

Interaction effect of seed treatments and season of sowing was non-significant with respect to Theni Local whereas, interaction effect had significant role in plant height of variety CO-4. Tallest plants were observed in T_3S_2 (21.07 cm) combination whereas physical makeup of plants in terms of height was lowest in T_1S_1 (11.41 cm) and this was on par with T_2S_1 (11.61 cm).

4.1.3.2. Plant height at harvest

Similar to the plant height recorded at 30 DAS, plant height of both the varieties at harvest was also influenced significantly by the pre-sowing treatments of seed.

Table 8a. Effect of seed treatments and season on plant height and number of leaves of coriander variety CO-4

Treatments /Season	Plant height at 30 DAS (cm)			Plant height at harvest (cm)			Number of leaves at 30 DAS			Number of leaves at harvest		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	11.41^{f}	18.54^{c}	14.98^{c}	21.94	24.78	23.36^{d}	4.53^{d}	5.80^{c}	5.17^{c}	6.27^{c}	9.33^{b}	7.80^{b}
T_2	11.61^{f}	18.72^{c}	15.17^{b}	22.78	25.25	24.02^{c}	4.60^{d}	6.33^{bc}	5.46^{bc}	6.33^{c}	9.40^{b}	7.87^{b}
T_3	13.35^{e}	21.07^{a}	17.21^{a}	23.07	25.97	24.52^{c}	4.60^{d}	7.23^{a}	5.92^{a}	6.40^{c}	9.60^{b}	8.00^{b}
T_4	14.26^{d}	19.72^{b}	16.99^{a}	26.32	29.01	27.67^{a}	4.80^{d}	6.67^{ab}	5.73^{a}	6.67^{c}	10.87^{a}	8.77^{a}
T_5	14.13^{d}	18.98^{c}	16.56^{b}	24.49	27.68	26.08^{b}	4.73^{d}	6.33^{bc}	5.53^{ab}	6.53^{c}	10.53^{a}	8.53^{a}
Mean	12.96^{b}	19.40^{a}		23.72^{b}	26.54^{a}		4.65^{b}	6.47^{a}		6.44^{b}	9.94^{a}	
CD (Season)	0.30			0.69			0.26			0.25		
CD (Treatments)	0.48			1.10			0.42			0.40		
CD (Season x Treatments)	0.67			NS			0.60			0.57		
CV	2.44			3.62			6.30			4.10		

Table 8b. Effect of seed treatments and season on plant height and number of leaves of coriander variety Theni Local

Treatments /Season	Plant height at 30 DAS (cm)			Plant height at harvest (cm)			Number of leaves at 30 DAS			Number of leaves at harvest		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	11.40	13.14	12.09^{b}	22.86	24.47	24.16^{c}	4.27	4.83	4.55^{b}	7.67^{f}	10.67^{c}	9.17^{c}
T_2	11.15	12.61	11.88^{b}	24.10	26.44	25.27^{bc}	4.27	4.93	4.60^{b}	8.20^{e}	11.27^{b}	9.73^{b}
T_3	11.84	14.02	12.93^{a}	5.71	26.80	26.26^{ab}	4.60	5.40	5.00^{a}	8.53^{de}	11.47^{b}	10.00^{b}
T_4	12.57	14.25	13.41^{a}	26.35	29.37	27.86^{a}	4.80	5.53	5.17^{a}	8.73^{d}	12.93^{a}	10.83^{a}
T_5	11.70	12.39	12.05^{b}	25.82	27.80	26.81^{ab}	4.60	5.20	4.90^{ab}	8.53^{de}	11.50^{b}	10.02^{b}
Mean	11.66^{b}	13.28^{a}		24.96^{b}	27.18^{a}		4.51^{b}	5.18^{a}		8.33^{b}	11.57^{a}	
CD (Season)	0.41			1.14			0.22			0.19		
CD (Treatments)	0.66			1.81			0.35			0.31		
CD (Season x Treatments)	NS			NS			NS			0.44		
CV	4.36			5.73			6.12			2.58		

In CO-4, significantly tallest plants were produced in T_4 (27.67 cm) whereas in variety Theni Local, tallest plants were observed in T_4 (27.86 cm) which was on par with T_5 (26.86 cm) and T_3 (26.26 cm). Control was found to produce short statured plants in both the varieties i.e., in CO-4, plant height recorded at harvest was 23.36 cm and in Theni Local, plant height at harvest was 24.16 cm and it was on par with T_2 (25.27 cm).

Data presented in Table 8a and Table 8b revealed that sowing of coriander seeds during different seasons had significant effect on plant height. Both the varieties were found to produce tallest plants during October – December compared to July – September sown crop. In variety CO-4, plant height during July – September and October – December were 23.72 cm and 26.54 cm respectively. In variety Theni Local, tallest and shortest plant during October – December and July – September measured 27.18 cm and 24.96 cm respectively.

Height of the plants was not affected by the synergic action of seed treatments and season of sowing in both the varieties.

4.1.4. Number of leaves

Data on number of leaves recorded at 30 DAS and at harvest are tabulated in Table 8a and Table 8b.

4.1.4.1. Number of leaves at 30 DAS

The number of leaves in both the varieties at 30 DAS was found to be significantly influenced by the individual effect of pre-sowing treatments done in seeds. In CO-4, highest number of leaves was produced in T_3 (5.92) which was on par with T_4 (5.73) and T_5 (5.53). In variety Theni Local, highest number of leaves was observed in T_4 which was on par with T_3 (5.00) and T_5 (4.90). In both the varieties control plants were found to produce least number of leaves followed by T_2. In CO-4, number of leaves produced by control was 5.17 and in T_2 it was 5.46. Similarly, in variety Theni Local, leaves produced by control was 4.55 and this was on par with T_2 (4.60).

The number of leaves at 30 DAS was significantly related to season of sowing. Both the varieties produced highest number of leaves during October – December. In variety CO-4, the number of leaves produced during October – December was 6.47 whereas, it was 4.65 during July – September. In variety Theni Local, the number of laves during October – December and July – September were 5.18 and 4.51 respectively.

The interaction effect of seed treatments and season of sowing was significant on the number of leaves at 30 DAS in CO-4 whereas, number of leaves produced in variety Theni Local was dependent only on individual effect of seed treatments as well as season of sowing. In CO-4, highest number of leaves was recorded in T_3S_2 (7.23) which was on par with T_4S_2 (6.67). The lowest number of leaves was produced in T_1S_1 (4.53) which was on par with T_2S_1 (4.60), T_3S_1 (4.60), T_5S_1 (4.73) and T_4S_1 (4.80).

4.1.4.2. Number of leaves at harvest

The number of leaves at harvest had significant relation with seed treatments in both the varieties. In both the varieties highest number of leaves was produced in T_4. In CO-4, number of leaves in T_4 was 8.77 at the time of harvest and this was on par with T_5 (8.53). In variety Theni Local, number of leaves recorded in T_4 was 10.83 followed by T_5 (10.02), T_3 (10.00) and T_2 (9.73). In both the varieties, lowest number of leaves was found in control. The lowest number of leaves observed in CO-4 was 7.80 and this was statistically similar to T_2 (7.87) and T_3 (8.00) whereas, in Theni Local, lowest number of leaves was found in control (9.17) which was significantly inferior to rest of the treatments.

Time of sowing and number of leaves at harvest were significantly interrelated. The highest number of leaves at harvest was found during October – December in both the varieties. In CO-4 number of leaves at harvest during October – December was 9.94 whereas it was 6.44 during the preceding season. In variety Theni Local, number of leaves produced during October – December was 11.57 compared to 8.33 during July – September.

Interaction effect of seed treatments and season of sowing on number of leaves at harvest was significant in both the varieties. In both the varieties highest number of leaves was found in T_4S_2 at the time of harvest. The number of leaves found in T_4S_2 of CO-4 was 10.87 and it was on par with T_5 (10.53). In variety Theni Local, number of leaves found in T_4 was 12.93 followed by T_5 (11.50). Lowest number of leaves in both the varieties was recorded in T_1S_1. In CO-4, number of leaves recorded in T_1S_1 was 6.27 and this was on par with T_2S_1 (6.33), T_3S_1 (6.40), T_5S_2 (6.53) and T_4S_1 (6.67). In variety Theni Local, number of leaves recorded in T_1S_1 was 7.67.

4.1.5. Biomass yield

Biomass yield of coriander plants was recorded by weighing the individual plants along with its root. Plot wise biomass yield was recorded by taking weight of 50 plants. The data on individual and plot wise biomass yield are furnished in Table 9a and Table 9b respectively (Plate 2 and Plate 3).

4.1.5.1. Biomass yield per plant

Biomass yield per plant was significantly influenced by the seed treatments followed in both the varieties. In CO-4, highest per plant biomass yield was obtained from T_3 (6.24 g plant^{-1}) followed by T_4 (4.48 g plant^{-1}) whereas in variety Theni Local, highest biomass yield per plant was recorded in T_4 (9.04 g plant^{-1}) which was on par with T_3 (8.61 g plant^{-1}). Lowest biomass yield was recorded in control in both the varieties. In CO-4, it was 3.99 g plant^{-1} whereas in Theni Local, it was 6.82 g plant^{-1}.

The influence of season of sowing on biomass yield per plant was significant. Highest biomass yield per plant was obtained during October – December irrespective of the varieties. In CO-4, biomass yield recorded during October – December was 8.37 g plant^{-1} whereas, it was 1.63 g plant^{-1} during July – September. In variety Theni Local, biomass yield recorded during October – December and July – September was 10.36 g plant^{-1} and 5.98 g plant^{-1} respectively.

Table 9a. Effect of seed treatments and season on biomass and green leaf yield of coriander variety CO-4

Treatments/ Seasons	Biomass yield per plant (g plant^{-1})			Biomass yield per plot (g m^{-2})			Green leaf yield per plant (g plant^{-1})			Green leaf yield per plot (g m^{-2})		
	S_1	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**
T_1	1.30^{g}	6.73^{e}	3.99^{e}	65.20^{g}	333.63^{e}	199.42^{e}	1.17^{g}	6.34^{e}	3.76^{e}	58.50^{g}	317.17^{e}	187.83^{e}
T_2	1.63^{fg}	8.20^{c}	4.92^{c}	81.57^{fg}	409.97^{c}	245.77^{c}	1.47^{fg}	7.88^{c}	4.67^{c}	73.33^{fg}	393.83^{c}	233.58^{c}
T_3	1.91^{f}	10.56^{a}	6.24^{a}	95.73^{f}	527.87^{a}	311.80^{a}	1.67^{f}	10.26^{a}	5.98^{a}	83.67^{f}	513.00^{a}	298.33^{a}
T_4	1.88^{f}	9.07^{b}	5.48^{b}	94.13^{f}	453.67^{b}	273.90^{b}	1.62^{f}	8.69^{b}	5.15^{b}	80.33^{f}	434.33^{b}	257.58^{b}
T_5	1.43^{g}	7.35^{d}	4.39^{d}	71.43^{g}	367.63^{d}	219.53^{d}	1.19^{g}	6.99^{d}	4.09^{d}	59.67^{g}	349.67^{d}	204.67^{d}
Mean	1.63^{b}	8.37^{a}		81.61^{b}	418.55^{a}		1.42^{b}	8.03^{a}		71.20^{b}	401.60^{a}	
CD (Season)	0.19			9.65			0.13			6.93		
CD (Treatments)	0.30			15.26			0.21			10.96		
CD (Season x Treatments)	0.43			21.59			0.31			15.50		
CV	5.01			5.03			3.84			3.82		

Table 9b. Effect of seed treatments and season on biomass and green leaf yield of coriander variety Theni Local

Treatments/ Seasons	Biomass yield per plant (g $plant^{-1}$)			Biomass yield per plot (gm^{-2})			Green leaf yield per plant (g $plant^{-1}$)			Green leaf yield per plot (g m^{-2})		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	5.22^{f}	8.41^{c}	6.82^{d}	261.14^{f}	420.33^{c}	340.74^{d}	4.86^{e}	8.06^{c}	6.46^{d}	243.17^{e}	403.00^{c}	323.08^{d}
T_2	5.58^{ef}	10.45^{b}	8.02^{c}	279.10^{ef}	522.43^{b}	400.77^{c}	5.22^{e}	10.05^{b}	7.64^{c}	261.17^{e}	502.33^{b}	381.75^{c}
T_3	6.31^{d}	10.92^{ab}	8.61^{ab}	315.53^{d}	545.92^{ab}	430.73^{ab}	6.09^{d}	10.56^{b}	8.33^{ab}	304.67^{d}	527.83^{b}	416.25^{ab}
T_4	6.52^{d}	11.56^{a}	9.04^{a}	326.07^{d}	577.73^{a}	451.90^{a}	6.22^{d}	11.23^{a}	8.73^{a}	311.17^{d}	561.33^{a}	436.25^{a}
T_5	6.26^{de}	10.47^{b}	8.37^{bc}	313.23^{de}	523.50^{b}	418.37^{bc}	5.95^{d}	10.24^{b}	8.09^{bc}	297.67^{d}	511.83^{b}	404.75^{bc}
Mean	5.98^{b}	10.36^{a}		299.01^{b}	517.98^{a}		5.67^{b}	10.03^{a}		283.57^{b}	501.27^{a}	
CD (Season)	0.32			16.13			0.30			15.04		
CD (Treatments)	0.51			25.51			0.47			23.78		
CD (Season x Treatments)	0.72			36.07			0.67			33.64		
CV	5.14			5.14			5.00			4.99		

Hydro priming for 24 h

GA_3 50 ppm for 8 h

Plate 2. Superior seed treatments in coriander variety CO-4

GA_3 50 ppm for 8 h

Hydro priming for 24 h

Plate 3. Superior seed treatments in coriander variety Theni Local

Interaction effect of seed treatments and season of sowing on biomass yield per plant was found significant. In variety CO-4, highest biomass was recorded in T_3S_2 (10.56 g plant^{-1}). In variety Theni Local, the biomass yield recorded in T_4 (11.56 g plant^{-1}) was highest and it was on par with T_3S_2 (10.92 g plant^{-1}). In both the varieties, lowest biomass yield was recorded in T_1S_1. In CO-4, it was 1.30 g plant^{-1} and it was on par with the biomass yielded by T_5S_1 (1.43 g plant^{-1}) and T_2S_1 (1.63 g plant^{-1}). In variety Theni Local, lowest biomass yield was 5.22 g plant^{-1} and it was on par with biomass yield obtained from T_2 (5.58 g plant^{-1}).

4.1.5.2. Biomass yield per plot

Plot wise biomass yield was significantly influenced by the pre-sowing seed treatments in both the varieties. In variety CO-4, highest biomass yield per plot was obtained from T_3 (311.80 g m^{-2}) whereas in variety Theni Local, biomass yield obtained from T_4 (451.90 g m^{-2}) was the highest and it was on par with T_3 (430.73 g m^{-2}). Lowest biomass yield in variety CO-4 as well as in variety Theni Local was recorded in control. In variety CO-4, lowest biomass yield per unit area was 199.42 g m^{-2} whereas it was 340.74 g m^{-2} in Theni Local.

Season of sowing also exerted significant influence on biomass yield per plot in both the varieties. The biomass yield obtained from unit area was highest during October – December in both the varieties. Biomass yield per plot recorded in CO-4 during October – December was 418.55 g m^{-2} when compared to the July – September crop (81.61 g m^{-2}). In variety Theni Local, biomass yield per plot obtained in October – December sown crop was 517. 98 g m^{-2} whereas, July – September crop sown crop yielded only 299.01 g m^{-2}.

Interaction effect of seed treatments and season of sowing on biomass yield from unit area was significant in both the varieties. Highest biomass yield per plot was recorded in T_3S_2 (527.87 g m^{-2}) in variety CO-4 whereas, in Theni Local, highest biomass yield was recorded in T_4S_2 (577.73 g m^{-2}) and this was on par with T_3S_2 (545.92 g m^{-2}). Lowest biomass yield obtained from unit area was recorded in T_1S_1 in both the varieties. In CO-4, it was 65.20 g m^{-2} and it was on par with T_5 (71.43 g m^{-2}) and T_2 (81.57 g m^{-2}). The biomass yield recorded in T_1S_1 of Theni Local was 261.14 g m^{-2} and it was on par with T_2 (279.10 g m^{-2}).

4.1.6. Green leaf yield

Green leaf yield was recorded by weighing the freshly harvested plants without roots. The green leaf yield of individual plant and plot wise yield was recorded and tabulated in Table a 9a and Table 9b respectively.

4.1.6.1. Green leaf yield per plant

Green leaf or herbage yield per plant varied significantly among the seed treatments applied in both the varieties. Similar to biomass yield recorded in CO-4, the highest green leaf yield was also found in T_3 (5.98 g plant^{-1}). In variety Theni Local, highest herbage yield was recorded in T_4 (8.73 g plant^{-1}) and it was on par with T_3 (8.33 g plant^{-1}). Control was found to produce lowest green leaf yield in both the varieties. In CO-4, it was 3.76 g plant^{-1} whereas in Theni Local, it was 6.46 g plant^{-1}.

Season of sowing also had significant effect on green leaf produced by a single plant in varieties CO-4 and Theni Local. The data presented in Table 4a and Table 4b revealed that October – December sown crop yielded highest green leaves per plant compared to July – September. In CO-4, per plant herbage yield during October – December and July – September were 8.03 g plant^{-1} and 1.42 g plant^{-1} respectively. In variety Theni Local, highest and lowest per plant green leaf yield was 10.03 g plant^{-1} and 5.67 g plant^{-1} respectively.

Interaction effect of seed treatments and season of sowing on herbage yield of single plant was significant. In variety CO-4, highest herbage yield was recorded in T_3S_2 (10.26 g plant^{-1}) and lowest was in T_1S_1 (1.17 g plant^{-1}). T_1S_1 was on par with T_2 (1.47 g plant^{-1}) in CO-4. In variety Theni Local, the highest herbage yield was recorded in T_4S_2 (11.23 g plant^{-1}) whereas lowest was recorded in T_1S_1 (4.86 g plant^{-1}) and it was on par with T_2S_1 (5.22 g plant^{-1}).

4.1.6.2. Green leaf yield per plot

Similar to per plant herbage production, plot wise herbage yield was also significantly influenced by the effect of seed treatments in both the varieties. Highest to lowest herbage yield produced in CO-4 was as follows: T_3 (298.33 g m^{-2}), T_4 (257.58 g m^{-2}), T_2 (233.58 g m^{-2}), T_5 (204.67 g m^{-2}) and control (187.83 g m^{-2}).

Similarly, highest herbage yield per plot of Theni Local was recorded in T_4 (436.25 g m^{-2}) which was statistically closer to T_3 (416.25 g m^{-2}). The lowest herbage yield in Theni Local was recorded in control (323.08 g m^{-2}).

Herbage yield per plot in both the varieties was influenced by the season of sowing significantly. Highest yield was recorded during October – December irrespective of the varieties. Herbage yield obtained during October – December in variety CO-4 and Theni Local was 401.60 g m^{-2} and 501.27 g m^{-2} respectively. Similarly, the herbage yield recorded during July – September in CO-4 and Theni Local was 71.20 g m^{-2} and 283.57 g m^{-2} respectively.

Combined effect of seed treatments and season of sowing was found significant in terms of herbage yield in both varieties. Highest herbage yield in variety CO-4 and variety Theni local was recorded in T_3S_2 (513.00 g m^{-2}) and T_4S_2 (561.33 g m^{-2}) respectively. In both the varieties lowest yield was recorded in T_1S_1i.e., in variety CO-4, herbage yield was 58.50 g m^{-2} and this was statistically similar to T_5S_1 (59.67 g m^{-2}) and T_2S_1 (73.33 g m^{-2}). Similarly, in variety Theni Local, herbage yield recorded in T_1S_1 was 243.17 g m^{-2} and this was on par with T_2S_2 (261.17 g m^{-2}).

4.1.7. Vitamin C content

Ascorbic acid content was estimated from the freshly harvested coriander leaves. The calculated values are expressed in the form of milligram in 100 g of the leaf sample. The analysed data are presented in Table 10a and Table 10b.

The data presented in Table 10a and Table 10b revealed that seed treatment done in both the varieties had significant influence on vitamin C content of fresh leaves. In CO-4, highest vitamin C content was recorded in T_4 (65.54 mg per 100g) whereas, in variety Theni Local highest vitamin C was recorded in T_3 (106.51 mg per 100g). In variety CO-4, lowest vitamin C was recorded in control (41.25 mg per 100g) and it was on par with T_5 (42.04 mg per 100g) and T_2 (43.25 mg per 100g). Lowest vitamin C content in variety Theni Local was recorded in T_2 (67.48 mg per 100g) followed by control (74.16 mg per 100g).

Table 10a. Effect of seed treatments and season on vitamin C and volatile oil content of coriander variety CO-4

Treatments/ Seasons	Vitamin C content (mg/100g)			Volatile oil (%)		
	S_1	S_2	Mean	S_1	S_2	Mean
T_1	18.50^f	64.00^c	41.25^c	0.1	0.1	0.1
T_2	21.17^f	65.33^c	43.25^c	0.1	0.1	0.1
T_3	29.17^e	73.33^b	51.25^b	0.1	0.1	0.1
T_4	43.75^d	81.33^a	65.54^a	0.1	0.1	0.1
T_5	18.75^f	65.33^c	42.04^c	0.1	0.1	0.1
Mean	26.27^b	69.87^a		0.1	0.1	
CD (Season)	1.44			NS		
CD (Treatments)	2.28			NS		
CD (Season x Treatments)	3.23			NS		
CV	3.92			N/A		

Table 10b. Effect of seed treatments and season on vitamin C and volatile oil content of coriander variety Theni Local

Treatments/ Seasons	**Vitamin C content (mg/100g)**			**Volatile oil (%)**		
	S_1	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**
T_1	52.83^{h}	95.49^{d}	74.16^{d}	0.1	0.1	0.1
T_2	64.15^{f}	70.82^{e}	67.48^{e}	0.1	0.1	0.1
T_3	71.69^{e}	141.33^{a}	106.51^{a}	0.1	0.1	0.1
T_4	61.63^{f}	100.09^{c}	80.86^{c}	0.1	0.1	0.1
T_5	56.60^{g}	120.49^{b}	88.55^{b}	0.1	0.1	0.1
Mean	61.38^{b}	105.55^{a}		0.1	0.1	0.1
CD (Season)	1.50			NS		
CD (Treatments)	2.38			NS		
CD (Season x Treatments)	3.36			NS		
CV	2.35			N/A		

The vitamin C content in both the varieties varied significantly between the seasons of cultivation. October-December was found to be the best season for vitamin C synthesis in coriander leaves irrespective of varieties. The vitamin C content recorded in variety CO-4 and Theni Local during October – December was 68.87 mg per 100g and 105.55 mg per 100g respectively. Similarly vitamin C content during July – September in variety CO-4 and Theni Local was 26.27 mg per 100g and 61.38 mg per 100g respectively.

The interaction of seed treatments and season of sowing had significant influence on vitamin C content of leaves. In both varieties, the vitamin C content varied significantly among the treatment combinations. In variety CO-4, vitamin C content was highest in T_4S_2 (81.33 mg per 100g) whereas in Theni Local, it was recorded highest in T_3S_2 (141.33 mg per 100g). In both the varieties, lowest vitamin C content was recorded in T_1S_1. In variety CO-4, lowest vitamin C content was recorded and it was statistically similar to T_5S_1 (18.75 mg per 100g) and T_2S_1 (21.17 mg per 100g). In variety Theni Local, vitamin C content recorded in T_1S_1 was 52.83 mg per 100g.

4.1.8. Volatile oil content

Volatile oil content did not vary significantly among the seed treatments. The individual effect of season of sowing and interaction effect of seed treatments and season of sowing were also found non-significant with respect to volatile oil content.

4.1.9. Chlorophyll content

Chlorophyll content of both varieties was estimated Using DMSO method. The content of chlorophyll ‘a’, chlorophyll ‘b’ and total chlorophyll were estimated and the values are presented in Table 11a and Table 11b.

4.1.9.1. Chlorophyll ‘a’ content

The chlorophyll ‘a’content varied significantly among the five seed treatments followed. In CO-4, highest chlorophyll ‘a’ content was recorded in T_3 (1.403 mg g^{-1}) which was on par with T_5 (1.385 mg g^{-1}). The lowest chlorophyll ‘a’ content was recorded in control (1.283 mg g^{-1}) which was on par with T_2 (1.319 mg g^{-1}).

Table 11a. Effect of seed treatments and season on chlorophyll content of coriander variety CO-4

Treatments/ Season	Chlorophyll 'a' (mg g^{-1})			Chlorophyll 'b' (mg g^{-1})			Total chlorophyll (mg g^{-1})		
	S_1	**S_2**	**Mean**	**S_1**	**S_2**	**S_2**	**S_1**	**S_2**	**Mean**
T_1	1.036^c	1.531^b	1.283^d	0.386^c	0.393^c	0.390^c	1.427^f	1.924^c	1.676^d
T_2	1.105^c	1.532^b	1.319^{cd}	0.390^c	0.448^b	0.419^b	1.495^e	1.979^b	1.737^c
T_3	1.046^c	1.759^a	1.403^a	0.507^a	0.435^b	0.471^a	1.554^d	2.195^a	1.875^a
T_4	0.937^d	1.750^a	1.344^{bc}	0.380^c	0.453^b	0.417^b	1.317^g	2.203^a	1.760^c
T_5	1.046^c	1.724^a	1.385^{ab}	0.384^c	0.454^b	0.419^b	1.455^{ef}	2.178^a	1.817^b
Mean	1.034^b	1.659^a		0.409^{b-}	0.437^a		1.450^b	2.096^a	
CD (Season)	0.037			0.016			0.025		
CD (Treatments)	0.058			0.026			0.039		
CD (Season x Treatments)	0.083			0.037			0.056		
CV	3.32			5.01			1.78		

Table 11b. Effect of seed treatments and season on chlorophyll content of coriander variety Theni Local

Treatments/ Season	Chlorophyll 'a' ($mg\ g^{-1}$)			Chlorophyll 'b' ($mg\ g^{-1}$)			Total chlorophyll ($mg\ g^{-1}$)		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	1.525^{cd}	1.746^{ab}	1.636^{ab}	0.341^{cd}	0.382^{cd}	0.362	1.866^{def}	2.129^{b}	1.998^{b}
T_2	1.524^{cd}	1.921^{a}	1.723^{a}	0.330^{d}	0.492^{a}	0.411	1.854^{ef}	2.143^{a}	2.134^{a}
T_3	1.142^{e}	1.588^{bc}	1.365^{d}	0.337^{cd}	0.415^{abc}	0.376	1.477^{g}	2.003^{bcd}	1.740^{d}
T_4	1.566^{bc}	1.538^{bcd}	1.552^{bc}	0.464^{ab}	0.412^{bc}	0.438	2.031^{bc}	1.950^{cde}	1.990^{b}
T_5	1.332^{de}	1.533^{bcd}	1.433^{cd}	0.404^{bcd}	0.415^{abc}	0.410	1.753^{f}	1.948^{cde}	1.850^{c}
Mean	1.418^{b}	1.665^{a}		0.375^{b}	0.423^{a}		1.796^{b}	2.089^{a}	
CD (Season)	0.099			0.036			0.064		
CD (Treatments)	0.156			NS			0.101		
CD (Season x Treatments)	0.221			0.080			0.143		
CV	8.45			11.19			4.30		

In variety Theni Local, highest chlorophyll ‘a’ content was recorded in T_2 (1.723 mg g^{-1}) which was on par with control (1.636 mg g^{-1}). The lowest chlorophyll ‘a’ content was recorded in T_3 (1.365 mg g^{-1}) which was statistically similar to T_5 (1.433 mg g^{-1}).

The influence of season of sowing on chlorophyll ‘a’ content was significant. In both the varieties, highest chlorophyll ‘a’ content was recorded during October – December i.e., in variety CO-4 it was 1.659 mg g^{-1} and in variety Theni Local it was 1.665 mg g^{-1}. The chlorophyll ‘a’ content recorded in variety CO-4 and variety Theni Local was 1.034 mg g^{-1} and 1.148 mg g^{-1} respectively.

Interaction effect of seed treatments and season of sowing was found significantly varying among the treatment combinations. In CO-4, highest chlorophyll a’ content was recorded in T_3S_2 (1.759 mg g^{-1}) and it was on par with T_4S_2 (1.750 mg g^{-1}) and T_5S_2 (1.724 mg g^{-1}). In the variety Theni Local, highest chlorophyll ‘a’ content was reported in T_2S_2 (1.921 mg g^{-1}) and it was on par with T_1S_2 (1.746 mg g^{-1}). The lowest chlorophyll ‘a’ content was recorded in T_3S_1 (1.142 mg g^{-1}) and it was on par with T_5S_1 (1.332 mg g^{-1}).

4.1.9.2. Chlorophyll ‘b’ content

The different seed treatments followed had significant influence on chlorophyll ‘b’ content in leaves at the time of harvest. The influence of seed treatments on chlorophyll ‘b’ content was significant as its values were significantly different among different treatments in variety CO-4 whereas, the influence of seed treatment on chlorophyll ‘b’ content in variety Theni Local was non-significant. The highest chlorophyll content in variety CO-4 was recorded in T_3 (0.471 mg g^{-1}) and the lowest was in control (0.390 mg g^{-1}). The chlorophyll ‘b’ content in variety Theni Local was in the range of 0.362 mg $g^{-1}$to 0.438 mg g^{-1}.

The influence of season of sowing on chlorophyll ‘b’ content was significant. Highest chlorophyll ‘b’ content was recorded during October – December in both the varieties. Chlorophyll ‘b’ recorded during October – December in variety CO-4 was 0.437 mg g^{-1} whereas during July – September it was 0.409 mg g^{-1}. In variety Theni Local, chlorophyll ‘b’ content recorded during October – December and July – September was 0.423 mg g^{-1} and 0.375 mg g^{-1} respectively.

Interaction effect of five different seed treatments and season of sowing was significant on chlorophyll ‘b’ content of coriander leaves. In variety CO-4, highest chlorophyll ‘b’ content was recorded in T_3S_1 (0.507 mg g^{-1}). T_4S_1 (0.380 mg g^{-1}) was reported lowest chlorophyll ‘b’ content in the same variety and it was on par with T_5S_1 (0.384 mg g^{-1}), T_1S_1 (0.386 mg g^{-1}) and T_1S_2 (0.393 mg g^{-1}). In variety Theni Local, highest chlorophyll ‘b’ content was recorded in T_2S_2 (0.492 mg g^{-1}) and this was on par with T_4S_1 (0.464 mg g^{-1}), T_3S_2 (0.415 mg g^{-1}) and T_5S_2 (0.415 mg g^{-1}). The lowest chlorophyll ‘b’ content of the same variety was reported in T_2S_1 (0.330 mg g^{-1}) which was on par with T_3S_1 (0.337 mg g^{-1}), T_1S_1 (0.341 mg g^{-1}) T_1S_2 (0.382 mg g^{-1}) and T_5S_1 (0.404 mg g^{-1}).

4.1.9.3. Total Chlorophyll content

The total chlorophyll content varied significantly between two seasons in both the varieties. Irrespective of the varieties, highest total chlorophyll content was recorded during October – December. In CO-4, the total chlorophyll content recorded during October – December was 2.096 mg g^{-1} whereas it was 1.450 mg g^{-1} during July – September. In variety Theni Local, the total chlorophyll content recorded during October – December and July – September was 2.089 mg g^{-1} and 1.796 mg g^{-1} respectively.

Overall mean of total chlorophyll content among five seed treatments varied significantly. In CO-4, T_3 (1.875 mg g^{-1}) recorded highest total chlorophyll content whereas in variety Theni Local, lowest total chlorophyll content was recorded in same treatment (1.850 mg g^{-1}). In variety Theni Local, T_2 (2.134 mg g^{-1}) recorded highest total chlorophyll content followed by control (1.998 mg g^{-1}) and T_4 (1.990 mg g^{-1}). In variety CO-4, lowest value was recorded in control (1.676 mg g^{-1}).

Interaction of seed treatments and season of sowing had significant influence on total chlorophyll content of both the varieties. T_4S_2 (2.203 mg g^{-1}) recorded highest total chlorophyll content in CO-4 and it was on par with T_3S_2 (2.195 mg g^{-1}) and T_5S_2 (2.178 mg g^{-1}). In variety Theni Local, highest total chlorophyll content was recorded in T_2S_2 (2.143 mg g^{-1}g). The lowest total chlorophyll content in varieties CO-4 and Theni Local was recorded in T_4S_1 (1.317 mg g^{-1}) and T_3S_1 (1.477 mg g^{-1}) respectively.

4.2. STANDARDIZATION OF SPACING

The experiment was conducted to evaluate the response of coriander varieties to different spacing in terms of quantity and quality. The field trial was conducted under rain shelter during July – September and October – December. Observations recorded during the study are presented in the form of tables and explained in following pages. The notations of treatments, seasons *etc*. are given below.

T_1 : 30 x 10 cm

T_2 : 20 x 10 cm

T_3 : 10 x 10 cm

S_1 : July – September

S_2 : October – December

4.2.1. Days to germination

Perusal of data given in Table 12 revealed that the influence of spacing on sprouting of seeds of both the varieties was non-significant. However, the influence of season of sowing was found significant on germination of both the varieties. October – December was found to be the best season for early sprouting of seeds irrespective of varieties. In variety CO-4, the seeds sprouted within 6.22 days during October – December whereas, it took 7.22 days for germination during July – September. The seeds of variety Theni Local sprouted within 6.33 days after sowing during October – December whereas, the sprouting was delayed for 7.44 days during July – September.

The interaction effect of season of sowing and spacing on days to germination of seeds was non-significant in both the varieties.

4.2.2. Days to leaf emergence

The number of days taken for first, second and third leaf emergence was recorded and analysed data are tabulated in Table 13.

Table 12. Effect of spacing and season on germination of coriander varieties

Variety	Treatments/ Season	S_1	S_2	Mean
CO-4	T_1	7.33	6.00	6.67
	T_2	7.33	6.33	6.83
	T_3	7.00	6.33	6.67
	Mean	7.22	6.22	
	CD (Season)	0.49		
	CD (Treatments)	NS		
	CD (Season x Treatments)	NS		
	CV	7.00		
Theni Local	T_1	7.00	6.00	6.50
	T_2	7.67	6.67	7.17
	T_3	7.67	6.33	7.00
	Mean	7.44	6.33	
	CD (Season)	0.49		
	CD (Treatments)	NS		
	CD (Season x Treatments)	NS		
	CV	6.83		

Table 13. Effect of spacing and season on emergence of leaves in coriander varieties

Variety	Treatments/ Season	First leaf			Second leaf			Third leaf		
		S_1	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**
CO-4	T_1	10.67	10.33	10.50	16.67	15.67	16.17	22.33	21.67	22.00
	T_2	11.00	10.00	10.50	16.67	16.00	16.33	22.00	21.33	21.67
	T_3	11.00	10.33	10.67	16.67	15.67	16.17	21.67	21.67	21.67
	Mean	10.89[a]	10.22[b]		16.67[a]	15.78[b]		22.00	21.56	
	CD (Season)	0.42			0.54			NS		
	CD (Treatments)	NS			NS			NS		
	CD (Season x Treatments)	NS			NS			NS		
	CV	3.87			3.23			3.05		
Theni Local	T_1	12.00	11.67	11.83	17.00	16.67	16.83	22.00	22.00	22.00
	T_2	12.00	11.00	12.00	17.00	16.67	16.83	22.67	22.00	22.33
	T_3	12.00	12.00	12.00	17.00	17.00	17.00	22.00	22.33	21.67
	Mean	12.00	11.89		17.00	16.78		22.22	22.11	
	CD (Season)	NS						NS		
	CD (Treatments)	NS			NS			NS		
	CD (Season x Treatments)	NS			NS			NS		
	CV	1.98			1.97			1.50		

4.2.2.1. Days to first leaf emergence

The number of days taken for first leaf emergence did not vary significantly among the different spacing. However, the season of sowing and first leaf emergence was interrelated in variety CO-4 whereas, in variety Theni Local the first leaf emergence was non-significant. First leaf emerged earlier (10.22) during October – December compared to the emergence during October – December (10.88).

The influence of interaction of spacing and season of sowing on emergence of first leaf was non-significant.

4.2.2.2. Days to second leaf emergence

The data presented on Table 13 clearly showed that individual effect of spacing on second leaf emergence of both the varieties was non-significant. However, the effect of season of sowing was significant on the second leaf emergence in variety Theni Local. Earliest second leaf emergence was observed in October – December (15.78) compared to July – September (16.67). The effect of season of sowing in variety Theni Local was non-significant.

Interaction effect of spacing and season of sowing on second leaf emergence was also non-significant.

4.2.2.3. Days to third leaf emergence

The third leaf emergence was not significantly affected by the individual effect of spacing and season of sowing. The interaction effect of spacing and season of sowing on third leaf emergence was also non-significant in both varieties.

4.2.3. Plant height

Height of the plants was recorded at 30 DAS and at harvest. Statistically derived data are presented in Table 14a and Table 14b.

Table 14a. Effect of spacing and season on plant height and number of leaves of coriander variety CO-4

Treatments/ Season	Plant height at 30 DAS (cm)			Plant height at harvest (cm)			Number of leaves at 30 DAS			Number of leaves at harvest		
	S_1	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**
T_1	13.49^{cd}	14.21^{c}	13.85^{c}	20.65	23.39	22.02^{c}	4.40	6.07	5.23	5.93^{c}	9.53^{b}	7.73^{b}
T_2	11.30^{e}	19.98^{b}	15.64^{b}	19.65	28.01	23.83^{b}	4.40	6.47	5.43	6.33^{c}	11.67^{a}	9.00^{a}
T_3	12.33^{d}	20.93^{a}	16.63^{a}	21.37	28.67	25.02^{a}	4.33	6.07	5.20	6.40^{c}	11.80^{a}	9.10^{a}
Mean	12.38^{b}	18.37^{a}		20.56^{b}	26.68^{a}		4.38^{b}	6.20^{a}		6.22^{b}	11.00^{a}	
CD (Season)	0.53			0.58			0.25			0.47		
CD (Treatments)	0.65			0.71			NS			0.58		
CD (Season x Treatments)	0.92			1.00			NS			0.82		
CV	3.34			2.37			4.70			5.30		

Table 14b. Effect of spacing and season on plant height and number of leaves of coriander variety Theni Local

Treatments/ Season	Plant height at 30 DAS (cm)			Plant height at harvest (cm)			Number of leaves at 30 DAS			Number of leaves at harvest		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	11.30	15.16	13.23[a]	22.83[d]	29.87[b]	26.35[b]	4.07	5.60	4.83	8.47	8.53	8.50[b]
T_2	10.3	13.55	11.94[b]	22.58[d]	25.45[c]	24.02[c]	4.27	5.60	4.93	8.40	10.00	9.20[b]
T_3	10.92	14.93	12.93[a]	28.76[b]	32.62[a]	30.69[a]	4.27	5.47	4.87	10.93	11.47	11.20[a]
Mean	10.85[b]	15.55[a]		24.72	29.32		4.20[b]	5.56[a]		9.27[b]	10.00[a]	
CD (Season)	0.63			0.92			0.37			NS		
CD (Treatments)	0.78			1.13			NS			1.56		
CD (Season x Treatments)	NS			1.60			NS			NS		
CV	4.85			7.37			3.30			12.78		

4.2.3.1. Plant height at 30 DAS

Height of the plant at 30 DAS was significantly influenced by the different spacing adopted in both the varieties. In variety CO-4, tallest plants were observed in T_3 (16.63 cm). In variety Theni Local, tallest plants were observed in T_1 (13.23 cm) which was on par with T_3 (12.93 cm). Lowest plant height in variety CO-4 and variety Theni Local was recorded in T_1 (13.85 cm) and T_2 (11.94 cm) respectively.

Season of sowing had significant effect on plant height 30 DAS in both the varieties. October – December season produced tallest plant irrespective of variety and spacing. The plant height of variety CO-4 recorded during October – December was 18.37 cm whereas, plant height in Theni Local was 15.55 cm during the same season. The lowest plant height recorded in varieties CO-4 and Theni Local during July – September was 12.38 cm and 10.85 cm respectively.

The interaction effect of spacing and season of sowing on plant height at 30 DAS was significant in variety CO-4 whereas, height of the plants was not influenced by the interaction effect spacing and season of sowing in variety Theni Local. The tallest plants were found in T_3S_2 (20.93 cm) followed by T_2S_2 (19.98 cm). The lowest plant height in same variety was reported in T_2S_2 (11.30 cm).

4.2.3.2. Plant height at harvest

Height of the plants was significantly influenced by the individual effect of spacing in both varieties. The overall mean of plant height recorded in three spacing were significantly different. In both the varieties, tallest plants were observed in T_3 i.e., in variety CO-4 it was 25.02 cm in variety Theni Local it was 30.69 cm. In variety CO-4, short statured plants were observed in T_1 (22.02 cm) whereas in variety Theni Local it was observed in T_2 (24.02 cm).

Influence of season of sowing on plant height at harvest was significant. Both the varieties sown during October – December were taller than July – September sown crop. The height of CO-4 plants during October – December was 26.68 cm whereas, height of variety Theni Local was 29.32 cm. Height of variety CO-4 and Theni Local recorded during July – September was 20.56 cm and 24.72 cm respectively.

The interaction effect of spacing and season of sowing was significant on the plant height at harvest. In both the varieties tallest plants were found in T_3S_2. In variety CO-4, plant height recorded in T_3S_2 combination was 28.67 cm and this was on par with T_2S_2 (28. 01cm). In variety Theni Local, the plant height recorded in T_3S_2 was 32.632 cm and it was significantly superior over all other treatment combinations. The short statured plants of both the varieties was observed in T_2S_1 i.e., in variety CO-4 plant height recorded was 19.65 cm and in variety Theni Local, it was 28.58 cm.

4.2.4. Number of leaves

Number of leaves was counted and recorded at 30 DAS and at the time of harvest. The statistically derived data are presented in Table 14a and Table 14b.

4.2.4.1. Number of leaves at 30 DAS

The number of leaves at 30 DAS did not vary significantly among different spacing followed. However, the influence of season of sowing on number of leaves was significant. In both the varieties, highest number of leaves was observed during October – December. The number of leaves recorded during October – December in varieties CO-4 and Theni Local was 6.20 and 5.56 respectively. Similarly, the number of leaves observed in same varieties during July – September was 4.38 and 4.20 respectively.

The interaction effect of spacing and season of sowing on number of leaves at 30 DAS was also non-significant.

4.2.4.2. Number of leaves at harvest

Both the varieties exhibited significant difference with regard to the number of leaves at harvest. Highest number of leaves was produced in T_3. The number of leaves produced in variety CO-4 was 9.10 it was on par with T_2 (9.00). In variety Theni Local, the number of leaves at harvest was 11.20. Lowest number of leaves recorded was 7.73 in variety CO-4, and 8.50 in variety Theni Local in T_1.

October – December season was found best for sowing CO-4 seeds as it produced a greater number of leaves (11.00) than July – September (6.22) sown crop.

The influence of season on number of leaves of variety Theni Local was non-significant.

The interaction effect of spacing and season of sowing on number of leaves at harvest was also significant in variety CO-4. The highest number of leaves was recorded in T_3S_2 (11.80) which was on par with T_2S_2 (11.67). The lowest number leaves at harvest was recorded in T_1S_1 (5.93) which was on par with T_2S_1 (6.33) and T_3S_1 (6.47). The interaction effect of spacing and season of sowing on number of leaves was non-significant in variety Theni Local.

4.2.5. Biomass yield

Biomass yield was recorded by taking the weight of single plant along with the roots. The plot wise yield was recorded by taking weight of 33 plants, 50 plants and 100 plants for 30 x 10 cm, 20 x 10 cm, 10 x10 cm spacing respectively. The data on biomass yield are presented in Table 15a and Table 15b (Plate 4).

4.2.5.1. Biomass yield per plant

Per plant biomass yield was significantly influenced by the spacing in both the varieties. In CO-4, highest biomass yield per plant was recorded in T_2 (7.81 g plant^{-1}) followed by T_3 (6.83 g plant^{-1}) whereas in variety Theni Local, highest biomass yield per plant was recorded in T_3 (14.77 g plant^{-1}) followed by T_2 (9.53 g plant^{-1}). In both varieties, lowest biomass yield per plant was recorded in T_1, i.e., biomass yield per plant recorded in variety CO-4 was 4.66 g plant^{-1} and in Theni Local, it was 7.78 g plant^{-1}.

The individual effect of season of sowing on biomass yield per plant of both the varieties was significant. The yield varied significantly between the seasons. Highest yield was recorded during October – December, irrespective of spacing and varieties. Biomass yield per plant recorded during October – December in variety CO-4 and Theni Local was 10.52 g plant^{-1} and 13.34 g plant^{-1} respectively. Similarly, the biomass yield in CO-4 and Theni Local during July – September was 2.35 g plant^{-1} and 8.04 g plant^{-1} respectively.

The interaction effect of spacing and season of sowing on biomass yield per

Table 15a. Effect of spacing and season on biomass and green leaf yield of coriander variety CO-4

Treatments/ Season	Biomass yield per plant (g plant^{-1})			Biomass yield per plot (g m^{-2})			Green leaf yield per plant (g plant^{-1})			Green leaf yield per plot (g m^{-2})		
	S_1	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**
T_1	1.92^{e}	7.41^{c}	4.66^{c}	63.47^{e}	244.51^{c}	153.99^{c}	1.17^{e}	6.99^{c}	4.35^{c}	56.54^{e}	230.78^{c}	143.66^{c}
T_2	2.77^{d}	12.84^{a}	7.81^{a}	138.57^{d}	642.10^{b}	390.33^{b}	2.59^{d}	12.52^{a}	7.56^{a}	129.50^{d}	626.17^{b}	377.83^{b}
T_3	2.36^{de}	11.31^{b}	6.83^{b}	235.67^{c}	1131.20^{a}	683.43^{a}	2.17^{d}	10.89^{b}	6.53^{b}	217.33^{c}	1088.67^{a}	653.00^{a}
Mean	2.35^{b}	10.52^{a}		145.90^{b}	672.60^{a}		2.16^{b}	10.13^{a}		134.45^{b}	648.54^{a}	
CD (Season)	0.40			24.07			0.38			23.39		
CD (Treatments)	049			29.48			0.46			28.65		
CD (Season x Treatments)	0.69			41.69			0.66			40.52		
CV	5.99			5.66			5.97			5.75		

Table 15b. Effect of spacing and season on biomass and green leaf yield of coriander variety Theni Local

Treatments/ Season	Biomass yield per plant (g plant^{-1})			Biomass yield per plot (g m^{-2})			Green leaf yield per plant (g plant^{-1})			Green leaf yield per plot (g m^{-2})		
	S_1	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**
T_1	4.79^{e}	10.78^{c}	7.78^{c}	158.07^{e}	355.76^{d}	256.92^{c}	4.55^{e}	10.47^{c}	7.51^{c}	150.04e	345.62^{d}	247.83^{c}
T_2	6.53^{d}	12.53^{b}	9.53^{b}	326.73^{d}	626.90^{c}	476.82^{b}	6.19^{d}	12.16^{b}	9.18^{b}	326.73^{d}	608.00^{c}	467.37^{b}
T_3	12.82^{b}	16.72^{a}	14.77^{a}	1282.33^{b}	1672.80^{a}	1477.57^{a}	12.59^{b}	16.37^{a}	14.48^{a}	1259.33^{b}	1636.67^{a}	1448.00^{a}
Mean	8.04^{b}	13.34^{a}		589.05	885.15		7.78^{b}	13.00^{a}		578.70^{b}	863.43^{a}	
CD (Season)	0.77			50.92			0.74			47.58		
CD (Treatments)	0.94			62.36			0.90			58.27		
CD (Season x Treatments)	1.33			88.19			1.28			82.41		
CV	6.81			6.65			6.87			6.35		

plant of both the varieties was significant. In variety CO-4, highest biomass yield per plant was recorded in T_2S_2 (12.84 g plant^{-1}) whereas, in variety Theni Local, T_3S_2 (16.72 g plant^{-1}) was found to record highest biomass yield per plant. The lowest yield was recorded in T_1S_1 of both the varieties. The biomass yield per plant recorded in T_1S_1 of variety CO-4 was (1.92 g plant^{-1}) and it was on par with T_3S_1 (2.36 g plant^{-1}).

4.2.5.2. Biomass yield per plot

The plot wise yield of biomass varied significantly in both the varieties as the density of plants per unit area differed with the spacing. In both varieties, highest biomass yield per plot was recorded in T_3 because the number of plants per unit area was 100. The plot wise biomass yield recorded in variety CO-4 and Theni Local was 683.43 g m^{-2} and 1477.57 g m^{-2} respectively. The least biomass yield was obtained from T_1 in both the varieties as the number of plants occupied per unit area was less. The lowest Biomass yield per plot recorded in CO-4 was 153.99 g m^{-2} whereas, it was 256.92 g m^{-2} in variety Theni Local.

The plot wise biomass yield was significantly affected by the season of sowing also. In both varieties, highest biomass yield was found during October – December. The yield recorded in CO-4 and Theni Local was 672.60 g m^{-2} and 885.15 g m^{-2} respectively. Similarly, the yield recorded during July – September was 145.90 g m^{-2} and 589.05 g m^{-2} respectively.

The interaction of spacing and season of sowing was also significant on the biomass yield per plot and it varied significantly among the treatment combinations. In both the varieties, highest biomass yield per plot was obtained from T_3S_2. The yield recorded in T_3S_2 of CO-4 variety was 1131.20 g m^{-2} whereas, it was 1672.80 g m^{-2} in same treatment combination of variety Theni Local. The lowest biomass yield recorded in T_1S_1 of CO-4 was 63.47 g m^{-2} whereas it was 158.07 g m^{-2} in same treatment combination of variety Theni Local.

4.2.6. Green leaf yield

Green leaf yield or herbage yield was recorded by weighing the freshly harvested plants without roots. The individual and plot wise yield was recorded and

CO-4 (10 x 10 cm)

Theni Local (10 x 10 cm)

Plate 4. Superior spacing treatments coriander varieties

the statistically derived data are presented in Table 15a and Table 15b.

4.2.6.1. Green leaf yield per plant

The herbage yield per plant of both the varieties was also affected by the individual effect of spacing significantly. In variety CO-4, highest herbage yield was recorded in T_2 (7.56 g $plant^{-1}$) whereas in variety Theni Local, highest herbage yield was obtained from T_3 (14.48 g $plant^{-1}$). The spacing treatment T_1 recorded lowest herbage yield in both the varieties. The recorded yield was 4.35 g $plant^{-1}$ and 7.51 g $plant^{-1}$ in variety CO-4 and Theni Local respectively.

The influence of individual effect of season of sowing on herbage yield was significant as the herbage yield obtained in the two varieties during both seasons exhibited significant difference. Both the varieties performed best during October – December in terms of herbage yield. In variety CO-4, the herbage yield recorded during October – December was 10.13 g $plant^{-1}$ whereas in the same season variety Theni Local recorded the herbage yield of 13.00 g $plant^{-1}$. The lowest herbage yield in variety CO-4 and Theni Local during July – September was 2.16 g $plant^{-1}$ and 7.78 g $plant^{-1}$ respectively.

The combined effect of spacing and season of sowing on herbage yield per plant was also significant in both the varieties. In CO-4, highest individual plant herbage yield was obtained from T_2S_2 (12.52 g $plant^{-1}$) whereas, the herbage yield in Theni Local was recorded in T_3 (16.37 g $plant^{-1}$). The treatment combination T_1S_1 was found to yield lowest herbage in both the varieties. The yield recorded in T_1S_1 in both the varieties *viz.*, CO-4 and Theni Local was 1.17 g $plant^{-1}$ and 4.55 g $plant^{-1}$ respectively.

4.2.6.2. Green leaf yield per plot

Plot wise herbage yield was significantly influenced by the spacing. T_3 was found to yield highest herbage in both the varieties. The herbage yield per plot recorded in CO-4 and Theni Local were 653.00 g m^{-2} and 1448.00 g m^{-2} respectively. Similar to biomass yield per plot, herbage yield also recorded lowest in T_1. The herbage yield in T_1 of variety CO-4 was 143.66 g m^{-2} and it was 247.83 g m^{-2}.

The individual effect of season of sowing on herbage yield from unit area was significant. Highest herbage yield was obtained during October – December compared to July – September. The herbage yield recorded in CO-4 variety during October – December was 648.54 g m^{-2} whereas the yield during July – September was 134.45 g m^{-2}. The herbage yield per plot recorded in variety Theni Local during October – December was 863.43 g m^{-2} whereas, the same variety recorded a herbage yield of 578.70 g m^{-2} during July – September.

The interaction effect of spacing and season of sowing on herbage yield per plot was also significant. In both the varieties T_3S_2 was found to produce highest herbage yield i.e., in variety CO-4, it was 1088.67 g m^{-2} and in variety Theni Local, it was 1636.67 g m^{-2}. Lowest herbage yield was recorded in T_3S_1. The herbage yield recorded in T_3S_1 of CO-4 was 56.54 g m^{-2} whereas; it was 150.04 g m^{-2} in variety Theni Local.

4.2.7. Vitamin C content

The vitamin C content of fresh leaves was significantly different among the spacing followed in both the varieties which is given in the Table 16. Highest vitamin C content in variety CO-4 was recorded in T_3 (65.16 mg per 100g) which was on par with the vitamin C recorded in T_2 (64.62 mg per 100g). The vitamin C content in variety Theni Local was found highest in T_2 (81.18 mg per 100g followed by T_3 (72.66 mg per 100g). In both the varieties, vitamin C content was lowest in T_1. The vitamin C content recorded in T_1 of variety CO-4 was 45.29 mg per 100g whereas it was 69.29 mg per 100g in variety Theni Local.

The season of sowing was also significantly responsible for the vitamin C content in freshly harvested leaves. In both the varieties, highest vitamin C content was found during October – December. The vitamin C content in variety CO-4 and Theni Local were 74.22 mg per 100g and 75.92 mg per 100g respectively.

The interaction effect of spacing and season of sowing had significant influence on the vitamin C content in both the varieties at harvest. T_2S_2 recorded highest vitamin C content in both the varieties i.e., the vitamin C content in variety CO-4 was 85.33 mg per 100g and it was 88.89 mg per 100g in Theni Local.

Table 16. Effect of spacing and season on vitamin C and Volatile oil content of coriander varieties

Variety	Treatments/ Season	Vitamin C content (mg/100g)			Volatile oil content (%)		
		S_1	S_2	Mean	S_1	S_2	Mean
CO-4	T_1	29.26[f]	61.33[c]	45.29[b]	0.1	0.1	0.1
	T_2	43.90[e]	85.33[a]	64.62[a]	0.1	0.1	0.1
	T_3	54.32[d]	76.33[b]	65.16[a]	0.1	0.1	0.1
	Mean	42.49[b]	74.22[a]		0.1	0.1	
	CD (Season)	1.31			NS		
	CD (Treatments)	1.60			NS		
	CD (Season x Treatments)	2.26			NS		
	CV	2.16			N/A		
Theni Local	T_1	72.10[b]	66.6[c]	69.29[c]	0.1	0.1	0.1
	T_2	73.46[b]	88.89[a]	81.18[a]	0.1	0.1	0.1
	T_3	73.10[b]	72.22[b]	72.66[b]	0.1	0.1	0.1
	Mean	72.88[b]	75.92[a]		0.1	0.1	
	CD (Season)	2.30			NS		
	CD (Treatments)	2.82			NS		
	CD (Season x Treatments)	3.99			NS		
	CV	2.98			N/A		

The lowest vitamin C content was reported in T_1S_1 (29.26 mg per 100g) in variety CO-4, whereas, lowest vitamin C content in variety Theni Local was recorded in T_1S_2 (66.6 mg per 100g).

4.2.8. Volatile oil content

The volatile oil present in fresh leaves coriander varieties did not vary with spacing and season of sowing. The interaction effect was also non-significant.

4.2.9. Chlorophyll content

Chlorophyll content of freshly harvested leaves was recorded in terms of photosynthetic pigments *viz*., chlorophyll 'a', chlorophyll 'b' and total chlorophyll. Statistically derived data are presented in Table 17a and Table 17b.

4.2.9.1. Chlorophyll 'a' content

The different spacing followed in variety CO-4 exhibited significant difference with regard to chlorophyll 'a' content of fresh leaves whereas, the effect of spacing on chlorophyll 'a' content recorded in variety Theni Local was non-significant.

In variety CO-4, the highest chlorophyll 'a' content was recorded in T_2 (1.442 mg g^{-1}) followed by T_1 (1.290 mg g^{-1}). Lowest chlorophyll 'a' content was 1.198 mg g^{-1} recorded in T_3. The chlorophyll 'a' content recorded in variety Theni Local was in the range of 1.568 mg g^{-1} to 1.916 mg g^{-1}.

The season of sowing and chlorophyll 'a' content was interrelated. In both the varieties, highest chlorophyll 'a' was recorded during October – December. The chlorophyll 'a' content of variety CO-4 and Theni Local during October – December was 1.774 mg g^{-1} and 2.142 mg g^{-1} respectively. Similarly, chlorophyll 'a' content recorded in the varieties during July – September was 0.846 mg g^{-1} and 1.306 mg g^{-1} respectively.

The interaction effect of spacing and season of sowing had significant influence on the chlorophyll content of variety CO-4 whereas, the combined effect did not influence the chlorophyll 'a' content of variety Theni Local. In CO-4,

Table 17a. Effect of spacing and season on chlorophyll content of coriander variety CO-4

Treatments/ Season	Chlorophyll 'a' (mg g^{-1})			Chlorophyll 'b' (mg g^{-1})			Total chlorophyll (mg g^{-1})		
	S_1	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**
T_1	0.874^{d}	1.705^{b}	1.290^{b}	0.349^{d}	0.464^{c}	0.407^{b}	1.223^{e}	2.169^{c}	1.696^{b}
T_2	0.971^{c}	1.912^{a}	1.442^{a}	0.356^{d}	0.535^{a}	0.446^{a}	1.326^{d}	2.447^{a}	1.887^{a}
T_3	0.692^{e}	1.705^{b}	1.198^{c}	0.265^{e}	0.479^{b}	0.372^{c}	0.957^{f}	2.183_{b}	1.570^{c}
Mean	0.846^{b}	1.774^{a}		0.323^{b}	0.493^{a}		1.169^{b}	2.266^{a}	
CD (Season)	0.004			0.006			0.007		
CD (Treatments)	0.004			0.008			0.009		
CD (Season x Treatments)	0.006			0.011			0.013		
CV	N/A			N/A			N/A		

Table 17b. Effect of spacing and season on chlorophyll content of coriander variety Theni Local

Treatments/ Season	Chlorophyll 'a' (mg g^{-1})			Chlorophyll 'b' (mg g^{-1})			Total chlorophyll (mg g^{-1})		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	1.098	2.038	1.568	0.551^a	0.553^a	0.552^a	1.649	2.591	2.120
T_2	1.487	2.345	1.916	0.429^b	0.118^c	0.273^b	1.915	2.463	2.189
T_3	1.332	2.042	1.687	0.375^b	0.539^a	0.457^a	1.707	2.581	2.144
Mean	1.306^b	2.142^a		0.452	0.404		1.757^b	2.545^a	
CD (Season)	0.24			NS			0.15		
CD (Treatments)	NS			0.10			NS		
CD (Season x Treatments)	NS			0.15			NS		
CV	13.61			19.58			6.89		

highest chlorophyll ‘a’ content was recorded in T_2S_2 (1.912 mg g^{-1}) whereas lowest was recorded in T_3S_1 (0.692 mg g^{-1}).

4.2.9.2. Chlorophyll ‘b’ content

Data presented in Table 17a and Table 17b revealed that Chlorophyll ‘b’ content varied significantly among spacing treatments. In variety CO-4, highest chlorophyll ‘b’ was recorded in T_2 (0.446 mg g^{-1}) whereas same spacing treatment recorded lowest (0.273 mg g^{-1}) chlorophyll ‘b’ content in Theni Local. Highest chlorophyll ‘b’ content in in variety Theni Local was recorded in T_1 (0.552 mg g^{-1}) and it was on par with T_3 (0.457 mg g^{-1}).

Season also had significant effect on chlorophyll ‘b’ content of fresh leaves in variety CO-4 whereas, it was non-significant with variety Theni Local. In variety CO-4, highest chlorophyll ‘b’ content was recorded during October – December (0.493 mg g^{-1}) whereas, it recorded during July – September (0.323 mg g^{-1}) was lowest.

Interaction effect of spacing and season of sowing on chlorophyll ‘b’ content was significant in both the varieties. Highest chlorophyll ‘b’ content recorded in variety CO-4 and Theni Local was T_2S_2 (0.535 mg g^{-1}) and T_1S_2 (0.553 mg g^{-1}) respectively. The values recorded during T_1S_2 (0.553 mg g^{-1}) was on par with T_3S_2 (0.539 mg g^{-1}) and T_1S_1 (0.551 mg g^{-1}). The lowest chlorophyll ‘b’ content was recorded in T_3S_2 (0.265 mg g^{-1}) in variety CO-4 whereas, in Theni Local T_2S_2 (0.118 mg g^{-1}) found to produce lowest chlorophyll ‘b’.

4.2.9.3. Total chlorophyll content

The individual effect of spacing treatments on total chlorophyll content in the variety CO-4 was significant whereas, in Theni Local the total chlorophyll content was not affected by the spacing treatments. In variety CO-4, highest total chlorophyll content was recorded in T_2 (1.887 mg g^{-1}) followed by T_1 (91.679 mg g^{-1}). The lowest was recorded in T_3 (1.570 mg g^{-1}).

The influence of season of sowing on total chlorophyll content of both varieties was significant. In both varieties highest total chlorophyll content was recorded during October – December i.e., the total chlorophyll content in CO-4 and Theni Local were 2.266 mg g^{-1} and 2.545 mg g^{-1} respectively. During July – September it was 1.169 mg g^{-1} in CO-4 and 1.757 mg g^{-1} in Theni Local.

The interaction effect of spacing and season of sowing on total chlorophyll content of variety CO-4 was found significant. Highest total chlorophyll was recorded in T_2S_2 (2.447 mg g^{-1}) whereas, lowest total chlorophyll content was recorded in T_3S_2 (0.957 mg g^{-1}). The interaction effect of spacing and season of sowing on total chlorophyll content of variety Theni Local was non-significant.

4.3. STANDARDIZATION OF FERTILIZER SCHEDULE OF CORIANDER

This experiment was conducted to standardize the suitable proportion of manures and fertilizers for early (CO-4) and late (Theni Local) varieties of coriander for leaf purpose. The trial was carried out in two seasons *i*.e., July – September and October – December with eleven fertilizer treatments. The observations pertaining to growth, yield and quality of coriander leaves were recorded during the study. The recorded data were subjected to statistical analysis and significance of the treatments was analyzed. The statistically analysed data are furnished in the following pages.

Details of the fertilizer schedules, season of sowing and notations are given below.

S_1 : July – September

S_3 : October – December

T_1 : Control

T_2 : 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal);
10 kg N ha^{-1}: 20 DAS (top dressing)

T_3 : 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal); 1 per cent urea: 20 DAS (foliar)

T_4 : 5 t ha^{-1} FYM +20:10:10 kg ha^{-1}NPK (basal);
1.5 per cent urea: 20 DAS (foliar)

T_5 : 5 t ha^{-1} FYM (basal); 19:19:19: 15, 30 DAS (foliar)

T_6 : 5 t ha^{-1}FYM (basal)

T_7 : 2.5 t ha^{-1} vermicompost+20:10:10 kg ha^{-1}NPK (basal);

10 kg ha^{-1} N: 20DAS (top dressing)

T_8 : 2.5 t ha^{-1}vermicompost+ 20:10:10 kg ha^{-1} NPK (basal);

1 per cent urea: 20 DAS (foliar)

T_9 : 2.5 t ha^{-1} vermicompost + 20:10:10 kg ha^{-1} NPK (basal);

1.5 per cent urea: 20 DAS (foliar)

T_{10} : 2.5 t ha^{-1}vermicompost (basal); 19:19:19: 15, 30 DAS (foliar)

T_{11} : 2.5 t ha^{-1}vermicompost (basal)

DAS : Days after sprouting

4.3.1. Days to germination

Data for variety CO-4 is presented in Table 18a and that for variety Theni Local is presented in Table 18b. In both the varieties, overall mean of number of days for sprouting of seeds was non-significant with respect to season of sowing, fertilizer treatments and interaction of season of sowing and fertilizer treatments.

4.3.2. Days to leaf emergence

Days taken for first, second and third leaf emergence was recorded and statistically analysed data are presented in Table 19a and Table 19b.

4.3.2.1. Days to first leaf emergence

Mean values furnished in Table 19a and 19b revealed that days to emergence of first leaf was not influenced by the individual effect of season of sowing and different fertilizer schedules. The interaction effect of season of sowing and fertilizer combination was also non-significant.

4.3.2.2. Days to second leaf emergence

Perusal of data given in Table 19a and 19b revealed that influence of season of sowing, fertilizer schedule on second leaf emergence was non-significant in both the varieties. The interaction effect was also found non-significant.

Table 18a. Effect of fertilizer schedule and season on days to germination of coriander variety CO-4

Treatments/ Seasons	**S_1**	**S_2**	**Mean**
T_1	6.00	6.50	6.25
T_2	6.50	8.00	7.25
T_3	7.00	8.00	7.50
T_4	7.00	7.50	7.25
T_5	6.50	6.50	6.50
T_6	6.00	6.50	6.25
T_7	8.00	6.50	7.25
T_8	7.00	7.00	7.00
T_9	7.00	7.50	7.25
T_{10}	7.00	8.00	7.50
T_{11}	6.00	8.50	7.25
Mean	6.73	7.32	
CD (Season)	NS		
CD (Treatments)	NS		
CD (Season x Treatments)	NS		
CV	14.40		

4.3.2.3. Days to third leaf emergence

Third leaf emergence was significantly influenced by the application of different fertilizer schedules. In CO-4, earliest emergence of third leaf was found in T_2 (22.75) which was on par with T_{11} (22.75), T_3 (23.00), T_4 (23.00), T_6 (23.00), T_7 (23.50) and T_{10} (23.50).In Theni Local, earliest (22.00) third leaf emergence was found in T_4, T_8, T_{11} which was on par with control (22.50), T_2 (22.50), T_7 (22.50) and T_9 (22.50). Delayed leaf emergence was observed T_6 (23.75) which was on par with T_3 (23.25) and T_5 (23.25). Third leaf emergence was not affected by the season of growing in both the varieties. Interaction effect of season of sowing and fertilizer schedule was also non-significant.

Table 18b. Effect of fertilizer schedule and season on days to germination of coriander variety Theni Local

Treatments/ Seasons	S_1	S_2	Mean
T_1	5.50	6.00	5.75
T_2	7.00	6.50	6.75
T_3	6.00	5.50	5.75
T_4	6.00	6.50	6.25
T_5	5.50	5.50	5.50
T_6	6.00	6.00	6.00
T_7	7.00	7.00	7.00
T_8	6.00	6.00	6.00
T_9	5.50	6.50	6.00
T_{10}	5.50	6.50	6.00
T_{11}	6.00	6.50	6.25
Mean	6.00	6.22	
CD (Season)	NS		
CD (Treatments)	NS		
CD (Season x Treatments)	NS		
CV	9.55		

Table 19 a. Effect of fertilizer schedule and season on emergence of leaves in coriander variety CO-4

Treatments / Season	First leaf			Second leaf			Third leaf		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	13.00	12.00	12.50	17.50	17.50	17.50	24.00	23.50	23.75[b]
T_2	12.50	12.50	12.50	16.50	17.00	16.75	22.00	23.00	22.50[c]
T_3	13.00	12.00	12.50	17.50	17.00	17.25	23.00	23.00	23.00[bc]
T_4	14.00	13.00	13.50	18.00	18.00	18.00	22.50	23.50	23.00[bc]
T_5	12.50	12.00	12.25	18.00	18.00	18.00	23.00	24.50	23.75[b]
T_6	13.50	12.50	13.00	16.50	17.50	17.00	22.00	24.00	23.00[bc]
T_7	12.00	13.50	12.75	18.50	18.00	18.25	24.00	23.00	23.50[bc]
T_8	12.00	13.00	12.50	18.50	18.50	18.50	26.00	24.00	25.00[a]
T_9	12.00	11.50	11.75	17.00	17.50	17.25	24.00	23.50	23.75[b]
T_{10}	14.00	13.00	13.50	17.50	17.50	17.50	24.00	23.00	23.50[bc]
T_{11}	12.00	14.00	13.00	16.50	18.50	17.50	22.50	23.00	22.75[bc]
Mean	12.77	12.63		17.45	17.72		23.36	23.45	
CD (Season)	NS			NS			NS		
CD (Treatments)	NS			NS			1.21		
CD (Season x Treatments)	NS			NS			NS		
CV	7.78			4.37			3.52		

Table 19b. Effect of fertilizer schedule and season on emergence of leaves in coriander variety Theni Local

Treatments / Season	First leaf			Second leaf			Third leaf		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	13.00	13.50	13.25	17.00	17.50	17.25	22.50	22.50	22.50[cd]
T_2	15.00	13.00	14.00	17.00	17.00	17.00	22.50	22.50	22.50[cd]
T_3	1.00	14.00	13.00	16.50	17.00	16.75	22.50	24.00	23.25[ab]
T_4	14.50	13.00	13.75	17.00	17.00	17.00	22.00	22.00	22.00[d]
T_5	12.00	13.50	12.75	16.50	16.50	16.50	22.50	24.00	23.25[ab]
T_6	14.50	13.00	13.75	18.00	17.50	17.75	24.00	23.50	23.75[a]
T_7	13.50	12.50	13.00	17.00	16.00	16.50	22.50	22.50	22.50[cd]
T_8	15.50	13.00	14.00	18.00	17.00	17.50	22.00	22.00	22.00[d]
T_9	12.00	15.00	13.50	17.50	17.50	17.50	22.50	22.50	22.50[cd]
T_{10}	12.00	12.00	12.00	17.00	16.00	16.50	23.00	23.00	23.00[bc]
T_{11}	13.00	12.00	12.50	17.50	16.50	17.00	22.00	22.00	22.00[cd]
Mean	13.36	13.09		17.18	16.86		22.54	22.77	
CD (Season)	NS			NS			NS		
CD (Treatments)	NS			NS			0.73		
CD (Season x Treatments)	NS			NS			NS		
CV	9.47			4.42			2.20		

4.3.3. Plant height

Plant height was recorded at 30 DAS and at the time of harvest. Analysed data of both the varieties are furnished in Table 20a and 20b.

4.3.3.1. Plant height at 30 DAS

Plant height at 30 DAS depicted in the form of data presented in Table 20a and Table 20b showed that fertilizer schedule significantly influenced the plant height at 30 DAS in both the varieties. Plants of variety CO-4 were found significantly tall in T_6 (15.57 cm) followed T_{11} (15.03 cm) and shortest plants were found in T_3 (12.83 cm) and this was on par with T_{10} (12.99 cm).In Theni Local, the tallest plant was observed in T_5 (14.02 cm) followed by T_3 (13.35 cm) and T_4 (13.16 cm) and plant height was lowest in T_8 (9.97 cm).

Height of the plant in both the varieties was significantly influenced by the season of sowing also. In CO-4 variety, plants sown during October – December (15.45 cm) produced tallest plants compared to crop sown during July – September (12.24 cm). Similar effect was observed in variety Theni Local also, the October – December (13.46 cm) sown crop was tallest than July – September (10.48 cm) sown crop.

Interaction effect of season and fertilizer treatments was significant on plant height at 30 DAS. In CO-4, Plant height was highest in T_6S_2 (17.60 cm) followed by T_{11} (16.40 cm) and T_9 (16.35 cm) and it was lowest in T_3S_1 (11.06 cm) and this combination was on par with T_{10} (11.13 cm). In Theni Local highest plant height was recorded in T_5S_2 (15.65 cm) and lowest (8.13 cm) was in T_8S_2.

4.3.3.2. Plant height at harvest

Overall mean of plant height recorded at the time of harvest was influenced by the application of different fertilizer schedules. Both the varieties responded differently to various fertilizer schedules. In CO-4, tallest plants were observed in T_6 (28.75 cm) whereas, short statured plants were observed in T_5 (19.36 cm). In Theni Local, highest plant height was recorded in T_4 (30.69 cm) whereas, lowest plant height was recorded in T_8 (21.28 cm).

Table 20a. Effect of fertilizer schedule and season on plant height and number of leaves of coriander variety CO-4

Treatments / Season	Plant height at 30 DAS (cm)			Plant height at harvest (cm)			Number of leaves at 30 DAS			Number of leaves at harvest		
	S_1	S_1	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	12.67^{i}	15.4^{cd}	14.03^{d}	20.87^{j}	26.55^{d}	23.71^{d}	4.10^{ij}	4.30^{hij}	4.20^{fg}	6.40^{k}	8.30^{e}	7.35^{e}
T_2	13.35^{h}	15.64^{cd}	14.49^{c}	23.63^{i}	28.39^{c}	26.00^{c}	5.00^{ef}	5.40^{cd}	5.20^{c}	6.60^{jk}	9.80^{d}	8.20^{d}
T_3	11.06^{n}	14.60^{ef}	12.83^{h}	14.50^{n}	24.75^{g}	19.63^{h}	4.70^{fg}	4.20^{hij}	4.45^{e}	6.00^{lm}	7.50^{gh}	6.75^{g}
T_4	11.45^{lm}	14.75^{ef}	13.10^{fg}	19.30^{k}	24.78^{fg}	22.04^{f}	4.00^{j}	4.20^{hij}	4.10^{g}	6.00^{lm}	7.40^{gh}	6.70^{gh}
T_5	11.95^{k}	14.65^{ef}	13.30^{f}	14.32^{n}	24.41^{ghi}	19.36^{i}	5.30^{de}	4.40^{ghi}	4.85^{d}	5.80^{m}	7.30^{h}	6.55^{h}
T_6	13.74^{g}	17.60^{a}	15.57^{a}	25.69^{def}	31.82^{a}	28.75^{a}	5.70^{bc}	6.40^{a}	6.05^{a}	7.80^{f}	12.65^{a}	10.22^{a}
T_7	11.82^{k}	15.25^{d}	13.54^{e}	18.65^{l}	25.71^{de}	21.98^{f}	5.00^{ef}	5.00^{ef}	5.00^{cd}	6.10^{k}	7.40^{gh}	6.75^{g}
T_8	11.48^{l}	14.45^{f}	12.97^{gh}	15.77^{m}	24.82^{efg}	20.29^{g}	4.45^{gh}	4.30^{hij}	4.37^{ef}	5.40^{n}	6.80^{ij}	6.10^{i}
T_9	12.31^{j}	16.35^{b}	14.33^{c}	23.75^{hi}	28.49^{c}	26.12^{c}	5.40^{cd}	5.70^{bc}	5.55^{b}	7.00^{i}	10.50^{c}	8.75^{c}
T_{10}	11.13^{mn}	14.85^{e}	12.99^{gh}	19.56^{k}	26.42^{d}	22.99^{e}	4.40^{ghi}	4.20^{hij}	4.30^{efg}	6.00^{lm}	8.20^{e}	7.10^{f}
T_{11}	13.66^{gh}	16.40^{b}	15.033^{b}	24.62^{gh}	29.95^{b}	27.28^{b}	5.50^{bcd}	5.80^{b}	5.65^{b}	7.60^{fg}	11.50^{b}	9.55^{b}
Mean	12.24^{b}	15.45^{a}		20.02^{b}	26.91^{a}		4.86	4.90		6.42^{b}	8.85^{a}	
CD (Season)	0.10			0.27			NS			0.06		
CD (Treatments)	0.23			0.65			0.21			0.15		
CD (Season x Treatments)	0.33			0.91			0.31			0.22		
CV	1.14			1.87			3.03			1.37		

Table 20b. Effect of fertilizer schedule and season on plant height and number of leaves of coriander variety Theni Local

Treatments/ Seasons	Plant height at 30 DAS (cm)			Plant height at harvest (cm)			Number of leaves at 30 DAS			Number of leaves at harvest		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	9.55^{i}	12.50^{de}	11.02^{f}	20.49^{m}	25.25^{ijk}	22.87^{f}	4.60	4.70	4.65^{cde}	8.20^{k}	13.00^{e}	10.60^{e}
T_2	10.95^{gh}	13.20^{c}	12.07^{d}	23.58^{l}	26.04^{ghi}	24.81^{e}	4.60	4.70	4.65^{cde}	8.40^{k}	13.10^{de}	10.75^{de}
T_3	11.61^{f}	15.10^{a}	13.35^{b}	27.00^{efg}	29.17^{bc}	28.08^{c}	4.80	5.10	4.95^{abc}	10.10^{h}	13.90^{bc}	12.00^{b}
T_4	11.25^{fg}	15.08^{a}	13.16^{b}	28.36^{cd}	33.03^{a}	30.69^{a}	4.50	4.40	4.45^{de}	10.77^{f}	14.50^{a}	12.63^{a}
T_5	12.40^{e}	15.65^{a}	14.02^{a}	26.51^{fgh}	28.30	27.40^{c}	5.20	5.50	5.35^{a}	9.20^{i}	13.50^{cd}	11.35^{c}
T_6	8.61^{j}	12.45^{de}	10.53^{g}	26.01^{hi}	27.25^{ef}	26.63^{d}	4.80	4.90	4.85^{bcd}	8.90^{ij}	13.20^{de}	11.05^{cd}
T_7	10.42^{h}	12.55^{de}	11.48^{e}	27.54^{de}	30.05^{b}	28.79^{b}	4.90	5.10	5.00^{abc}	10.20^{gh}	14.25^{ab}	12.22^{b}
T_8	8.13^{j}	11.81^{f}	9.97^{h}	18.19^{op}	24.37^{kl}	21.28^{h}	4.10	4.40	4.25^{e}	7.10^{l}	10.45^{fgh}	8.77^{g}
T_9	10.73^{gh}	13.02^{cd}	11.87^{de}	20.57^{m}	25.67^{hij}	23.12^{f}	4.90	5.20	5.05^{abc}	8.30^{k}	10.55^{fg}	9.42^{f}
T_{10}	10.66^{h}	12.67^{cde}	11.65^{e}	25.03^{jk}	27.01^{ef}	26.01^{d}	5.20	5.40	5.30^{ab}	8.60^{jk}	13.20^{de}	10.90^{de}
T_{11}	10.98^{gh}	14.10^{b}	12.54^{c}	19.43^{n}	24.82^{jk}	22.12^{g}	4.70	4.80	4.75^{cd}	7.40^{l}	10.60^{fg}	9.00^{g}
Mean	10.48^{b}	13.46^{a}		23.88^{b}	27.36^{b}		4.75	4.93		8.83^{b}	12.75^{a}	
CD (Season)	0.17			0.29			NS			0.13		
CD (Treatments)	0.41			0.68			0.46			0.32		
CD (Season x Treatments)	0.58			0.96			NS			0.45		
CV	2.33			1.80			6.43			2.00		

Plant height at the time of harvest was significantly influenced by the season of sowing in both the varieties. Plant height observed during October – December was higher than July – September. In CO-4, mean plant height recorded during October – December was 26.1 cm, whereas, it was 20.02 cm during July – September. Plant height in Theni Local recorded during October – December was 27.36 cm while, it was 23.88 cm during July – September.

The interaction of season and application of different fertilizer schedules had significant effect on plant height at harvest. In CO-4, the highest plant height was observed in T_6S_2 (31.82 cm) at the time of harvest followed by $T_{11}S_2$ (29.95 cm). Lowest plant height was recorded in T_5S_1 (14.32 cm) which was on par with T_3S_1 (14.50 cm). In Theni Local, the highest and lowest values for plant height was recorded in T_4S_2 (33.03 cm) and T_8S_1 (18.19 cm) respectively.

4.3.4. Number of leaves

Number of leaves was counted at 30 DAS and at harvest. Mean values are presented in Table 20a and 20b.

4.3.4.1. Number of leaves at 30 DAS

The **i**nfluence of different fertilizer schedules on the number of leaves of both the varieties at 30 DAS was significant. In CO-4, significantly highest number of leaves was produced in T_6 (6.05). The second highest number of leaves was recorded in T_{11} (5.65) which was on par with T_9 (5.55). Lowest number of leaves was observed in T_4 (4.10) which was on par with control (4.20) and T_{10} (4.30). In variety Theni Local, highest number of leaves was recorded in T_5 (5.35) which was on par with T_{10} (5.30), T_9 (5.30) T_7 (5.05) and T_3 (4.95). Least number of leaves were observed in T_8 (4.25) and this was on par with T_4 (4.45), control (4.65), T_2 (4.65).

The seasonal effect on number of leaves produced in both varieties was non-significant, the number of leaves recorded in CO-4 and Theni Local during both seasons ranged from 4.86-4.90 and 4.73-4.93 respectively.

The interaction effect of season and different fertilizer schedules on number of leaves at 30 DAS was significant in CO-4 whereas it was otherwise in Theni Local.

In CO-4, the highest number of leaves was produced in T_6 (6.05). The least number of leaves was recorded in T_4 (4.00) which was on par with T_1S_1 (4.10), T_3S_1 (4.20), T_4S_2 (4.20), $T_{10}S_2$ (4.20), T_1S_2 (4.30) and T_8S_2 (4.30).

4.3.4.1. Number of leaves at harvest

Number of leaves at harvest was affected by the various fertilizer schedules in both the varieties. In CO-4, highest number of leaves was recorded in T_6 (10.22) followed by T_{11} (9.55) whereas, in Theni Local it was recorded in T_4 (12.63) followed by T_7 (12.22). In both the varieties, lowest number of leaves was recorded T_8 i.e., in CO-4 it was 6.10 and in Theni Local it was 8.77.

Season of sowing also significantly influenced the number of leaves at harvest. In both the varieties October – December season was found to produce highest number of leaves compared to preceding season. In CO-4, number of leaves was 8.85 during October – December whereas; it was 6.42 during July – September. In Theni Local, number of leaves recorded during October – December was 12.75 whereas, it was 8.83 during July – September.

Interaction effect of fertilizer combination and season of sowing had significant influence on number of leaves at harvest. In CO-4, highest number of leaves was produced by T_6S_2 (12.65). Lowest was produced by T_5S_1 (5.80) and this was on par with T_3S_1 (6.00), T_4S_1 (6.00) and $T_{10}S_1$ (6.00). In Theni Local highest number of leaves was recorded in T_4S_2 (14.50) which was on par with T_7S_2 (14.25). Lowest number of leaves was recorded in T_8S_1 (7.10).

4.3.5. Biomass yield

Biomass yield was recorded by weighing individual plant along with root. Individual plant weight as well as plot wise yield was recorded and data pertaining to biomass yield are presented in Table 21a and Table 21b (Plate 5 and Plate 6).

4.3.5.1. Biomass yield per plant

Single plant weight including root was significantly influenced by the application of different fertilizer schedules in both the varieties. In CO-4, the highest biomass yield per plant was recorded in T_6 (10.27 g $plant^{-1}$) followed by

Table 21a. Effect of fertilizer schedule and season on biomass and green leaf yield of coriander variety CO-4

Treatments / Season	Biomass yield per plant (g plant^{-1})			Biomass yield per plot (g m^{-2})			Green leaf yield per plant (g plant^{-1})			Green leaf yield per plot (g m^{-2})		
	S_1	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**
T_1	1.83^{l}	12.68^{d}	7.26^{e}	91.50^{l}	634.10^{d}	362.80^{e}	1.66^{n}	12.19^{de}	6.93^{e}	83.20^{n}	609.70^{de}	346.45^{e}
T_2	2.28^{k}	12.72^{d}	7.50^{d}	113.75^{k}	636.22^{d}	374.98^{d}	2.09^{m}	12.36^{d}	7.22^{d}	104.85^{m}	617.97^{d}	361.41^{d}
T_3	1.56^{n}	12.28^{ef}	6.9^{gh}	78.05^{n}	614.10^{ef}	346.07^{g}	1.38^{qr}	11.79^{h}	6.58^{g}	68.75^{qr}	589.75^{h}	329.25^{g}
T_4	1.61^{mn}	12.29^{ef}	6.95^{fg}	80.50^{mn}	614.48^{ef}	347.49^{fg}	1.53^{nopq}	11.97^{fg}	6.75^{f}	76.30^{nopq}	598.70^{fg}	337.50^{f}
T_5	1.45^{op}	12.26^{f}	6.86^{h}	72.70^{op}	612.90^{f}	342.80^{h}	1.29^{rs}	11.91^{gh}	6.59^{g}	64.40^{rs}	595.25^{gh}	329.83^{g}
T_6	4.13^{h}	16.41^{a}	10.27^{a}	206.45^{h}	820.70^{a}	513.57^{a}	3.99^{j}	16.02^{a}	10.04^{a}	199.55^{j}	800.85^{a}	500.20^{a}
T_7	1.63^{mn}	12.31^{ef}	6.97^{f}	81.25^{mn}	615.73^{ef}	348.49^{fg}	1.43^{opqr}	12.08^{ef}	6.75^{f}	71.80^{opqr}	604.05^{ef}	337.93^{f}
T_8	1.33^{q}	11.63^{g}	6.48^{i}	66.30^{q}	581.90^{g}	324.10^{i}	1.19^{s}	11.37^{i}	6.28^{h}	59.70^{s}	568.45^{i}	314.08^{h}
T_9	2.71^{j}	13.14^{c}	7.92^{c}	135.30^{j}	656.95^{c}	396.15^{c}	2.58^{l}	12.86^{c}	7.72^{c}	129.10^{l}	643.05^{c}	386.08^{c}
T_{10}	1.65^{m}	12.35^{e}	7.00^{f}	82.50^{m}	617.75^{e}	350.12^{f}	1.56^{nop}	11.97^{fg}	6.77^{f}	78.10^{nop}	598.60^{fg}	338.35^{f}
T_{11}	3.23^{i}	13.84^{b}	8.54^{b}	161.45^{i}	692.20^{b}	426.82^{b}	3.10^{k}	13.39^{b}	8.25^{b}	155.0^{k}	669.75^{b}	412.48^{b}
Mean	2.13^{b}	12.09^{a}		106.34	645.18		1.98^{b}	12.54^{a}		99.18^{b}	626.92^{a}	
CD (Season)	0.02			1.16			0.05			2.55		
CD (Treatments)	0.05			2.72			0.12			5.98		
CD (Season x Treatments)	0.07			3.85			0.16			8.46		
CV	0.42			0.49			1.15			1.11		

Table 21b. Effect of fertilizer schedule and season on biomass and green leaf yield of coriander variety Theni Local

Treatments / Season	Biomass yield per plant (g plant^{-1})			Biomass yield per plot (g m^{-2})			Green leaf yield per plant (g plant^{-1})			Green leaf yield per plot (g m^{-2})		
	S_1	**S_1**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**
T_1	5.32^{m}	11.87^{gh}	8.59^{i}	265.75^{m}	593.50	429.62h	5.04^{m}	11.51^{h}	8.27^{g}	252.00^{m}	575.50^{h}	413.75^{g}
T_2	6.07^{l}	12.14^{f}	9.10^{g}	303.58^{l}	606.75^{f}	455.16^{g}	5.81^{l}	11.85^{fg}	8.83^{f}	290.50^{l}	592.50^{fg}	441.50^{f}
T_3	9.40^{i}	13.07^{c}	11.23^{c}	470.00^{i}	653.75^{c}	561.87^{c}	9.16^{i}	13.82^{c}	11.49^{c}	458.25^{i}	691.00^{c}	574.6^{c}
T_4	12.68^{de}	15.92^{a}	14.30^{a}	634.00^{de}	796.25^{a}	715.12^{a}	12.42^{d}	15.51^{a}	13.96^{a}	621.25^{d}	775.50^{a}	698.37^{a}
T_5	8.48^{j}	12.89^{cd}	10.69^{d}	424.30j	644.75^{cd}	534.52^{d}	8.04^{j}	12.41^{d}	10.22^{d}	402.25^{j}	620.50^{d}	511.37^{d}
T_6	8.04^{k}	12.66^{de}	10.35^{e}	402.20^{k}	633.00^{de}	517.60^{e}	7.82^{jk}	12.28^{de}	10.05^{de}	391.00^{jk}	614.25^{de}	502.62^{d}
T_7	12.01^{fg}	15.11^{b}	13.65^{b}	600.55^{fg}	755.50^{b}	678.02^{b}	11.66^{gh}	14.78^{b}	13.22^{b}	583.00^{gh}	739.25^{b}	611.12^{b}
T_8	4.31^{n}	11.65^{h}	7.98^{k}	215.75^{n}	582.50^{h}	399.12^{k}	4.03^{n}	11.50^{h}	7.76^{h}	201.50^{n}	575.25^{h}	388.37^{h}
T_9	5.83^{l}	12.13^{f}	8.98^{h}	291.80^{l}	606.75^{f}	449.27^{g}	5.56	11.87^{fg}	8.71^{f}	278.00^{l}	593.75^{fg}	435.87^{f}
T_{10}	7.84^{k}	12.44^{e}	10.14^{f}	392.35^{k}	622.25^{e}	507.30^{f}	7.6^{k}	12.09^{ef}	9.87^{e}	383.00^{k}	604.50^{ef}	493.75^{e}
T_{11}	4.44^{n}	11.92^{fg}	8.18^{j}	222.10^{n}	596.00^{fg}	409.05^{i}	4.17^{n}	11.49^{h}	7.83^{h}	208.50^{n}	574.50^{h}	391.50^{h}
Mean	7.68^{b}	12.89^{a}		383.85^{b}	644.63^{a}		7.39^{b}	12.64^{a}		369.93^{b}	632.40	
CD (Season)	0.07			3.70			0.07			3.93		
CD (Treatments)	0.17			8.69			0.18			9.22		
CD (Season x Treatments)	0.24			12.29			0.26			13.04		
CV	1.15			1.14			1.26			1.24		

5 t ha^{-1} FYM (Basal)

Plate 5. Superior fertilizer treatment in coriander variety CO-4

5 t ha^{-1} FYM + 20:10:10 kg ha^{-1} NPK (basal)+ 1.5 per cent urea (foliar) 20 DAS

Plate 6. Superior fertilizer treatment in coriander variety Theni Local

T_{11} (8.54 g plant^{-1}) whereas, in Theni Local it was highest (14.30 g plant^{-1}) in T_4 followed by T_7 (13.65 g plant^{-1}). In both the varieties, lowest biomass yield per plant was recorded in T_8 i.e., it was 6.48 g plant^{-1} in CO-4 and 7.98 g plant^{-1} in Theni Local.

Season of sowing also had significant effect on single plant weight. The biomass yield of CO-4 as well as Theni Local was higher during October – December. Biomass yield recorded in CO-4 and Theni Local during October – December was 12.09 g plant^{-1} and 12.89 g plant^{-1} respectively. During July – September it was 2.13 g plant^{-1} and 7.68 g plant^{-1} respectively.

Interaction effect of season of sowing and fertilizer schedules was significant on biomass yield in both the varieties. In CO-4, highest biomass yield was recorded in T_6S_2 (16.41 g plant^{-1}) followed by $T_{11}S_2$ (13.84 g plant^{-1}). In Theni Local, highest biomass was found T_4S_2 (15.92 g plant^{-1}) followed by T_7 (15.11 g plant^{-1}). In both the varieties lowest biomass yield per plant was recorded in T_8S_1. In CO-4 and Theni local it was 1.33 g plant^{-1} and 4.31 g plant^{-1} respectively.

4.3.5.2. Biomass yield per plot

Biomass yield from unit area (1 m^2) was significantly influenced by the application of various fertilizer schedules. Data furnished in Table 4a and Table 4b indicated that among different fertilizer schedules, T_6 (513.57 g m^{-2}) produced highest biomass yield per plot followed by T_{11} (426.82 g m^{-2}) in CO-4. In variety Theni Local, highest biomass yield per plant was recorded in T_4 (715.12 g m^{-2}) followed by T_7 (678.02 g m^{-2}). Plot wise biomass yield in both the varieties was observed in T_8 i.e., 324.10 g m^{-2}in CO-4 and 399.12 g m^{-2} in Theni Local).

Season of sowing had significant influence of biomass yield per plot, irrespective of fertilizer schedules. Both the varieties were found to produce highest biomass yield per plot during October – December. Biomass yield per plot recorded during October – December in CO-4 and Theni Local was 645.18 g m^{-2} and 644.63 g m^{-2} respectively whereas it was 106.34 g m^{-2} and 383.85 g m^{-2} during July – September.

Interaction effect of season of sowing and fertilizer schedule was also significant in CO-4 as well as Theni Local with respect to biomass yield per plot. In CO-4, highest biomass yield per plot was recorded in T_6S_2 (820.70 g m^{-2}) followed T_{11} (692.20 g m^{-2}). In Theni Local it was highest in T_4 (715.12 g m^{-2}) followed by T_7 (755.50 g m^{-2}). Lowest biomass yield in CO-4 as well as in Theni Local was observed in T_8. Lowest value recorded in CO-4 was 66.30 g m^{-2}. In Theni Local it was 215.75 g m^{-2} which was on par with T_{11} (222.10 g m^{-2}).

4.3.6. Green leaf yield

Data on yield in terms of green leaves per plant and green leaves per plot are presented in Table 21a and Table 21b respectively.

4.3.6.1. *Green leaf yield per plant*

Green leaves produced by single plant was significantly influenced by the fertilizer schedules. Highest green leaf yield of CO-4 was recorded in T_6 (10.04 g $plant^{-1}$) followed by T_{11} (8.25 g $plant^{-1}$) whereas, the highest herbage yield per plant in Theni Local was observed in T_4 (13.96 g $plant^{-1}$) followed by T_7 (13.22 g $plant^{-1}$). Lowest green leaf yield per plant in both the varieties was recorded in T_8. Lowest herbage yield in CO-4 and Theni Local was 6.28 g $plant^{-1}$ and 7.76 g $plant^{-1}$ respectively.

The individual effect of season of sowing on herbage yield was also significant. Both the varieties produced highest herbage yield during October – December. Herbage yield in CO-4 was 12.54 g $plant^{-1}$ and in Theni it was 12.64 g $plant^{-1}$. Lowest herbage yield in CO-4 was 1.98 g $plant^{-1}$ recorded during July – September. Herbage yield per plant in Theni was 7.39 g $plant^{-1}$ in the same season.

The data presented in Table 4a and Table 4b revealed that interaction effect of sowing season and fertilizer schedule on herbage yield per plant remained significant. Thus, in variety CO-4, significantly highest green leaf yield per plant was found in T_6S_2 (16.02 g $plant^{-1}$). In Theni Local, highest herbage yield was found in T_4S_2 (15.51 g $plant^{-1}$). In both the varieties lowest yield was recorded in T_8S_2. In CO-4, lowest herbage yield was 1.19 g $plant^{-1}$ which was on par with T_5 (1.29 g $plant^{-1}$). In

Theni Local, lowest herbage yield recorded was 4.03 g plant^{-1} which was on par with T_{11} (4.17 g plant^{-1}).

4.3.6.2. Green leaf yield per plot

Plot wise herbage yield was significantly influenced by the fertilizer schedules applied. In CO-4, highest green leaf yield was recorded in T_6 (500.20 g m^{-2}) followed by T_{11} (412.48 g m^{-2}). In Theni Local, herbage yield per plot was higher in T_4 (698.37 g m^{-2}) followed by T_7 (611.12 g m^{-2}). Lowest herbage yield was recorded in T_8 in both the varieties. In CO-4, lowest herbage yield was 314.08 g m^{-2}. In Theni Local it was 388.37 g m^{-2} and this was on par with T_{11} (391.50 g m^{-2}).

Herbage yield obtained from unit area was also significantly affected by the influence of season of sowing. Highest herbage in CO-4 and Theni Local was recorded in T_6 (500.20 g m^{-2}) and T_4 (698.37 g m^{-2}) respectively. T_8 gave lowest herbage yield in both varieties i.e.., in CO-4 it was 314.08 g m^{-2} and in Theni Local it was 388.37 g m^{-2}.

Interaction effect of season of sowing and fertilizer schedule was significant in terms of plot wise herbage yield too. In CO-4, highest herbage yield was recorded in T_6S_2 (800.85 g m^{-2}) whereas in Theni Local highest yield was recorded in T_4S_2 (775.50 g m^{-2}). The lowest herbage yield observed in CO-4 and Theni Local was 59.70 g m^{-2} and 201.50 g m^{-2} respectively in T_8S_2.

4.3.7. Vitamin C content

Data given in Table 22a and Table 22b revealed that, ascorbic acid content of both the varieties was significantly influenced by the individual effect of fertilizer schedule. In CO-4, highest vitamin C content was recorded in T_{11} (65.78 mg per 100g) followed by T_6 (65.15 mg per 100g). In Theni Local, the highest ascorbic acid content was obtained in T_4 (87.05 mg per 100g) which was statistically on par with T_7 (86.75 mg per 100g). Lowest vitamin C content in both the varieties was observed in T_8 i.e., in CO-4 it was 57.87 mg per 100g and in Theni Local it was 74.42 mg per 100g.

Table 22a. Effect of fertilizer schedule and season on vitamin C content and volatile oil content of coriander variety CO-4

Treatments/ Season	Vitamin C content (mg/100g)			Volatile oil (%)		
	S_1	**S_2**	**Mean**	S_1	S_2	Mean
T_1	38.50^{k}	87.70^{b}	63.10^{e}	0.1	0.1	0.1
T_2	39.10	88.33^{b}	63.71^{d}	0.1	0.1	0.1
T_3	37.05^{mn}	85.80^{d}	61.42^{g}	0.1	0.1	0.1
T_4	37.40^{lm}	86.00^{cd}	61.70^{g}	0.1	0.1	0.1
T_5	34.10^{op}	83.50^{f}	58.80^{i}	0.1	0.1	0.1
T_6	40.10^{i}	90.25^{a}	65.17^{b}	0.1	0.1	0.1
T_7	36.70^{n}	84.30^{e}	60.50^{h}	0.1	0.1	0.1
T_8	33.65^{p}	82.10^{g}	57.87^{j}	0.1	0.1	0.1
T_9	39.50^{ij}	89.70^{a}	64.60^{c}	0.1	0.1	0.1
T_{10}	37.75^{l}	86.60^{c}	62.17^{f}	0.1	0.1	0.1
T_{11}	41.23^{h}	90.33^{a}	65.78^{a}	0.1	0.1	0.1
Mean	37.73^{b}	86.78^{a}		0.1	0.1	
CD (Season)	0.19			NS		
CD (Treatments)	0.46			NS		
CD (Season x	0.65			NS		
CV	0.50			N/A		

Season of sowing too had significant effect on producing vitamin C in leaves. In both the varieties highest vitamin C content was recorded in October – December followed by the preceding season. In CO-4, vitamin C content produced during October – September (86.78mg per 100g) was found two times higher than that produced during July – September (37.73 mg per 100g). In Theni Local, vitamin C content recorded during October – December was 86.78 mg per 100g whereas, it was 74.24 mg per 100g during July – September.

Synergic action of season of sowing and fertilizer schedule on vitamin C content was evident. In CO-4, highest vitamin C content was recorded in $T_{11}S_2$ (90.33 mg per 100g) which was on par with T_6S_2 (90.25 mg per 100g).

Table 22b. Effect of fertilizer schedule and season on vitamin C content and volatile oil of coriander variety Theni Local

Treatments/ Season	Vitamin C content (mg/100g)			Volatile oil (%)		
	S_1	**S_2**	**Mean**	S_1	S_2	Mean
T_1	70.15^{n}	81.50^{h}	75.82^{h}	0.1	0.1	0.1
T_2	74.65^{k}	88.29^{d}	81.47^{c}	0.1	0.1	0.1
T_3	72.40^{m}	82.95^{g}	77.67^{f}	0.1	0.1	0.1
T_4	79.55^{i}	94.55^{a}	87.05^{a}	0.1	0.1	0.1
T_5	70.75^{n}	82.30^{g}	76.5^{g}	0.1	0.1	0.1
T_6	73.25^{l}	84.80^{f}	79.02^{e}	0.1	0.1	0.1
T_7	79.40^{i}	93.75^{b}	86.57^{a}	0.1	0.1	0.1
T_8	69.35^{o}	79.50^{i}	74.42^{i}	0.1	0.1	0.1
T_9	78.10^{j}	92.50^{c}	85.30^{b}	0.1	0.1	0.1
T_{10}	74.55^{k}	87.75^{d}	81.15^{c}	0.1	0.1	0.1
T_{11}	74.50^{k}	86.00^{e}	80.25^{d}	0.1	0.1	0.1
Mean	74.24^{b}	86.71^{a}		0.1	0.1	
CD (Season)	0.21			NS		
CD (Treatments)	0.49			NS		
CD (Season x	0.69			NS		
CV	0.41			N/A		

In Theni Local, highest vitamin C was yielded in T_4S_2 (94.55 mg per 100g) combination. T_8S_2 recorded lowest value in terms of vitamin C content in both varieties. In CO-4 it was 33.65 mg per 100g and it was on par with T_5 (34.10 mg per 100g). In Theni Local it was 69.35 mg per 100g.

4.3.8. Volatile oil

Volatile oil present in leaf was extracted using Clevenger apparatus. Oil collected was pale yellowish brown in colour. The volatile oil content of both the varieties seemed unaltered by the fertilizer schedule, season of sowing, and the interaction of these two factors.

4.3.9. Chlorophyll content

Chlorophyll content of both the varieties was estimated using DMSO method. The mean values are presented in Table 23a and Table 23b. In CO-4, data of chlorophyll analysis during October – December is unavailable.

Table 23a. Effect of fertilizer schedule and season on chlorophyll content of coriander variety CO-4

Treatments / Season	Chlorophyll 'a' (mg g^{-1})	Chlorophyll 'b' (mg g^{-1})	Total chlorophyll (mg g^{-1})
	Mean	Mean	Mean
T_1	1.015^{b}	0.361^{cd}	1.375^{b}
T_2	1.112^{a}	0.412^{a}	1.525^{a}
T_3	0.935^{e}	0.333^{e}	1.268^{c}
T_4	0.953^{cde}	0.339^{e}	1.291^{c}
T_5	0.995^{bc}	0.391^{b}	1.385^{b}
T_6	0.762^{g}	0.290^{f}	1.051^{e}
T_7	0.946^{de}	0.348^{de}	1.293^{c}
T_8	0.988^{bcd}	0.369^{c}	1.357^{b}
T_9	0.994^{bc}	0.378^{bc}	1.372^{b}
T_{10}	0.890^{f}	0.335^{e}	1.224^{d}
T_{11}	0.764^{g}	0.273^{g}	1.036^{e}
CD (Treatments)	0.043	0.019	0.037
CV	2.03	2.41	1.29

4.3.9.1. Chlorophyll 'a' content

Chlorophyll 'a' content varied with the fertilizer schedule applied. In both the varieties, the highest chlorophyll 'a' content was recorded in T_2. In CO-4 it was 1.112 mg g^{-1} and Theni Local it was 1.643 mg g^{-1}. In CO-4, lowest chlorophyll 'a' content was observed in T_{11} (0.764 mg g^{-1}). In Theni Local, lowest chlorophyll 'a' was found in T_3 (1.020 mg g^{-1}) which was on par with T_{11} (1.143 mg g^{-1}), T_9 (1.178 mg g^{-1}) and T_7 (1.197 mg g^{-1}).

Season of sowing too had significant effect on chlorophyll 'a' content of the variety Theni Local. Highest chlorophyll 'a' content was observed during October – December whereas, it was lowest during July – September (1.221 mg g^{-1}).

Interaction effect of season and fertilizer schedule was also significant on chlorophyll 'a' content of Theni Local. Highest (2.134 mg g^{-1}) chlorophyll 'b'

Table 23b. Effect of fertilizer schedule and season on chlorophyll content of coriander variety Theni Local

Treatments/ Season	Chlorophyll 'a' (mg g^{-1})			Chlorophyll 'b' (mg g^{-1})			Total chlorophyll (mg g^{-1})		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	1.282^{fghi}	1.421^{de}	1.351^{c}	0.386^{fgh}	0.625^{b}	0.506^{b}	1.668^{g}	2.046^{d}	1.857^{c}
T_2	1.153^{jk}	2.134^{a}	1.643^{a}	0.352^{hi}	0.368^{ghi}	0.360^{e}	1.505^{h}	2. 502^{a}	2.003^{a}
T_3	1.146^{jk}	0.895^{m}	1.020^{d}	0.353^{hi}	1.635^{a}	0.994^{a}	1.499^{h}	2.529^{a}	2.014^{a}
T_4	1.039^{kl}	1.889^{b}	1.464^{b}	0.324^{ij}	0.295^{j}	0.309^{f}	1.364^{j}	2.184^{c}	1.774^{d}
T_5	0.998^{lm}	1.655^{c}	1.327^{c}	0.368^{ghi}	0.647^{b}	0.508^{b}	1.366^{j}	2.302^{b}	1.834^{c}
T_6	1.164^{hijk}	2.091^{a}	1.627^{a}	0.354^{hi}	0.184^{k}	0.269^{g}	1.518^{h}	2.274^{b}	1.896^{b}
T_7	1.158^{ijk}	1.236^{ghij}	1.197^{d}	0.355^{hi}	0.538^{c}	0.446^{cd}	1.513^{h}	1.774^{f}	1.643^{e}
T_8	1.488^{d}	1.228^{ghij}	1.358^{c}	0.421^{ef}	0.457^{de}	0.439^{cd}	1.908^{e}	1.684^{g}	1.796^{d}
T_9	1.337^{efg}	1.019^{lm}	1.178^{d}	0.413^{efg}	0.361^{hi}	0.387^{e}	1.750^{fg}	1.381^{ij}	1.565^{f}
T_{10}	1.387^{def}	1.248^{ghij}	1.317^{c}	0.415^{ef}	0.491^{d}	0.453^{c}	1.80^{f}	1.738^{fg}	1.770^{d}
T_{11}	1.284^{fgh}	1.002^{lm}	1.143^{d}	0.383^{fgh}	0.453^{de}	0.418^{d}	1.667^{g}	1.455^{hi}	1.561^{f}
Mean	1.221^{b}	1.438^{a}		0.375^{b}	0.550^{a}		1.596^{b}	1.988^{a}	
CD (Season)	0.038			0.014			0.025		
CD (Treatments)	0.089			0.033			0.059		
CD (Season x Treatments)	0.126			0.046			0.083		
CV	4.75			4.83			2.49		

content was recorded in T_2S_2 combination. Lowest (0.895 mg g^{-1}) was in T_3S_2 which was statistically similar to T_5S_1 (0.998 mg g^{-1}), $T_{11}S_2$ (1.002 mg g^{-1}) and T_9S_2 (1.019 mg g^{-1}).

4.3.9.2. Chlorophyll 'b' content

Chlorophyll 'b' content was significantly different among the fertilizer schedules. In CO-4, highest chlorophyll 'b' content was recorded in T_2 (0.412 mg g^{-1}) whereas in Theni Local, highest chlorophyll 'b' was in T_3 (0.994 mg g^{-1}). T_{11} was found to produce lowest (0.273 mg g^{-1}) chlorophyll 'b' in CO-4. In Theni Local, lowest chlorophyll 'b' recorded was 0.269 mg g^{-1} in T_6. Chlorophyll 'b' recorded in Theni Local during both the seasons was significantly different. Highest chlorophyll 'b' content was obtained during October – December (0.550 mg g^{-1}) whereas, lowest was recorded during July – September (0.375 mg g^{-1}).

Interaction effect of season and fertilizer schedule was found significant in terms of chlorophyll 'b' content of Theni Local. Highest (1.635 mg g^{-1}) chlorophyll 'b' was recorded in T_3S_2 combination. Lowest (0.184 mg g^{-1}) was in T_6S_2.

4.3.9.3. Total chlorophyll

Total chlorophyll content varied significantly with the fertilizer schedule in both the varieties. Similar to chlorophyll 'a' and 'b' content in CO-4, highest total chlorophyll content was also recorded in T_2 (1.525 mg g^{-1}). Similarly, in Theni Local, total chlorophyll content was highest in T_3 (2.014 mg g^{-1}). In CO-4, the lowest total chlorophyll content recorded in T_{11} (1.037 mg g^{-1}) which was on par with T_6 (1.051 mg g^{-1}). In Theni Local, total chlorophyll was lowest (1.561 mg g^{-1}) in T_{11} and this was on par with T_9 (1.565 mg g^{-1}).

Season of sowing had significant effect on total chlorophyll content of Theni Local. Similar to the quantitative parameters such as biomass yield and green leaf yield, total chlorophyll was also found highest (1.988 mg g^{-1}) during October – December. During July – September, it was 1.596 mg g^{-1}.

In Theni Local, interaction effect of season and fertilizer schedule on total chlorophyll content of leaves was significant. Highest total chlorophyll content was recorded in T_3S_2 (2.529 mg g^{-1}) which was on par with T_2S_2 (2.502 mg g^{-1}). Lowest total chlorophyll content was found in T_4 (1.364 mg g^{-1}) and this was statistically closer to T_5 (1.366 mg g^{-1}) and T_9 (1.381 mg g^{-1}).

4.4. STANDARDIZATION OF HARVEST MATURITY

The experiment was conducted to identify the optimum stage of harvest for getting fresh coriander leaves in terms of quantity as well as quality. The coriander varieties chosen for study were CO-4 and Theni Local. Emergence of first serrated leaf was taken as the indication of beginning of reproductive phase. Growth of the plants was observed and recorded as done in other experiments. In the variety CO-4, the serrated leaf was visible thirty-seven days after sprouting and hence the plants were uprooted at 40 DAS i.e., when 50 per cent of the plants showed serrated leaf. The variety Theni Local did not flower at all up to 60DAS, however it was harvested at 40, 45, 50 and 60 days after sprouting to record the growth and yield parameters. Statistically derived data are presented in following pages. In the variety CO-4, the observations on flowering, fruit set and fruit maturity were also recorded in sample plants which were left uncut in the field.

Details of the notations of days to harvest and season of sowing are given below.

T_1 : 40 DAS

T_2 : 45 DAS

T_3 : 50 DAS

T_4 : 60 DAS

S_1 : July – September

S_2 : October – December

4.4.1. Plant height at harvest

The plants of variety CO-4 entered into reproductive phase by the emergence of serrated leaf from 37 DAS. The plants were harvested at 40 DAS when 50 per cent of the population produced serrated leaf. Since there is only one set observation in all the characters, a seasonal comparison only was possible in this variety. The data given in Table 24 revealed that plant height at harvest was significantly different between the seasons of sowing. Tallest plants were observed during October – December (28.75 cm) compared to previous season (20.73 cm).

In the variety Theni Local, harvest at different days had significant influence on plant height. The statistically derived data presented in Table 25 revealed that plant height increased with the delay in harvest. Tallest plants were found in T_4 (27.04 cm) whereas, shortest plants were observed in T_1 (20.98 cm).

The individual effect of season of sowing on plant height at harvest was also significantly different. Tallest plants were observed during October – December (27.26 cm) whereas, lowest plant height was observed during July – September (19.68 cm). The interaction effect 1of harvest maturity and season of sowing on plant height at harvest was also significant. The plant height was found highest in T_4S_2 (31.83 cm) followed by T_3S_2 (27.97 cm). Lowest plant height was recorded in T_1S_2 (18.42 cm) and it was on par with T_2S_2 (18.65 cm).

Table 24. Growth and yield parameters of coriander variety CO-4 at final harvest in different growing seasons

Biometric parameters	S_1	S_2	CD	CV
Plant height (cm)	20.73^b	28.75^a	0.55	2.47
Number of leaves	6.33^b	11.67^a	0.33	4.37
Biomass yield per plant (g $plant^{-1}$)	2.71^b	12.84^a	0.42	6.44
Biomass yield per plot (g m^{-2})	138.57^b	642.10^a	21.30	6.44
Green leaf yield per plant (g $plant^{-1}$)	2.59^b	12.52^a	0.40	6.27
Green leaf yield per plot (g m^{-2})	129.50^b	626.17^c	20.05	6.26

4.4.2. Number of leaves at harvest

In the variety Theni Local, number of leaves increased significantly with delay in harvesting. Highest number of leaves was recorded in T_4 (11.50) whereas, lowest was recorded in T_1 (6.80) (Table 25).

The interaction effect of days to harvest and season of sowing on number of leaves of variety Theni Local was significant. The number of leaves was significantly different among the treatment combinations. Highest number of leaves was observed in T_4S_2

(12.13) whereas, lowest number of leaves was recorded in T_1S_1 (6.67) and it was on par with T_2S_2 (6.93).

Season of sowing had significant influence on number of leaves at the time of harvest. In both varieties, the highest number of leaves was recorded during October – December. In variety CO-4, it was 11.67 whereas in variety Theni Local, it was 9.77. The number of leaves recorded during July – September in variety CO-4 and variety Theni Local were 6.33 and 9.31 respectively.

Table 25. Plant height and number of leaves of coriander variety Theni Local at different harvest maturity and growing seasons

Treatments/ Season	Plant height (cm)			Number of leaves		
	S_1	S_2	Mean	S_1	S_2	Mean
T_1	18.42^{g}	23.53^{d}	20.98^{d}	6.67^{e}	6.93^{e}	6.80^{d}
T_2	18.65^{fg}	25.73^{c}	22.19^{c}	9.73^{cd}	9.17^{d}	9.45^{c}
T_3	19.42^{f}	27.97^{b}	23.69^{b}	10.00^{c}	10.86^{b}	10.43^{b}
T_4	22.24^{d}	31.83^{a}	27.04^{a}	10.86^{b}	12.13^{a}	11.50^{a}
Mean	19.68^{b}	27.26^{a}		9.31^{b}	9.77^{a}	
CD (Season)	0.48			0.27		
CD (Treatments)	0.68			0.38		
CD (Season x Treatment)	0.96			0.54		
CV	2.36			3.28		

4.4.3. Biomass yield

Biomass yield was recorded by weighing the individual plants along with the roots at the time of harvest. Plot wise yield was recorded by taking the weight of 50 plants. Statistically derived data are presented in Table 26. Biomass yield of variety CO-4 is given in the Table 24 (Plate 7).

4.4.3.1. Biomass yield per plant

In the variety Theni Local, per plant yield was significantly influenced by the harvest time. The data presented in Table 26 revealed that there was an increase in biomass per plant with the delay in harvest. Highest biomass yield was recorded in T_4

Table 26. Biomass and green leaf yield of coriander variety Theni Local at different harvest maturity and growing season

Treatments/ Season	Biomass yield per plant (g plant^{-1})			Biomass yield per plot (g m^{-2})			Green leaf yield per plant (g plant^{-1})			Green leaf yield per plot (g m^{-2})		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	4.81^g	8.98^d	6.89^d	240.33^h	449.00^d	344.67^d	4.57^g	8.68^d	6.63^d	228.50^h	434.17^d	331.33^d
T_2	5.13^g	9.67^c	7.37^c	256.50^g	480.33^c	368.42^c	4.85^g	9.27^c	7.06^c	242.50^g	463.67^c	353.08^c
T_3	5.84^f	10.93^b	8.39^b	292.33^f	546.50^b	419.42^b	5.57^f	10.57^b	8.07^b	278.67^f	52850^b	403.58^b
T_4	6.54^e	12.21^a	9.37^a	326.73^e	610.23^a	468.48^a	6.19^e	11.82^a	9.01^a	309.50^e	591.33^a	450.42^a
Mean	5.58^b	10.43^a		278.97^b	521.52^a		5.29^b	10.08^a		264.79^b	504.42^a	
CD (Season)	0.14			7.08			0.13			6.87		
CD (Treatments)	0.20			10.02			0.19			9.71		
CD (Season x Treatment)	0.28			14.17			0.27			13.74		
CV	2.01			2.02			2.05			2.04		

CO-4 at 40 DAS

Theni Local at 60 DAS

Plate 7. Coriander varieties at harvest

(9.37 g plant^{-1}) followed by T_3 (8.39 g plant^{-1}). Lowest biomass yield per plant was recorded in T_1 (6.89 g plant^{-1}).

The interaction effect of harvest maturity and season of sowing on biomass yield per plant was significant. In variety Theni Local, highest biomass yield per plant was recorded in T_4S_2 (10.43 g plant^{-1}). The lowest biomass yield per plant was recorded in T_1S_1 (4.81 g plant^{-1}) and it was on par with T_2S_1 (5.13 g plant^{-1}).

The season of sowing also had significant effect on biomass yield of both varieties irrespective of harvesting days. The highest biomass yield per plant was recorded during October - December, i.e., in variety CO-4, it was 12.84 g plant^{-1} and in variety Theni local it was 10.43 g plant^{-1}. The biomass yield per plant recorded in CO-4 and Theni Local during July - September was 2.71 g plant^{-1} and 5.58 g plant^{-1} respectively.

4.4.3.2. Biomass yield per plot

Biomass yield obtained from unit area was significantly affected by the influence of harvest days. In variety Theni Local, highest per plot biomass yield was recorded in T_4 (468.48 g m^{-2}). Biomass yield per plot was lowest in T_1 (344.67 g m^{-2}).

The interaction effect of harvest maturity and season of sowing had significant influence on per plot biomass yield of variety Theni Local. Highest biomass yield per plot was recorded in T_4S_2 (610.23 g m^{-2}) and lowest was recorded in T_1S_1 (240.33 g m^{-2}).

The individual effect of season of sowing on plot wise biomass yield was significant. Irrespective of harvesting days, the biomass yield recorded during both the seasons in the two varieties exhibited significant difference. The biomass yield per plot was highest during October –December. In variety CO-4, yield recorded during October – December was (642.10 g m^{-2}) whereas in variety Theni Local, it was 521.52 g m^{-2}. The biomass yield per plot recorded during July – September in CO-4 and Theni Local was 138.57 g m^{-2} and 278.97 g m^{-2} respectively.

4.4.4. Green leaf yield

The herbage yield was recorded at the time of harvest by taking weight of individual plant without the roots. Green leaf yield of variety Theni Local is given in the Table 26.

4.4.4.1. Green leaf yield per plant

The herbage yield from a single plant significantly varied with the harvesting days in variety Theni Local. The highest herbage yield per plant was recorded in T_4 (9.01 g plant^{-1}). Herbage yield produced by the single plant was lowest in T_1 (6.63 g plant^{-1}).

Herbage yield per plant was also influenced by the interaction effect of days to harvest and season of sowing. Highest herbage yield per plant was recorded in T_4S_2 (11.82 g plant^{-1}) whereas the lowest was recorded in T_1S_1 (4.57 g plant^{-1}) in the variety Theni Local.

The herbage yield and season of sowing was inter related. Herbage production was highest during October – December in both the varieties irrespective of the harvesting days. In variety CO-4, herbage yield produced during October – December was 12.5 g plant^{-1} whereas during July – September, it was 2.59 g plant^{-1}. Similarly in variety Theni Local, herbage yield recorded during October – December was 10.08 g plant^{-1} whereas during July – September, it was 5.29 g plant^{-1}.

4.4.4.2. Green leaf yield per plot

Herbage production from unit area was influenced by the days to harvest in variety Theni Local. The highest herbage yield from the plot was recorded in T_4 (450.42 g m^{-2}). Plot wise herbage yield recorded in T_1 (331.33 g m^{-2}) was lowest.

The interaction effect of harvest maturity and season of sowing had significant influence on herbage yield per plot in Theni Local. Highest herbage yield per plot was recorded in T_4S_2 (591.33 g m^{-2}) whereas the herbage yield per plot recorded in T_1S_1 (228.50 g m^{-2}) combination was found lowest.

The seasonal influence on plot wise herbage yield was significant in both the varieties irrespective of the harvest maturity. In both varieties, highest herbage yield was recorded during October – December. In variety CO-4, herbage yield recorded during October – December was 626.17 g m^{-2} whereas it was 129.50 g m^{-2} during July– September. In variety Theni Local, herbage yield per plot recorded during October – December was 504.42 g m^{-2}. Herbage yield recorded during July – September was 264.79 g m^{-2}.

4.4.5. Vitamin C content

The data presented in Table 28 revealed that ascorbic acid content present in the leaves was increasing with the delay in harvest in coriander variety Theni Local. Highest vitamin C content was recorded in T_4 (84.64 mg per 100g) followed by T_3 (69.52 mg per 100g). Lowest vitamin C content was recorded in T_1 (55.28 mg per 100g).

In variety Theni Local, the interaction effect of days to harvest and season of sowing was significant with respect to the vitamin C content at harvest. The vitamin C content among treatment combinations varied significantly. Highest vitamin C content was recorded in T_4S_1 (86.03 mg per 100g). The lowest vitamin C content was in T_1S_1 (43.90 mg per 100g) and it was on par with T_1S_2 (44.60 mg per 100g).

Seasonal influence was also found significant on vitamin C content of both the varieties at the time of harvest. In both the varieties highest vitamin C content was recorded during October – December i.e., in variety CO-4 (Table 27), it was 85.18 mg per 100g and in Theni Local 74.70 mg per 100g. Lowest vitamin C content recorded in variety CO-4 and Theni Local were 29.26 g per 100g and 63.26 mg per 100g respectively.

4.4.6. Volatile oil content

The volatile oil present in leaves did not vary significantly among different treatments. In both the varieties, the seasonal influence was also non-significant. Interaction effect of days to harvest and season of sowing was also found non-significant.

.**Table 27. Qualitative parameters of CO-4 at harvest in different growing seasons**

Qualitative parameters	S_1	S_2	CD	CV
Vitamin C content (mg/100g)	29.26[b]	85.18[a]	3.12	6.45
Volatile oil (%)	0.1	0.1	NS	N/A
Chlorophyll ‘a’ (mg g^{-1})	1.019[b]	1.619[a]	0.002	0.17
Chlorophyll ‘b’(mg g^{-1})	0.378[b]	0.461[a]	0.004	1.15
Total chlorophyll (mg g^{-1})	1.397[b]	2.079[a]	0.004	0.29

Table 28. Vitamin C and volatile oil content Theni Local at different harvest maturity and growing seasons

Treatment/ Season	Vitamin C content			Volatile oil content		
	S_1	S_2	Mean	S_1	S_2	Mean
T_1	43.90[e]	44.66[e]	55.28[d]	0.1	0.1	0.1
T_2	55.31[d]	74.07[b]	64.69[c]	0.1	0.1	0.1
T_3	64.04[c]	74.99[b]	69.52[b]	0.1	0.1	0.1
T_4	86.20[a]	83.07[a]	84.64[a]	0.1	0.1	0.1
Mean	62.36[b]	74.70[a]		0.1	0.1	
CD (Season)	2.39			NS		
CD (Treatments)	3.39			NS		
CD (Season x Treatments)	4.79			NS		
CV	4.01			N/S		

4.4.4.7. Chlorophyll content

The photosynthetic pigment chlorophyll was estimated at the time of harvest. Chlorophyll ‘a’, chlorophyll ‘b’ and total chlorophyll was calculated and presented in Table 29 for variety Theni Local and Table 27 for variety CO-4.

4.4.7.1. Chlorophyll ‘a’

Chlorophyll ‘a’ content present in the fresh leaves of Theni variety varied significantly. Highest chlorophyll ‘a’ content was recorded in T_4 (1.685 mg g^{-1}) followed by T_2 (1.622 mg g^{-1}). The lowest chlorophyll ‘a’ content was recorded in T_1 (1.052 mg g^{-1}).

Table 29. Chlorophyll content of coriander variety Theni Local at different harvest maturity and growing seasons

Treatment/ Season	Chlorophyll 'a' (mg g^{-1})			Chlorophyll 'b'(mg g^{-1})			Total chlorophyll (mg g^{-1})		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	0.714^{g}	1.391^{e}	$1..052^{d}$	0.289^{g}	0.402^{f}	0.345^{c}	1.009^{h}	1.792^{g}	1.397^{d}
T_2	1.475^{d}	1.769^{b}	1.622^{b}	0.431^{e}	0.520^{c}	0.475^{b}	1.905^{f}	2.289^{c}	2.097^{c}
T_3	1.244^{f}	1.597^{c}	1.420^{c}	0.950^{b}	0.457^{d}	0.703^{a}	2.193^{d}	2.054^{e}	2.123^{b}
T_4	1.387^{e}	1.984^{a}	1.685^{a}	0.971^{a}	0.439^{e}	0.705^{a}	2.358^{b}	2.422^{a}	2.390^{a}
Mean	1.205^{b}	1.685^{a}		0.601^{a}	0.455^{b}		1.865^{b}	2.139^{a}	
CD (Season)	0.004			0.004			0.007		
CD (Treatments)	0.006			0.006			0.009		
CD (Season x Treatments)	0.008			0.008			0.013		
CV	**N/A**			**N/A**			**0.39**		

The influence of interaction effect of days to harvest and season of sowing was significant in variety Theni Local. Highest chlorophyll ‘a’ was recorded in T_4S_2 (1.984 mg g^{-1}) whereas lowest was recorded in T_1S_1 (0.714 mg g^{-1}).

Season of sowing had significant influence on chlorophyll ‘a’ content in both the varieties. In both the varieties, highest chlorophyll ‘a’ content was recorded during October – December. In variety CO-4, chlorophyll content recorded during October – December was 1.619 mg g^{-1} and it was 1.019 mg g^{-1} during July – September. In variety Theni Local, the chlorophyll ‘a’ content recorded during October – December was 1.685 mg g^{-1} whereas, it was 1.205 mg g^{-1} during July – September.

4.4.7.2. Chlorophyll ‘b’

The chlorophyll ‘b’ content in leaves varied significantly when the leaves were harvested at different days. In Theni Local, highest chlorophyll ‘b’ was recorded in T_4 (0.705 mg g^{-1}) which was on par with T_4 (0.703 mg g^{-1}). The chlorophyll ‘b’ content recorded in T_1 (0.345 mg g^{-1}) was found lowest.

The interaction effect of harvest maturity and season of sowing on chlorophyll ‘b’ content was significant in variety Theni Local. Highest chlorophyll ‘b’ was recorded in T_4S_1 (0.971 mg g^{-1}) followed by T_3 (0.950 mg g^{-1}). The lowest chlorophyll ‘b’ content was recorded in T_4S_2 (0.439 mg g^{-1}).

The individual effect of season on chlorophyll ‘b’ content was significant in both the varieties. In variety CO-4, October – December (0.461 mg g^{-1}) was found to record highest chlorophyll ‘b’ content whereas, in variety Theni Local, the highest chlorophyll ‘b’ was recorded during July – September (0.601 mg g^{-1}). The chlorophyll ‘b’ content of CO-4 during July – September was 0.378 mg g^{-1}. In variety Theni Local, chlorophyll ‘b’ content recorded during October – December was 0.455 mg g^{-1}.

4.4.7.3. Total Chlorophyll

Harvesting of coriander leaves at different days had significantly influenced the total chlorophyll content of leaves at the time of harvest. In variety Theni Local, highest total chlorophyll content was recorded in T_4 (2.390 mg g^{-1}) followed by T_3 (2.123 mg g^{-1}). The lowest total chlorophyll content was 1.397 mg g^{-1} recorded in T_1.

The interaction effect of harvest maturity and season of sowing was significantly influenced the total chlorophyll content of variety Theni Local. Highest total chlorophyll content was recorded in T_4S_2 (2.422 mg g^{-1}) combination followed by T_4S_1 (2.358 mg g^{-1}). Lowest total chlorophyll content was recorded in T_1S_1 (1.00 mg g^{-1}).

Influence of individual effect of season on total chlorophyll content of both varieties was significant. In both the varieties, highest total chlorophyll content was recorded during October – December. The total chlorophyll recorded in variety CO-4 and Theni Local during October – December was 2.079 mg g^{-1} and 2.139 mg g^{-1}. Similarly, total chlorophyll recorded during July – September was 1.397 mg g^{-1} and 1.865 mg g^{-1} respectively.

4.4.8. Flowering and fruit set in CO-4

4.4.8. 1. Days to emergence of serrated leaf

The serrated leaf was produced only in the variety CO-4 variety which marked its entry into reproductive phase. The data given in the Table 30 (Plate 8) revealed that serrated leaf emergence did not vary with the two seasons of sowing. During July-September the serrated leaf was visible by 37.75 days and during October-December, by 37.33 days.

Table 30. Flowering and fruiting parameters of coriander variety CO-4

Parameters	CO-4			
	S_1	S_2	CD	CV
Days to emergence of serrated leaf	37.75	37.33	NS	2.19
Days to flowering	43.75	44.50	NS	2.33
Days fruit set	57.41	57.50	NS	3.23
Days to fruit maturity	73.33^b	75.33^a	1.29	2.05

4.4.8.2. Days to flowering

The data given in Table 30 (Plate 8) revealed that days taken for flowering was not affected by the season significantly. The days taken for flowering during July – September was 43.75 whereas, it took 44.50 days for flowering during October – December.

4.4.8.3. Days to fruit set

The data furnished in Table 30 (Plate 8) clearly showed that similar to serrated leaf emergence and flowering, days to fruit set also did not vary significantly in the two seasons. The days taken for flowering was observed from 57.41 to 57.50 days.

4.4.8.4. Days to fruit maturity

Days to fruit maturity was identified by the change of colour of fruit from green to pale yellow. The fruits were harvested at that time and dried. The number of days taken for fruit maturity differed significantly between the seasons (Table 30). Highest number of days taken for fruit maturity was observed during October – December (75.33) whereas, it was 73.33 during July – September.

4.4.8.5. Number of primary and secondary branches

Data given in Table 31 shows that number of primary branches differed significantly between the two seasons. Highest number of primary branches was observed during July – September (3.75) compared to October – December (3.00). Similarly, the number of secondary branches also significantly differed between the two seasons. The number of secondary branches observed during July – September was 3.17 and it was 3.08 during October – December.

Table 31. Umbel characters and seed yield of coriander variety CO-4

Parameters	CO-4			
	S_1	**S_2**	**CD**	**CV**
Number of primary branches/plant	3.75^a	3.00^b	0.51	18.14
Number of secondary branches/plant	3.17	3.08	NS	22.95
Seed yield plant^{-1}	0.050^b	0.14^a	0.021	25.08
Seed yield plot^{-1}	2.48^b	7.37^a	1.04	25.08

4.4.8.6. Seed yield

Seeds were harvested when it turned from dark green to pale yellow colour. The seeds were dried and single plant seed yield and plot wise yield were recorded. The statistically derived data are presented in Table 31.

Serrated leaf

Flowering

Green unripe fruit

Mature fruit

Plate 8. Flowering and fruit set in coriander variety CO-4

4.4.8.6.1. Seed yield per plant

Seeds obtained from single plant significantly differed between two seasons. The highest seed yield per plant was recorded during October – December (0.14 g plant^{-1}) whereas, the seed yield obtained during July – September was 0.050 g plant^{-1}.

4.4.8.6.2. Seed yield per plot

Plot wise seed yield was recorded by taking weight of dried seeds obtained from 50 plants. The highest plot wise seed yield was obtained during October – December (7.37g m^{-2}). The seed yield per plot was lowest during July – September (2.48 g m^{-2}).

4.4.9. Incidence of pests and diseases

Irrespective of the experiments and seasons, both the varieties were susceptible to aphid attack (Plate 9). Aphid infestation was controlled by spraying of imdiacloprid 350 SC at the rate of 3 ml 10 L^{-1} water. The plants were also infested by Tobacco cut worm (*Spodoptera litura*) and it was controlled by spraying quinalphos 25 % at the rate of 2 ml L^{-1} water. There was considerable damage by ants in the experimental plot and it was controlled by drenching chlopyrifos 20 % at the rate 2.5 ml L^{-1} water .

Damping off (*Choaenephora* sp.) was the only disease infection noticed during the initial stages of growth. The disease was controlled by drenching copper oxy chloride 50 WP at the rate of 2g L^{-1} water.

Tobacco cut worm

Aphid

Damping off

Plate 9. Incidence of Pests and diseases

Discussion

5. DISCUSSION

Coriander (*Coriandrum sativum* L.) is an important seed as well as herbal spice used as a common flavouring substance. Whole plant possesses pleasant aroma. Apart from the culinary uses, coriander leaves and grains are also valued for their medicinal value. The demand of the crop is increasing day by day due to its multiple uses. The growth, development and quality of coriander depend on important factors such as season of sowing, seed treatments, plant density, fertilizer schedule and optimum harvest maturity. Plant density, requirement of fertilizer and harvest maturity may vary with the agro climatic regions. Even though, scattered cultivation of coriander for leaf purpose started in high range areas of Kerala, the daily demand of this herbal spice is met from the border states like Tamil Nadu, Karnataka and Andhra Pradesh. Preliminary studies on growing coriander for leaf purpose revealed the scope for its large scale cultivation in plains of Kerala too. Therefore, the present investigation entitled "Standardization of package of practices for leaf coriander (*Coriandrum sativum* L.) under rain shelter" was undertaken to study the response of coriander varieties to different seed treatments, spacing, fertilizer schedules and harvest maturity at Department of Plantation Crops and Spices, College of Horticulture, Vellanikkara. The results obtained from the study are described in the preceding chapter. Efforts have been made to establish the cause of various parameters which were found to be significantly influenced by the treatments applied and they are given in ensuing pages. Related findings of other researchers on these parameters have also been cited to discuss with the results obtained from the present study.

5.1. EFFECT OF SEED TREATMENTS ON GROWTH, YIELD AND QUALITY OF CORIANDER

Efficient germination of seeds is important in agriculture. Uniform growth is essential for the establishment of seedling in field. Seed priming is the seed treatment using water, chemicals and plant growth regulators. Seed treatments have been used for decades and are proven to be an effective method not only to enhance the emergence in adverse conditions, but also to help in the growth and development of plants. It advances the stage of maturity which optimizes the harvesting efficiency that can increase yield potential. It also helps in reducing the use of other agrochemical products during the crop period. Apart from the chemical seed treatments used for disease and pest control, the seed treatment using plant growth regulators are becoming popular now a days. The plant response not only depends on the method of seed treatment, but also by the duration of seed treatment. The present study was undertaken to evaluate the response of coriander varieties, its growth, yield and quality to various pre-sowing seed treatments.

5.1.1. Effect of seed treatments on germination and leaf emergence

Seed treatments had significant influence on sprouting of seeds in both the varieties. Even though, just splitting of seeds (control) gave good germination, earlier sprouting was exhibited by the seeds which received treatments using plant growth regulators (PGR) and water.

Both the varieties responded differently to the seed treatments. The emergence of first leaf was unaffected by the seed treatments in variety CO-4. With regard to the emergence of first leaf of variety Theni Local, seeds treated with plant growth regulator 50 mg L^{-1} GA_3 for 8 h exhibited early emergence followed by hydro priming for 24 h and 20 mg L^{-1} NAA for 8 h. The emergence of second and third leaf of both the varieties indicated better performance with plant growth regulators and hydro priming than control. 50 mg L^{-1} GA_3 for 8 h, hydro priming for 12 h and soaking of seeds in 20 mg L^{-1} NAA for 8 h gave earlier emergence compared to control.

In many seeds, germination and subsequent establishment of seedling can be inhibited by mechanical restriction exerted by the seed coat (Sung and Chiu, 1995). Arif *et al*. (2008) suggested that early emergence of primed seeds might be due to the completion of pre-germinative metabolic activities that makes the plumule and radicle to emerge. The priming improved seed performance might be applicable in part to the decreased lipid peroxidation and increased anti-oxidative activities during seed imbibition (Maroufi *et al*., 2011). Coriander produces seed with heterogeneous maturity range at harvest and long germination period and seed priming is an effective technique to ensure the uniform germination (Bazzigaluppi *et al*., 2013). The early emergence of seeds and germination percentage might be imputed to the induction of synthesis of α amylase, protease and other hydrolytic enzymes by the application of gibberellic acid, as reported by Kumar *et al*. (2018). An earlier study on *Cyclomen hederifolium* plant species showed that concentration of 50 mg L^{-1} GA_3 could significantly support the seed germination (Cornea-cipcigan *et al*., 2020).

5.1.2. Effect of seed treatments on plant height and number of leaves

The plant height recorded at 30 DAS and at harvest was influenced significantly by the seed treatments. In both the varieties, the highest plant height at 30 DAS was recorded in hydro priming of seeds for 24 h and soaking of seeds in 50 mg L^{-1} GA_3 for 8 h. The CO-4, seeds soaked in NAA for 8 h showed poor performance than control in terms of height at initial stages of growth. Highest plant height at harvest was recorded in seed treatment with 50 mg L^{-1} GA_3 for 8 h followed by 20 mg L^{-1} NAA for 8 h.

The variety Theni Local soaked in 50 mg L^{-1} GA_3 for 8 h showed better plant growth and this was on par with the plant growth exhibited by hydro priming for 24 h and soaking in NAA for 8 h. However, it appears from the Fig. 5 that the stratification of coriander seed in water for long period and in plant growth regulators for short period could improve the vegetative growth parameters. The increase in plant height might be due to the stimulation of cell division and cell elongation activities of PGR, increasing the plasticity of cell wall (Paleg, 1965). The effect of plant growth regulators such as GA_3 and NAA irrespective of their concentration could increase the vegetative growth of coriander as reported by Verma (2002). The positive effect of pre-soaking followed by spraying of 50 mg L^{-1} GA_3 at 20 DAS on plant height at 45 days as reported by Verma and Sen (2008) in coriander is also in confirmation with the effect of GA_3 obtained in this experiment. Enhanced plant growth might also be due to the increased osmotic uptake of water and nutrients under the influence of plant growth regulators. In an earlier study, foliar spray of 50 mg L^{-1} GA_3 was found to be effective for influencing the vegetative growth of coriander cv. NRCSS ACr-1 (Singh *et al*., 2012).

Similarly, the positive effect of hydro priming for 24 h on plant height of ground nut was also reported by Oghuehi *et al*. (2013). The foliar spray of GA_3 and

NAA at different growth stages also increased the plant height in coriander (Haokip *et al*., 2016). The plant height of French bean was also increased with the spraying of GA_3 at the initial stages of growth (Noor *et al*., 2017). Similar effects of GA_3 on herb growth (plant height and petiole length) of celery (*Aphium graveolens*) were noted by Mishrsiky (1990). The effect of 10^{-3} M concentration NAA increased the plant height of spinach than control at 60^{th} day (Durrani *et al*., 2010). Several plant growth regulators including 50 mg L^{-1} NAA significantly increased the plant height at harvest than coriander plants sprayed with water (Kuri *et al*., 2015). Gibberellins activate the vegetative growth, mobilization of energy reserves from endosperm and also promotes the fructification by transition process of plants from juvenile to adult (Bano *et al*., 2016).

In general, increase in vegetative growth was observed in primed seeds compared to untreated seeds. The number of leaves in both varieties at initial stage as well as at harvesting stage was significantly different which is depicted in the form of graph (Fig. 6). In both the varieties, highest number of leaves in the early stages of growth was recorded in hydro priming for 24 h, and soaking of seeds in PGR's such as 50 mg L^{-1} GA_3 and 20 mg L^{-1}NAA for 8 h. As the crop neared harvest, highest number of leaves in both the varieties was observed in seeds treated with plant growth regulators followed by hydro priming for longtime compared to control i.e., seed soaked in 50 mg L^{-1} GA_3 and 20 mg L^{-1} NAA for 8 hour and hydro priming for 24 h. The effect of GA_3 on increased number of leaves was also reported by Verma and Sen (2008) in coriander. The effect of application of growth regulators on increased plant growth of coriander might be due the stimulation of cell division and cell elongation.

The result obtained by the plant growth regulators was quite in line with the findings of Verma (2002) in coriander. Durrani *et al*., (2010) have reported increased number of leaves in spinach by the foliar spray of 10^{-3}, 10^{-4} and 10^{-5} M concentration of NAA and Singh *et al*. (2012) got more number of branches in coriander with the foliar application of 50 mg L^{-1} GA_3. Similar findings were also reported by Oghuehi *et al*. (2013) in ground nut.

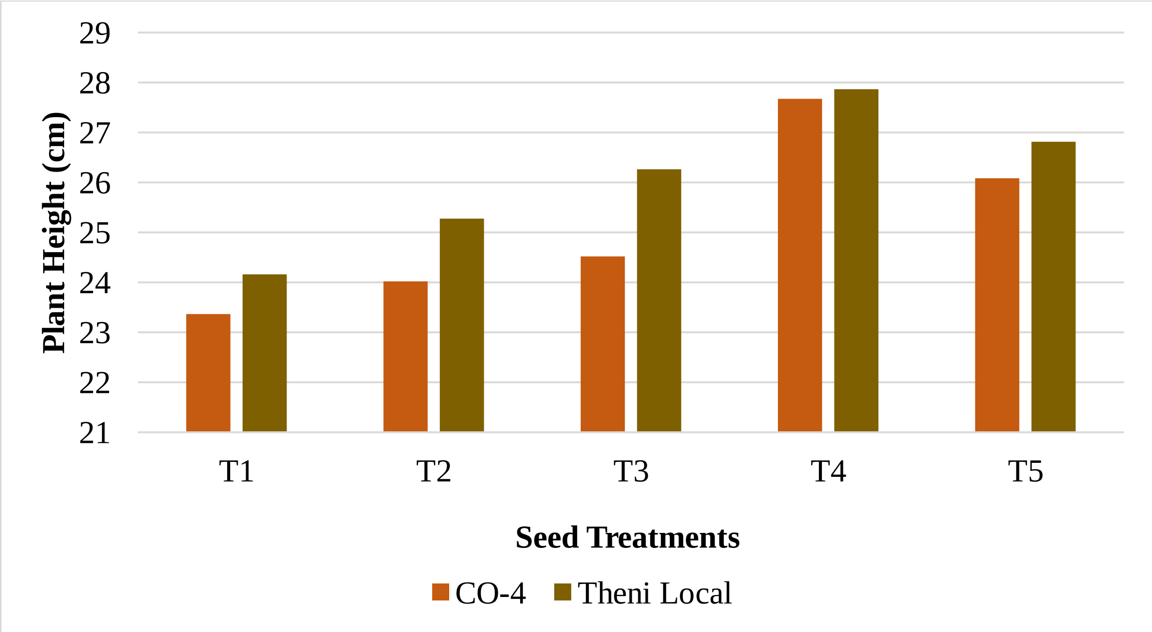
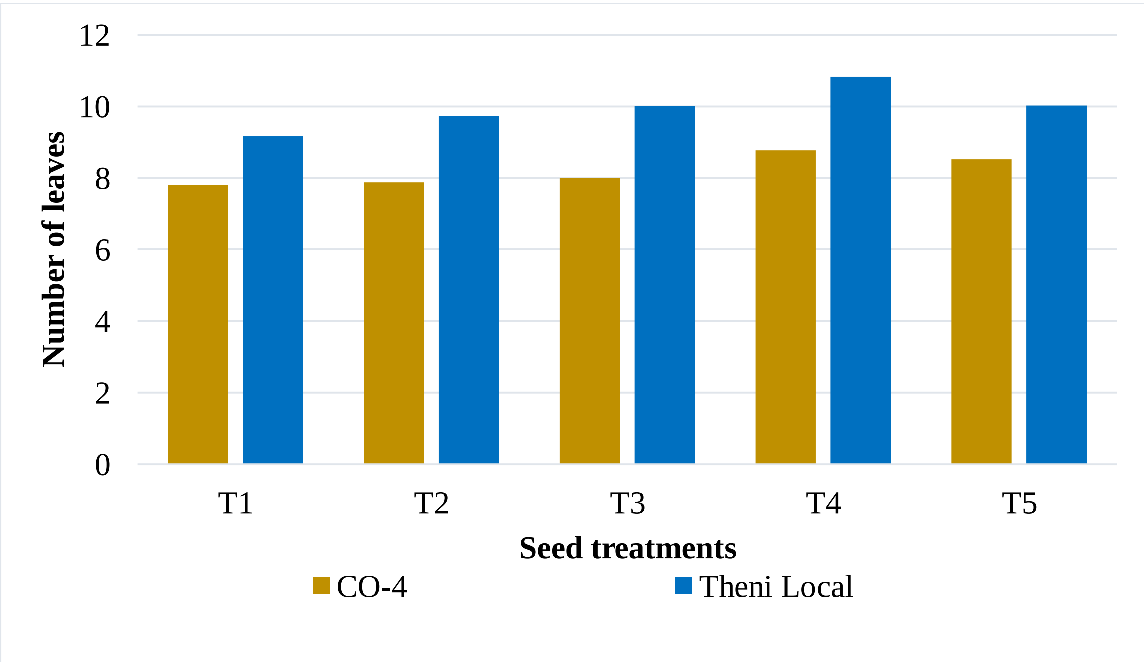


Fig.5. Effect of seed treatments on plant height of coriander varieties



T_1: Control; **T_2**: Hydropriming (12h)**;** **T_3**: Hydropriming (24h); **T_4**: GA_3 50 ppm (8 hours); **T_5**: NAA 20 ppm (8 hours)

Fig.6. Effect of seed treatments on number of leaves of coriander varieties

5.1.3. Effect of seed treatments on yield of coriander

The biomass and herbage yield from a plant is an important factor in coriander, to be considered for leaf purpose. Both the varieties exhibited significant difference in terms of yield than control which is depicted in the form of Fig.7. Both the varieties responded differently to the seed treatments received with regard to biomass and herbage yield. The variety CO-4 responded very well to hydro priming for 24 h giving the highest yield followed by 50 mg L^{-1} GA_3 for 8 h. Variety Theni Local recorded highest biomass yield in hydro primed seeds for 24 h as well as seeds treated with 50 mg L^{-1} GA_3 for 8 h. Response of seeds of both the varieties to NAA in terms of biomass yield was significantly higher than control. The results of the present study revealed that hydro priming for 24 h and soaking of seeds in 50 mg L^{-1} GA_3 for 8 h could produce significantly highest biomass yield than untreated seeds. Similar trend was observed in plot wise biomass yield in which 311.80 g m^{-2} was realized in variety CO-4 and 451.90 g m^{-2} was realized in variety Theni Local. The research findings of Verma (2002) is in line with the result obtained from the present experiment with regard to the effect of GA_3 in coriander. Research findings of Zarei *et al*. (2011) showed that the biomass yield of chickpea increased with the increase in duration of hydro priming to an extent of 6 h. Nouman *et al*. (2012) reported that hydro priming for 8 h effectively increased the biomass yield of *Moringa oleifera*. Exogenous application of GA_3 may distinctly change the morphological traits in plants that can promote biomass allocation to the leaves (Miceli *et al*., 2018).

The herbage yields also followed similar trend as for biomass yield. The response of both the varieties to the seed treatments was different. However, the treated seeds exhibited better performance in terms of per plant as well as per plot herbage yield compared to untreated seeds. Variety CO-4 produced highest herbage yield in seeds which were hydro primed for 24 h followed by soaking in 50 mg L^{-1} GA_3 for 8 h whereas response of variety Theni Local to both these treatments was on par. The positive effect of GA_3 on green leaf yield of coriander was also reported by Swathi (2012). He also suggested that increase in vegetative growth and yield parameters might be not only due to the cell division and cell elongation but also by increasing the plasticity of cell wall. Improved growth due to the PGR application not only increases the photosynthesis but also increases the yield attributes (Singh *et al*., 2012). They also reported that the fresh weight of leaves gradually increased from 40th day and recorded highest at harvest in the plants treated with foliar spray of 50 mg L^{-1} GA_3.

5.1.4. Effect of seed treatments on quality of coriander varieties.

Quality of coriander leaves is determined by the vitamin C, volatile oil and chlorophyll content present in the fresh leaves. Vitamin C is one of the major active compounds responsible for its nutritional value. Among the different factors responsible for the productivity and quality of coriander leaves, seed treatment plays an important role as it increased the vitamin C content of leaves. Highest Vitamin C content of variety CO-4 was found in 50 mg L^{-1} GA_3 treated seeds for 8 h followed by hydro priming for 24 h (Fig. 8). In variety CO- 4, other seed treatments followed had similar effects in vitamin C content. In Theni Local, hydro priming for longer period recorded highest vitamin C content followed by 20 mg L^{-1} NAA for 8 h. Even though hydro priming for 12 h recorded better growth parameters and yield than control, vitamin C recorded in the same treatment was lower than control. The Ascorbic acid is synthesized from the sugars. Kumar *et al*., (2012) have observed maximum ascorbic acid content in strawberry by the application of 80 mg L^{-1} GA_3. The high vitamin C content might be due to the increased synthesis of sugars. It may also be due to the transformation of organic acids to sugars (Jangid *et al*., 2018).

The essential oil present in the immature leaves is responsible for the characteristic aroma and flavour of coriander leaves. Essential oil extraction was performed by hydro distillation method using Clevenger apparatus. In general, the essential oil content did not vary among the treatments. There are reports that essential oil content and its chemical composition in coriander are significantly affected by different factors. The ontogenetic variability is important factor which determines the essential oil content of coriander (Nurzynska-Wierdak, 2013). Application of GA_3 and NAA had significant influence on the essential oil yield of Ajwain as reported by Rohamare *et al*., (2013). The present study speaks about the leaf essential oil and not the seed essential oil, that is reported in most of the studies. However the finding of Raj (2017) who reported that the leaf essential oil content of

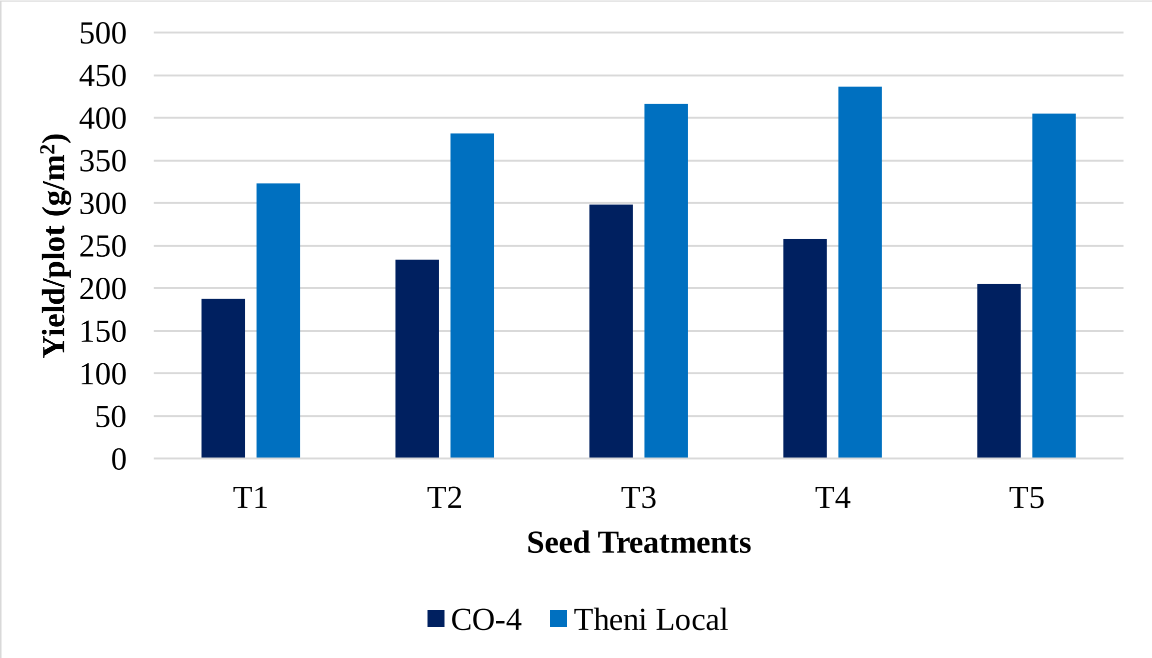
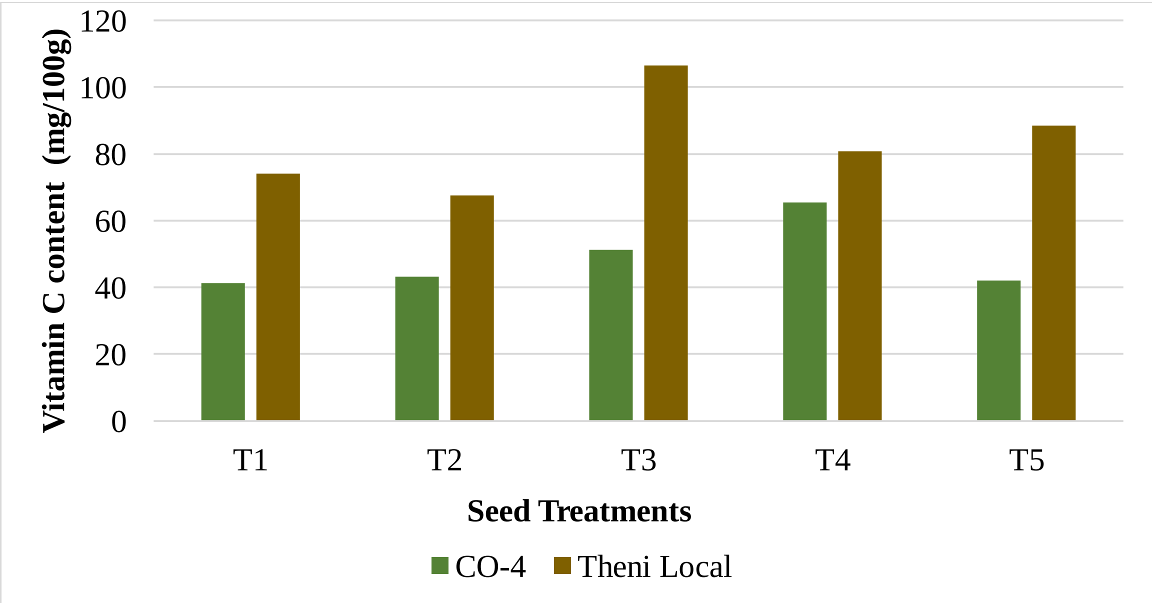


Fig.7. Effect of seed treatments on herbage yield of coriander varieties



T_1: Control; **T_2**: Hydropriming (12h); **T_3**: Hydropriming (24h): **T_4**: GA_3 50 ppm (8h);

T_4: NAA 20 ppm (8h)

Fig.8. Effect of seed treatments on vitamin C content of coriander varieties

various coriander varieties did not vary much is in support of the result obtained in the present study.

Chlorophyll is an important pigment in plant leaves. The highest chlorophyll content in both the varieties was recorded in hydro priming than PGR treated seeds and control, but the duration of hydro priming was different. The chlorophyll ‘a’, ‘b’ and total chlorophyll content of variety CO-4 was highest in seeds hydro primed for 24 h whereas in variety Theni Local, seeds soaked for 12 h gave good results in terms of chlorophyll ‘a’ and total chlorophyll. Hydro priming for longer period (24 h) significantly reduced the chlorophyll content of variety Theni Local. Hydro primng for different durations significantly increased the chlorophyll ‘b’ content *Moringa oleifera* (Nouman *et al*., 2012). Pre-sowing seed treatment with water for 12 h recorded highest total chlorophyll content in *Phaseolus vulgaris* (Mohajeri *et al*., 2017).

In general, it could be concluded that better performance of both the varieties was found in the seeds treated with water and PGRs. The seed treatment by hydro priming for 24 h and 50 mg L^{-1} GA_3 for 8 h were the best seed treatments which increased the growth yield as well as quality parameters.

5.2. EFFECT OF SPACING ON GROWTH, YIELD AND QUALITY OF CORIANDER VARIETIES

Allowing right number of plants to grow in a unit area is quite important as each plant needs certain space for well establishment of roots as well as shoots. The well-established plants give maximum production. The plant density is important to obtain maximum biomass yield of leafy vegetables. Information on the influence of spacing on growth, yield and quality of coriander varieties is useful for crop management studies. This is also useful for analyzing the relationships between plant density and all other parameters. Optimizing the plant densities will not only improve the growth and yield but also reduce the input cost in terms of seed rate and fertilizers without reducing the yield and quality. The present investigation was undertaken to evaluate the performance of coriander varieties under different row spacing. The effects of different row spacing on growth, yield and quality are discussed hereunder.

5.2.1. Effect of spacing on germination and leaf emergence of coriander varieties

The study revealed that the sprouting of seeds as well as the emergence of first second and third leaf was not affected by the spacing followed. It is quite natural that there will not be much competition for inputs during germination of seeds and, the sprouting remained unaffected by the spacing adopted. The findings of Ahmad *et al*. (2004) in germination of fennel seed also support the results obtained in the present study.

5.2.2. Effect of spacing on plant height and number of leaves

Growth and development of plants showed significant increase under different spacing in terms of plant height at initial stages as well as at harvest. The influence of spacing on plant height is depicted in the form of graph in Fig. 9. In the initial stages and at the time of harvest, highest plant height was recorded in closer spacing in both the varieties. Wider spacing also produced tallest plants in variety Theni Local in early stages of growth. It was observed that the plant height decreases with the increase in row spacing. This might be due to increased plant density which accelerated the rate of plant growth. Closer spacing of 5 cm x 5 cm was found to produce tallest plants in leafy vegetable *Moringa oleifera* Lam (Amaglo *et al*., 2007). He also suggested that, the plants tend to compete for essential growth factors such as water, fertilizer and sunlight. Similar findings were reported by Venugopal (2006) in patchouli and Farooq (2013) in coriander. The increased plant height in coriander in closer spacing might be due to the mutual shading of plants which decreased availability of light that led the plant stem to elongate from lower internodes (Sharma *et al*., 2016; Diwan *et al*., 2018). They also suggested that increase in plant height under closer spacing might be checked at certain level due to the unavailability of photosynthates. The increased plant height might also be due to the less space availability for spreading as suggested by Ahmad *et al*., (2004). Moosavi *et al*. (2013) also reported that increase in plant density has a positive effect on plant height of coriander. Pooja *et al*., (2018) observed tallest sacred basil plants in closer spacing.

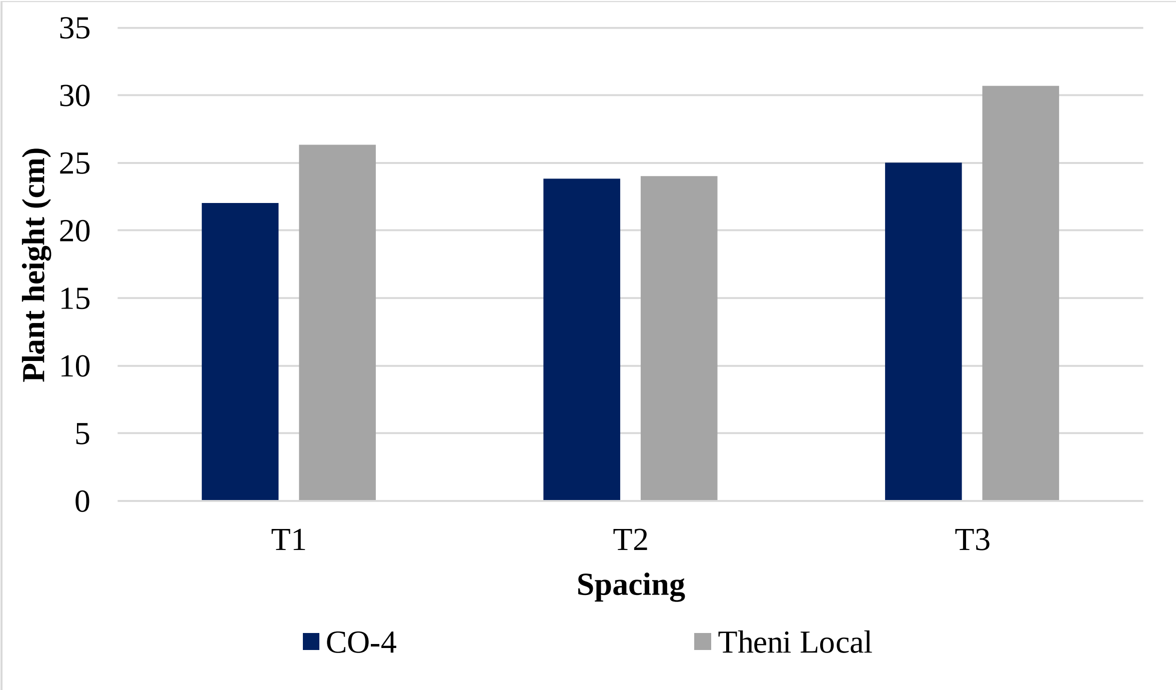
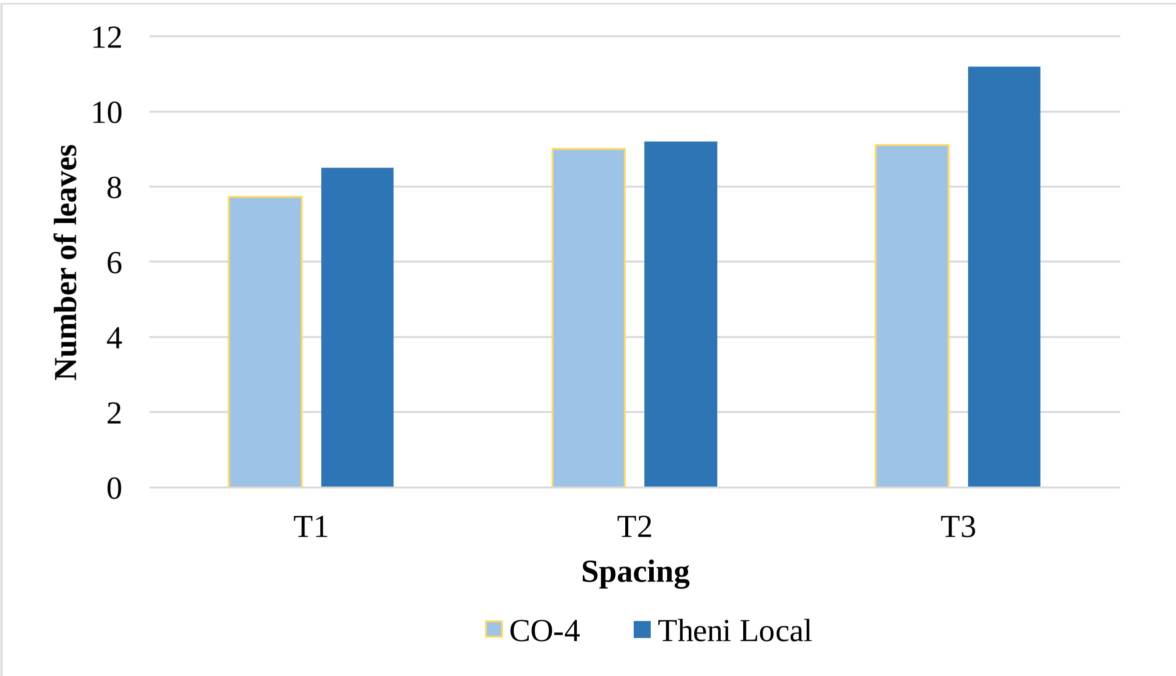


Fig.9. Effect of spacing on plant height at harvest of coriander varieties



$\mathbf{T_1}$: 30 x 10 cm $\mathbf{T_2}$: 20 x 10 cm $\mathbf{T_2}$: 10 x 10 cm

Fig.10. Effect of spacing on number of leaves at harvest in coriander varieties

However, the results obtained from this investigation are in contrast to the findings given by Sharma *et al*. (2016) who found that medium spacing produced tall plants than wider spacing and closer spacing in coriander.

The number of leaves in the initial stages of growth was non significant with respect to spacing. Similar to plant height, number of leaves per plant in both the varieties significantly increased in closer spacing of 10 cm x 10 cm as the crop neared to harvest (Fig.10). This may be due to the mutual support of plant in closer spacing which allow the plants to grow straight and avoid the fall of lower leaves. The lack of mutual support of plants in wider spacing can cause the lower leaves to fall. The results from the present investigation is in contradiction to the findings given by Chinnabba (1991) in mint, Venugopal (2006) in patchouli, Islam *et al*. (2011) in *Capsicum annuum* L., Desai and Mamatha (2016) in tube rose and Kiran (2017) in *kasuri methi*.

5.2.3. Effect of spacing on yield of coriander varieties

With respect to biomass and herbage yield, medium spacing of 20 cm x 10 cm gave the highest yield per plant in variety CO-4 (Fig.11). The highest yield in medium and wider spacing might be due to the abundant growth and spread of plant with less competition. Similar results were obtained by Patil (1994) in green leaf yield of spinach. This is also in line with the findings of Sharma *et al*., (2016) who got highest fresh weight per plant in coriander under medium spacing. In variety Theni Local, highest biomass and herbage per plant was observed in closer spacing of 10 cm x 10 cm. This might be due to taller plants with more number of leaves. The biomass and herbage yield per plot was highest in closer spacing and lowest in wider spacing of 30 cm x 10 cm in both the varieties. Higher plant density in a unit area increased the total biomass and herbage yield. Similar results were also recorded by Jat (1995), Asundi (2001) in Japanese mint, Naruka *et al*. (2012) and Kaur (2019) in coriander. Badi *et al*. (2004) reported that higher vegetative coverage in higher population of plants increased the fresh herbage yield of thyme. Pooja *et al*. (2018) recorded profuse growth of plants and highest fresh yield in narrow spacing in sacred basil. In herbaceous leafy vegetables, the unit area yield is more important than the single plant yield and hence the increased yield from closer spacing obtained in the present study goes in line with the results obtained in similar crops.

5.2.4. Effect of spacing on quality of coriander

The quality parameter ascorbic acid varied with the spacing adopted which is shown in Fig. 12. In variety CO-4, highest vitamin C was obtained in closer spacing of 10 cm x 10 cm as well as in medium spacing of 10 cm x 10 cm. The vitamin C content decreased with the increase in spacing. In variety Theni Local, highest ascorbic acid content was found in medium spacing followed by closer spacing. The findings of Dharmik (1996) in palak and Shimray (2019) in chilli are in contradiction to the result obtained in the present investigation. Ascorbic acid content was also not affected by the spacing followed in broccoli (Roni *et al*., 2014).

The volatile oil content of coriander leaves did not vary with the spacing adopted. But in the same variety CO-4 there are reports that the seed essential oil content of variety CO-4 decreased with the increase in spacing (Farooq, 2013). In another study Sharma *et al*., (2016) got highest essential oil content of coriander seeds under wider spacing and Kadbe *et al*. (2016) got highest essential oil content in dill under medium spacing. The photosynthetic pigment chlorophyll varied with the row spacing followed in coriander. The highest chlorophyll 'a', 'b' and total chlorophyll in variety CO-4 was observed in medium spacing of 20 cm x 10 cm. Chlorophyll 'b' content of variety Theni Local was found highest in wider spacing of 30 cm x 10 cm and closer spacing of 10 cm x 10 cm. The chlorophyll 'a' and total chlorophyll content did not vary with the spacing followed. Reports of wider spacing giving increase in the total chlorophyll content is available in ajwain (Naruka *et al*., 2012) and coriander (Sharma *et al*., 2016). Significantly higher chlorophyll content in wider spacing might be due to the larger space which resulted in profuse growth of plants. Wu *et al*., (2020) opined that the increased chlorophyll content of sprouts of *Perilla friesians* L. might be associated with the internal factors such as net photosynthetic rate and level of intercellular CO_2 concentration.

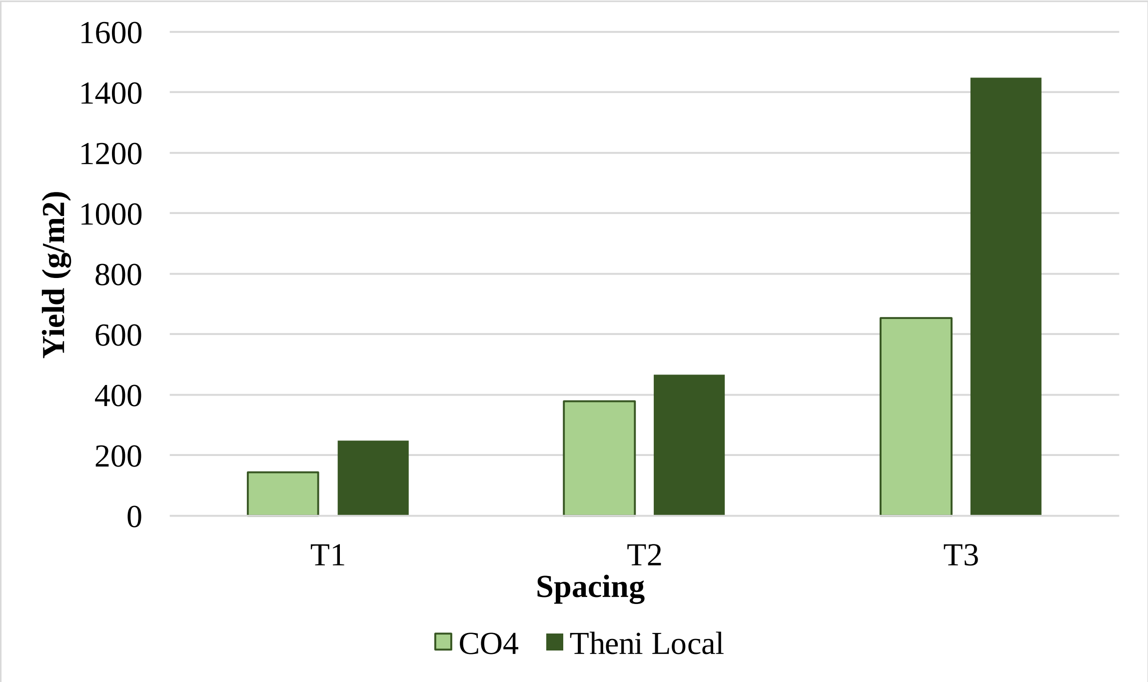
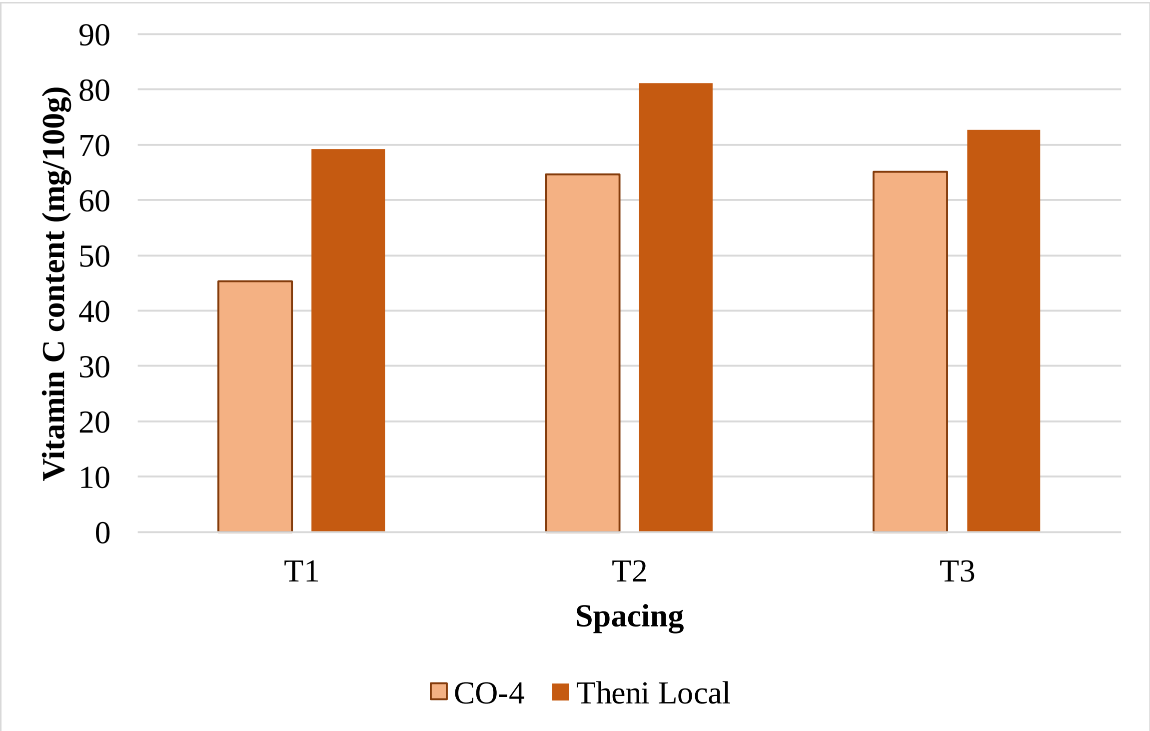


Fig.11. Effect of spacing on herbage yield of coriander varieties



T_1: 30 x 10 cm **T_2**: 20 x 10 cm **T_2**: 10 x 10 cm

Fig.12. Effect of spacing on vitamin C content of coriander varieties

5.3. EFFECT OF FERTILIZER SCHEDULE ON GROWTH, YIELD AND QUALITY OF CORIANDER

One of the most important reasons for low production and yield of plants is the improper and unbalanced fertilizer application. Fertilizer is an unavoidable input that plays an important role in the growth and development of plants. Generally the excessive application of inorganic fertilizers results in inferior quality of the produce as well as creates health problems to humans. Some crops deplete the available soil nutrients in continuous cultivation for a couple of periods. Application of nutrients in the form inorganic or organic fertilizers as basal dose as well as topdressing to the soil helps the plant to grow fast. Foliar application of fertilizer is another technique of feeding plants with liquid form of fertilizers. This makes the plants to absorb fertilizers directly through their leaves. When the soil conditions are unfavourable to the plants, foliar application of fertilizers can be followed. Site specific crop management and proper dosage of fertilizer application helps in attaining good yield and quality produce as well as reduces the cost of production. The present investigation was undertaken to evaluate the performance of coriander varieties to different fertilizers.

5.3.1. Effect of fertilizer schedule on germination and leaf emergence of coriander varieties

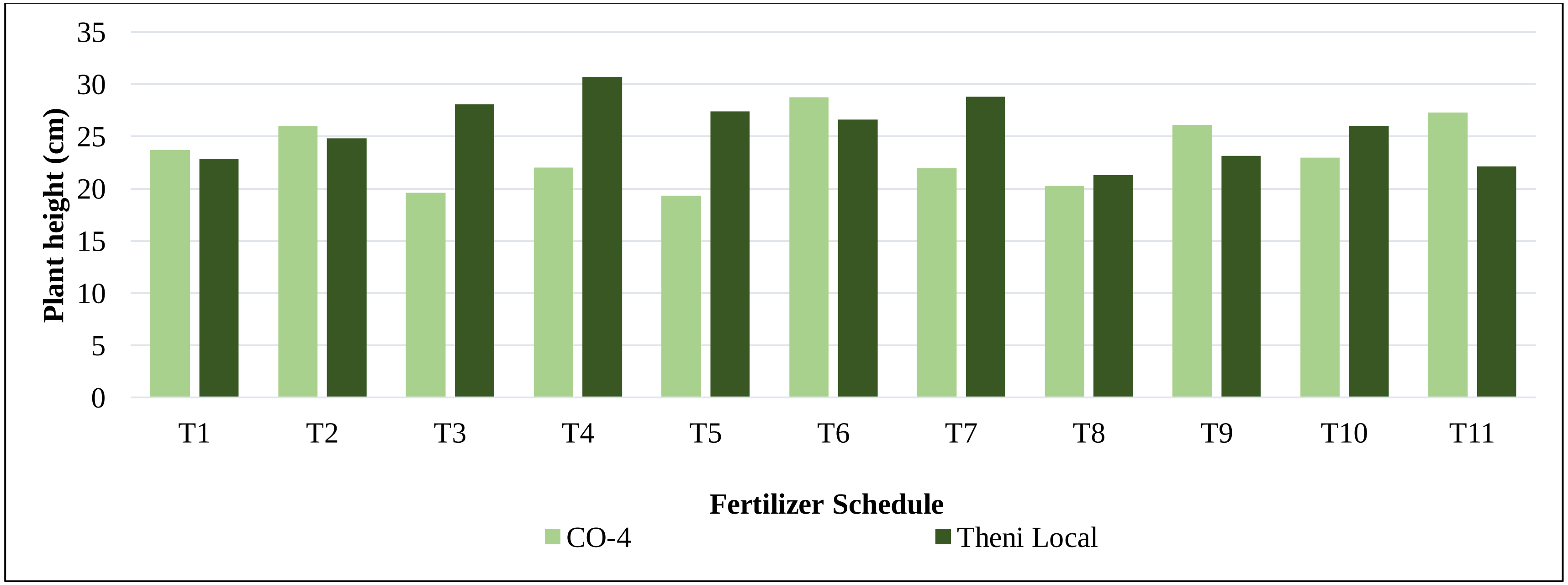
The number of days for sprouting of seeds, first and second leaf emergence was not affected by the fertilizer applied in both the varieties. But, majority of fertilizer schedules including control exhibited early emergence of third leaf. The results obtained from the present investigation are in contradiction to the findings of several researchers in other crops. Coriander being a short duration crop, the root development for absorption of soil nutrients might not be sufficient in the initial stages. And when the plants reached the third leaf stage there could be sufficient uptake of nutrients which was manifested in plant growth.

5.3.2. Effect of fertilizer schedule on plant height and number of leaves

The growth of coriander was significantly influenced by the fertilizer application which is shown in Fig. 13. Basal application of 5t ha^{-1} FYM alone improved plant growth attributes in variety CO-4 significantly over control as well as other fertilizer schedules. This might be due to the growth promoting effects of FYM which improves the soil physical condition, microbial activity and soil aeration. Similar results were also reported by Singh *et al*. (2012) in chickpea. The positive effect of FYM irrespective of quantity was also reported by Joy *et al*. (2005) in black musli (*Curculigo orchioides* Gaertn.). Oad *et al*. (2004) suggested that application of medium quantity of 3 t ha^{-1} FYM increased the plant height over high and low quantity. Application of 5 t ha^{-1} FYM significantly increased the plant height than control (Malhotra, 2006). Khaitov *et al*. (2019) reported the favourable effects of organic manure on growth attributes and nutrient uptake of chilli. In coriander variety Theni Local, tall plants were observed in the fertilizer schedule of 5 t ha^{-1} FYM (basal) +19:19:19 (foliar) at 15 and 30 DAS. This might be due to the combined effect of FYM and 19:19:19 on general nutritional status of plants. Somimol (2012) explained the positive effect of 19:19:19 on plant height of *Capsicum annuum* L. The positive effect of 19:19:19 on nutrient uptake was reported by Bonasode and Math (2018). Foliar application of NPK several times increased the plant height in tomato (Devi, 2016).

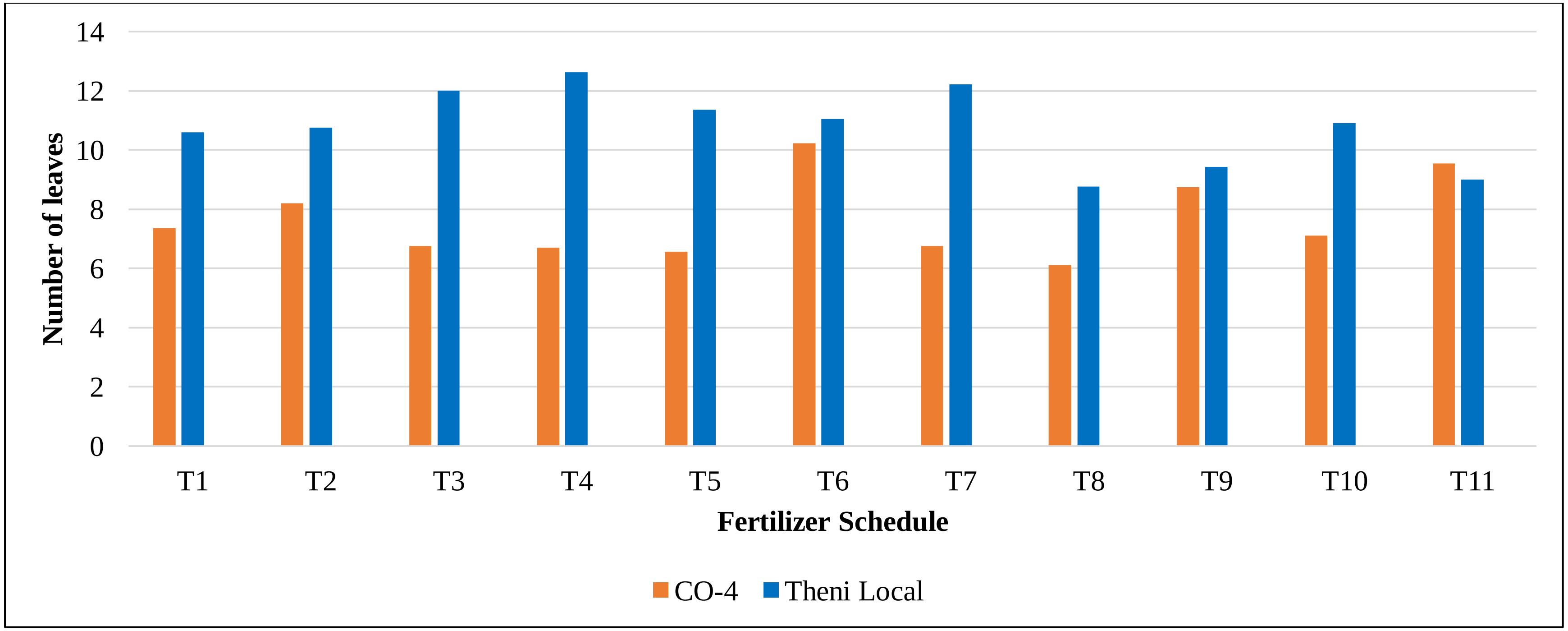
In Theni Local, highest plant height at harvest was observed in a fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+1.5 per cent urea (foliar) at 20 DAS. Higher doses of urea significantly increased the plant height, spike length and other yield attributes in wheat (Khan *et al*., 2009). Sharangi *et al*. (2011) reported that foliar spray of 2.5 per cent urea improved the stem elongation rate of coriander during later phases of regrowth after of tomato plant (Mondal and Mamun, 2011).

The information on effect of fertilizer schedule on number of leaves is given in Fig. 14. Basal application of 5 t ha^{-1} FYM significantly increased the number of leaves in variety CO-4 in initial stages of growth as well at harvest. Higher levels of FYM significantly increased the number of leaves in potato plants (Sahu, 1996). The highest number of leaves of Theni Local during initial stages of growth was recorded in few fertilizer schedules whereas, highest number of leaves at harvest was recorded in the fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+1.5 per cent Urea (foliar) at 20 DAS. Among four doses of foliar spray of urea, higher dose



T_1: Control ; **T_2**: 5t FYM+20:10:10 kg NPK/ha (basal); 10 kg N/ha: 20 DAS (top dressing); **T_3**: 5t FYM+20:10:10 kg NPK/ha (basal); 1% Urea: 20 DAS (foliar) ; **T_4**: 5t FYM +20:10:10 kg NPK/ha (basal);1.5% Urea: 20 DAS (foliar); **T_5**: 5t FYM/ha (basal); 19:19:19: 15, 30 DAS (foliar); **T_6**: 5t FYM/ha (basal) **T_7**: 2.5t VC+20:10:10 kg NPK /ha(basal);10 kg N/ha: 20DAS (top dressing); **T_8**: 2.5t VC+ 20:10:10 kg NPK/ha (basal); 1% Urea: 20 DAS (foliar); **T_9**:2.5t VC + 20:10:10 kg NPK/ha (basal); 1.5% Urea: 20 DAS (foliar) ; **T_{10}**: 2.5t VC/ha (basal); 19:19:19: 15, 30 DAS (foliar); **T_{11}**: 2.5t VC/ha (basal); **VC**: Vermicompost

Fig.13. Effect of fertilizers on plant height of coriander varieties



T_1: Control ; **T_2**: 5t FYM+20:10:10 kg NPK/ha (basal); 10 kg N/ha: 20 DAS (top dressing); **T_3**: 5t FYM+20:10:10 kg NPK/ha (basal); 1% Urea: 20 DAS (foliar) ; **T_4**: 5t FYM +20:10:10 kg NPK/ha (basal);1.5% Urea: 20 DAS (foliar); **T_5**: 5t FYM/ha (basal); 19:19:19: 15, 30 DAS (foliar); **T_6**: 5t FYM/ha (basal) **T_7**: 2.5t VC+20:10:10 kg NPK /ha(basal);10 kg N/ha: 20DAS (top dressing); **T_8**: 2.5t VC+ 20:10:10 kg NPK/ha (basal); 1% Urea: 20 DAS (foliar); **T_9**:2.5t VC + 20:10:10 kg NPK/ha (basal); 1.5% Urea: 20 DAS (foliar) ; **T_{10}**: 2.5t VC/ha (basal); 19:19:19: 15, 30 DAS (foliar); **T_{11}**: 2.5t VC/ha (basal); **VC**: Vermicompost

Fig. 14. Effect of fertilizers on number of leaves of coriander varieties

increased the total number of leaves and number of green leaves per plant in tomato (Mondal and Moman, 2011).

5.3.3. Effect of fertilizer schedule on yield of coriander varieties

Biomass and herbage yield was significantly influenced by the fertilizer applied to the plants. Data depicted in the form of graph in Fig. 15 revealed that basal application of 5 t ha^{-1} of FYM significantly influenced the biomass and herbage yield of variety CO-4 followed by the basal application of 2.5 t ha^{-1} vermicompost alone. Joy *et al*. (2005) reported increased high biomass yield of *Curculigo orchioides* Gaertn. by the application of FYM alone. Similarly, application of vermicompost recorded highest herbage yield and seed yield that was comparable to chemical fertilizers as observed by Vadiraj *et al*. (1998). They also suggested that higher yield might be due to the higher levels of nutrient besides growth stimulating substances such as enzymes, antibiotics and hormones available in vermicompost. The highest biomass and herbage yield of variety Theni Local was recorded in the fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+1.5 per cent urea (foliar) at 20 DAS. This might be due to the combined effect of FYM, basal dose of nitrogen and foliar spray of nitrogen. Foliar spray of urea at different concentrations enhanced the overall growth and yield parameters of lemon grass variety OD-19 and highest biomass production was recorded in higher doses of urea (Aradhna and Yeshpal, 2014).

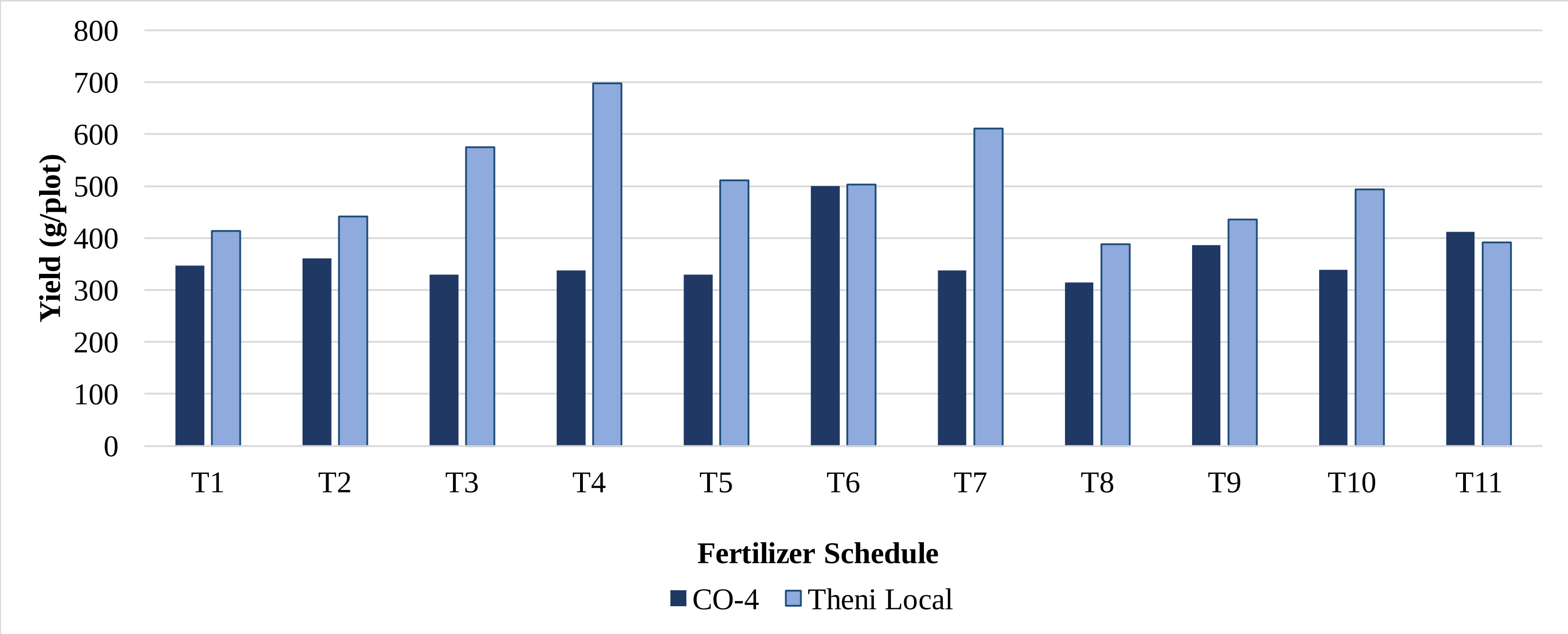
5.3.4. Effect of fertilizers on quality of coriander varieties

Vitamin C, essential oil and chlorophyll content in the leaves are the important parameters which determine the quality of coriander leaves. The effect of fertilizers on vitamin C content is shown in the form of graph in Fig. 16. Basal application of 2.5 t ha^{-1} vermicompost alone recorded highest vitamin C content in variety CO-4 followed by 5 t ha^{-1} FYM (basal). Roberts *et al*. (2007) opined that vermicompost could be used as a viable alternative to peat-based growth media because the yield and vitamin C concentration were unaffected by the presence of vermicompost .Higher doses of vermicompost increased the vitamin C content of lettuce than recommended NPK doses as reported by Sunaryo, 2010). Similar results were also reported by Kafle *et al*. (2011) in cabbage.

In the variety Theni Local, the fertilizer schedules: 5 t ha^{-1} FYM+ 20:10:10 kg ha^{-1} (basal)+1.5 per cent urea (foliar) 20 DAS and 2.5 t ha^{-1} vermicompost+ 20:10:10 kg ha^{-1} NPK (basal)+10 kg ha^{-1} N (topdressing) at 20 DAS recorded highest vitamin C content compared to control. Lisiewska and Kmiecik (1996) reported the significant effect of nitrogen on vitamin C content of cauliflower and found that increasing the level of nitrogen fertilization from 80 to 120 kg N ha^{-1} caused a decrease in vitamin C content in cauliflower. The results from this investigation is in contradiction with the findings of Yildirim *et* al. (2007) who found that vitamin C content of broccoli decreased with the application of mineral nitrogen as well as elevated foliar spray of urea. Higher vitamin C content in the fertilizer schedule 2.5 t ha^{-1} Vermicompost+20:10:10 kg ha^{-1} NPK (basal) +10 kg ha^{-1} N (topdressing) might be due to the combined effect of vermicompost and nitrogen in vegetative growth as well as in quality.

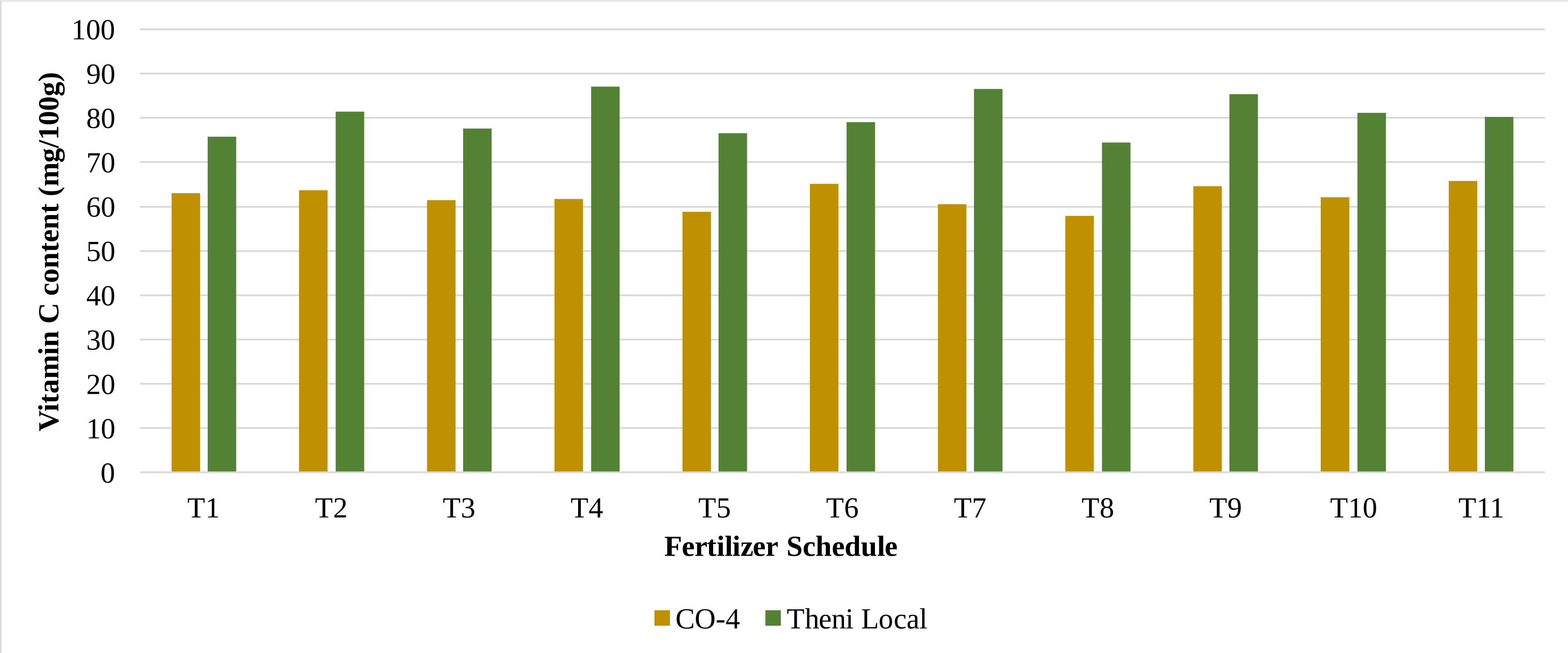
The essential oil content of both the varieties was independent on fertilizers treatments. Interaction effect of season and fertilizer schedule was also non significant. Similar results was also reported by Acimovic *et al*. (2015) in coriander seed oil. The non significant effect of fertilizers on essential oil content of coriander leaves might be due to the negligible quantity of essential oil present in leaves than seeds.

The fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+ 10 kg ha^{-1} N (topdressing) 20 DAS recorded highest chlorophyll ‘a’, ‘b’ and total chlorophyll in variety CO-4. This might be due to the combined effect of FYM and nitrogen. The highest chlorophyll ‘a’ of variety Theni Local was recorded in fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+10 kg ha^{-1} N (topdressing) 20 DAS whereas, chlorophyll ‘b’ was recorded in a fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+1 per cent Urea (foliar) at 20 DAS. Total chlorophyll content was found to be highest in a fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+10 kg ha^{-1} N (topdressing) at 20 DAS as well as in 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+1 per cent Urea (foliar) 20 DAS. Total chlorophyll content was found to be highest in a fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+10 kg ha^{-1} N (topdressing) at 20 DAS as well as



T$_1$: Control ; **T$_2$**: 5t FYM+20:10:10 kg NPK/ha (basal); 10 kg N/ha: 20 DAS (top dressing); **T$_3$**: 5t FYM+20:10:10 kg NPK/ha (basal); 1% Urea: 20 DAS (foliar) ; **T$_4$**: 5t FYM +20:10:10 kg NPK/ha (basal);1.5% Urea: 20 DAS (foliar); **T$_5$**: 5t FYM/ha (basal); 19:19:19: 15, 30 DAS (foliar); **T$_6$**: 5t FYM/ha (basal) **T$_7$**: 2.5t VC+20:10:10 kg NPK /ha(basal);10 kg N/ha: 20DAS (top dressing); **T$_8$**: 2.5t VC+ 20:10:10 kg NPK/ha (basal); 1% Urea: 20 DAS (foliar); **T$_9$**:2.5t VC + 20:10:10 kg NPK/ha (basal); 1.5% Urea: 20 DAS (foliar) ; **T$_{10}$**: 2.5t VC/ha (basal); 19:19:19: 15, 30 DAS (foliar); **T$_{11}$**: 2.5t VC/ha (basal); **VC**: Vermicompost

Fig.15. Effect of fertilizers on herbage yield of coriander varieties



T$_1$: Control ; **T$_2$**: 5t FYM+20:10:10 kg NPK/ha (basal); 10 kg N/ha: 20 DAS (top dressing); **T$_3$**: 5t FYM+20:10:10 kg NPK/ha (basal); 1% Urea: 20 DAS (foliar) ; **T$_4$**: 5t FYM +20:10:10 kg NPK/ha (basal);1.5% Urea: 20 DAS (foliar); **T$_5$**: 5t FYM/ha (basal); 19:19:19: 15, 30 DAS (foliar); **T$_6$**: 5t FYM/ha (basal) **T$_7$**: 2.5t VC+20:10:10 kg NPK /ha(basal);10 kg N/ha: 20DAS (top dressing); **T$_8$**: 2.5t VC+ 20:10:10 kg NPK/ha (basal); 1% Urea: 20 DAS (foliar); **T$_9$**:2.5t VC + 20:10:10 kg NPK/ha (basal); 1.5% Urea: 20 DAS (foliar) ; **T$_{10}$**: 2.5t VC/ha (basal); 19:19:19: 15, 30 DAS (foliar); **T$_{11}$**: 2.5t VC/ha (basal); **VC**: Vermicompost

Fig.16. Effect of fertilizers on vitamin C content of coriander varieties

in 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+1 per cent Urea (foliar) 20 DAS. The increase in chlorophyll content of safflower with nitrogen application was reported by Dordas and Sioulas (2008). Mansour (2017) reported the increase in chlorophyll 'a' and total chlorophyll content of sweet potato with the increase in quantity of FYM.

In general best growth and yield parameters of coriander variety CO-4 was obtained in the plants treated with organic fertilizers such as 5 t ha^{-1} FYM and 2.5 t ha^{-1} vermicompost. The variety Theni Local put forth best growth and yield in the plants treated with a fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal); 1.5 per cent urea: 20 DAS (foliar) and 2.5 t ha^{-1} vermicompost+ 20:10:10 kg ha^{-1} NPK (basal)+10 kg ha^{-1} N: 20DAS (top dressing).

The differential response of the two varieties to fertilizer schedules could also be explained taking into account the initial nutrient status of the experimental plot given in Table 5. All the major nutrients were high in the soil; the secondary and micronutrients present in sufficient amounts. CO-4, being an early variety could perform well with only organic manures whereas Theni Local which behaved as a late variety responded well to topdressing as well as foliar spray of fertilizers.

5.4. STANDARDIZATION OF HARVEST MATURITY

The maturity of coriander leaves at harvest is an important factor that determines the post-harvest management, shelf life and final quality of leaves. The coriander leaves reach their best quality attributes at various stages and development of leaves. The possibilities of harvesting depends on several factors such as, processing, desired quality and flexibility of handling the produce after harvest. The present investigation was undertaken to find out the correct stage of harvest in coriander varieties for leaf purpose.

5.4.1. Standardization of harvest maturity for coriander variety CO-4

The crop completed its vegetative phase by 37-40 DAS. Beginning of reproductive phase was marked by the emergence of serrated leaf. The serrated leaf was observed from 37.33 to 37.75 DAS. When 50% of the plant population started to produce serrated leaf, the crop was harvested by pulling out. It was reached on the 40^{th} day after sprouting during both the seasons. Moreover, at this stage all the leaves remained intact and healthy. Hence, it was concluded the harvest maturity of CO-4 variety of coriander is 40 DAS. In coriander, the impact of growing season on days taken for physiological maturity is significant and prolonged vegetative stage could be attained by sowing the seeds during June or July (Guha *et al*., 2013).

5.4.2. Standardization of harvest maturity for coriander variety Theni Local

The growth pattern of coriander variety Theni Local harvested at 40, 45, 50 and 60 DAS to determine the optimum harvesting date revealed that all growth, yield and quality parameters were in its peak level when the crop reached at 60 days duration. There was 28.88 per cent increase in plant height by 60 DAS (Fig. 17). Similarly there was 84.33 per cent increase in number of leaves when plants were at 60^{th} DAS (Fig. 18.). Coming to biomass yield, it increased gradually giving 6.96 per cent increase in 40^{th} day and 35.99 per cent increase by 60 DAS. The same increase was seen in herbage yield also which recorded 35.89 per cent increase by 60 DAS (Fig. 19). Dhanasekar *et al*. (2000) reported significant increase in plant height when coriander plants were harvested from 25 to 35 DAS.

There was an approximate 1.53 fold increase in vitamin C content when the plants reached 60 DAS (Fig. 20). Similarly, 1.60, 2.04 and 1.71 fold increase was recorded for chlorophyll 'a', chlorophyll 'b' and total chlorophyll content respectively when the plants reached 60^{th} day. The essential oil content present in leaves did not vary with the duration of harvest. Geographical and ecological factors can lead to quantitative and qualitative differences in essential oil content of coriander as reported by Ramezani *et al*. (2009). They also found that green unripe fruit stage yielded highest essential oil than matures seed stage and significantly lowest essential oil content was at vegetative stage.

Considering the growth, yield and quality parameters, it was concluded that the crop of Theni Local could be harvested for leaf purpose at 60 DAS. After 60^{th} day, the plants of coriander variety Theni Local were not retained as the lower leaves started withering. The growth of this variety was observed to be indefinite. But since the senescence started by 60^{th} day, without plant entering to its reproductive phase, the crop was harvested at 60 DAS.

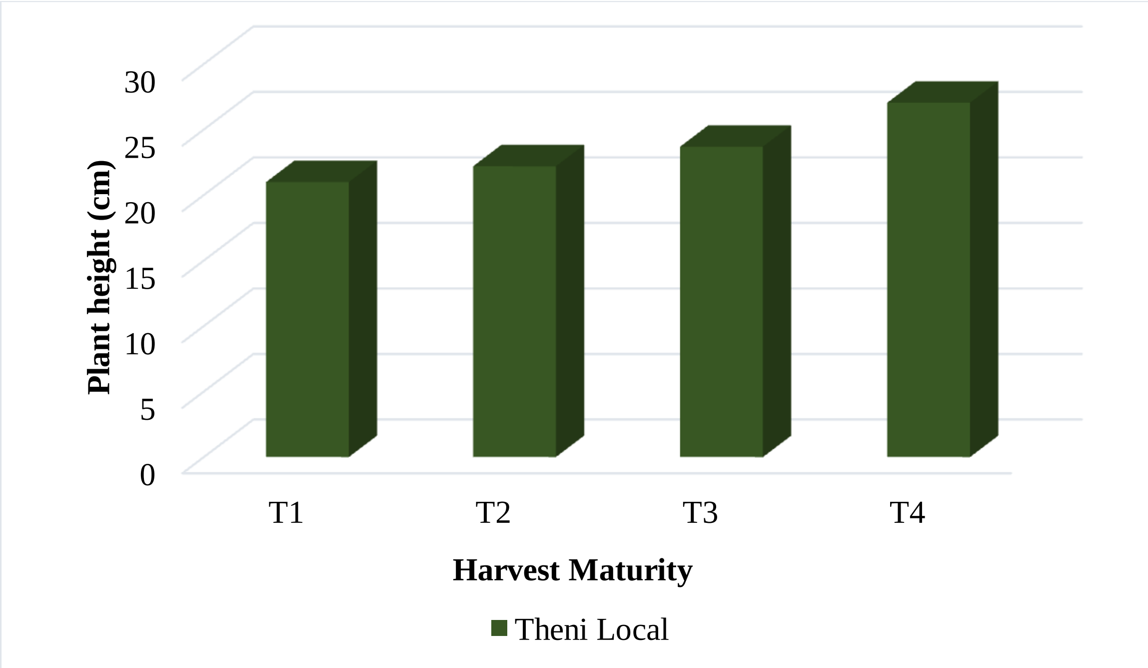
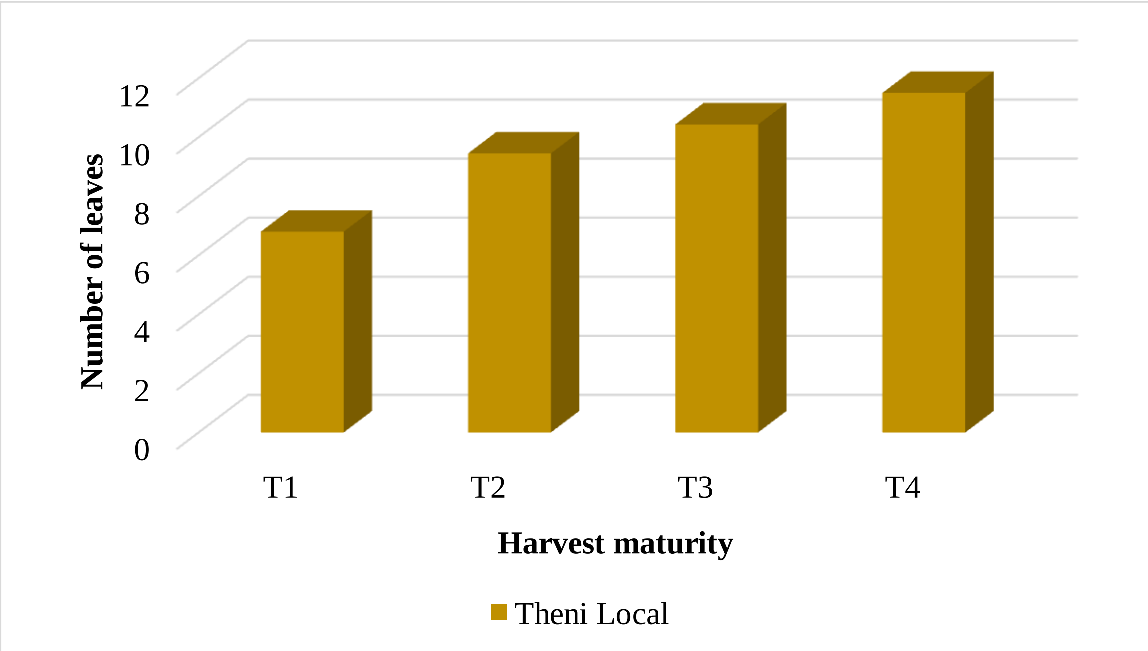


Fig.17. Plant height of coriander varieties at different harvest stage



T_1: 40 DAS T_2: 45 DAS T_3: 50 DAS T_4: 60 DAS

Fig.18. Number of leaves of coriander varieties at different stage of harvest

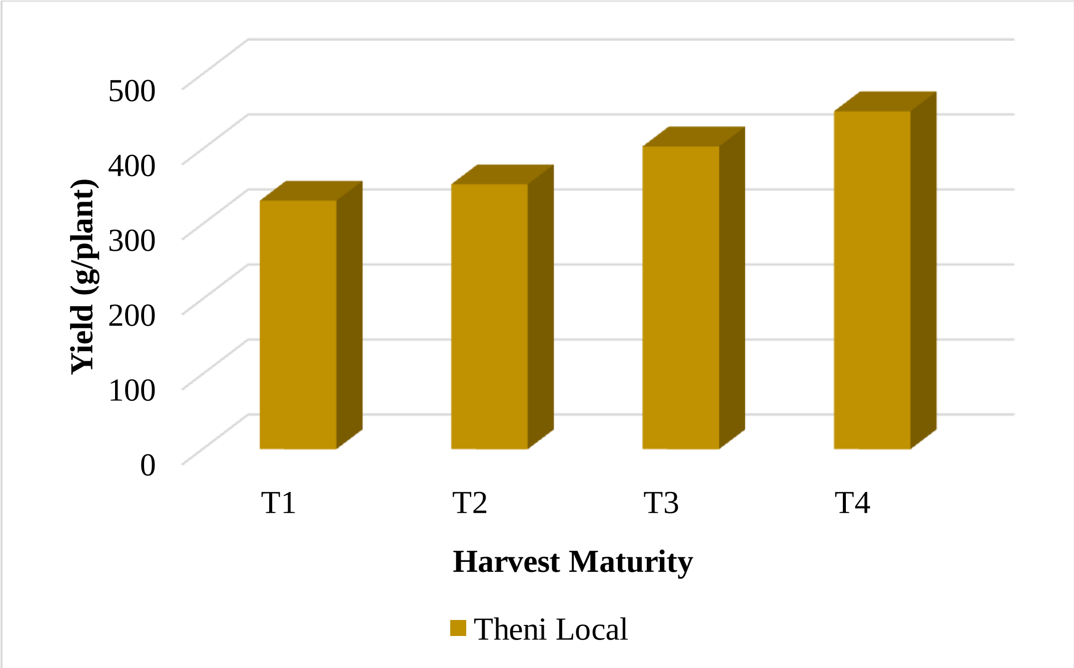
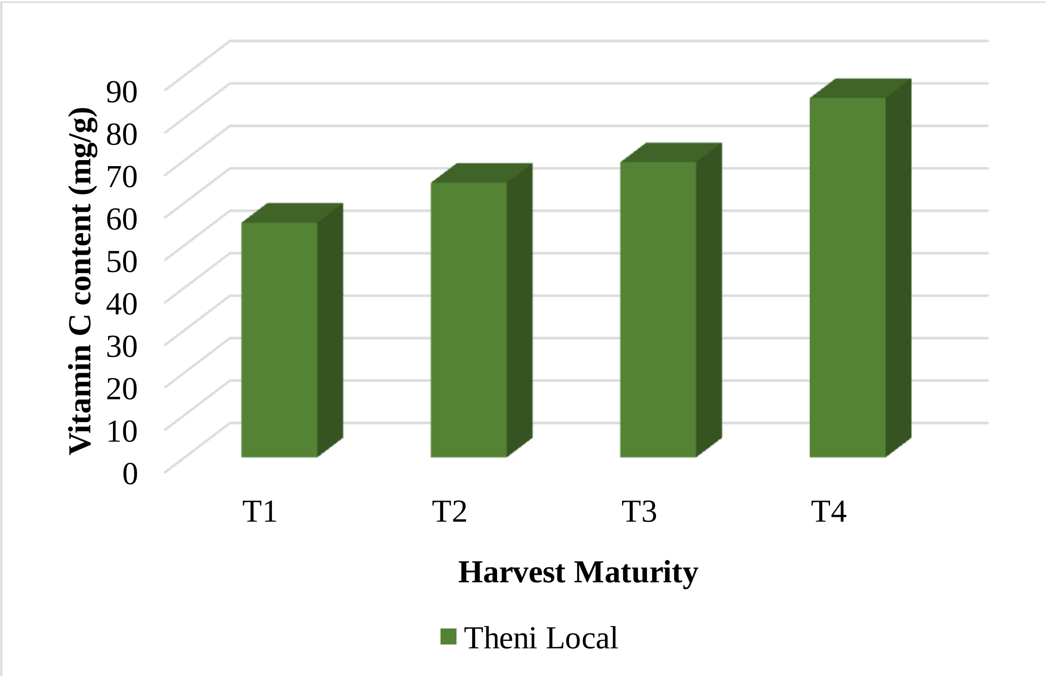


Fig.19. Herbage yield of coriander variety Theni Local at different stages of harvest



T_1: 40 DAS **T_2**: 45 DAS **T_3**: 50 DAS **T_4**: 60 DAS

Fig.20. Vitamin C content of coriander variety Theni Local at different stages of harvest

5.4.3. Flowering and seed set in coriander variety CO-4

Among the two varieties, only the variety CO-4 entered to its reproductive phase which was marked by the emergence of serrated leaf. The number of days taken for the emergence of first serrated leaf, ranged from 37.33 -37.75 days. Seasonal variation was not observed with respect to production of serrated leaf, flowering and fruit set. Similar results were also reported by Raj (2017). Before flowering, the umbels produced primary and secondary branches. The number of primary branches per plant was highest (3.75) during September –December whereas number of secondary branches was not affected by the season. Flowering was observed from primary branches as well as secondary branches. Days to flowering ranged 43.75-44.50 days and flowers were white in colour. The days taken for fruit set was identified by the withering of petals as well as bulging of ovary. It was observed from 57.41-57.50 days. Varietal evaluation trial of coriander conducted by Raj (2018) revealed that coriander variety CO-4 took minimum number of days for flowering (38.83) during January – March whereas maximum number of days for flowering (42.88) was recorded during October – December. She also found that early fruit set was obtained during October – December compared to July – September sown crop. The days for fruit maturity was identified by the colour change of 50 per cent fruits from dark green to pale yellow or brown as the coriander fruit have heterogeneous maturity. Days to fruit maturity significantly varied with seasons. Early fruit maturity was observed during July – September in 73.33 days compared to October – December. Farooq (2013) reported that days for physiological maturity of coriander variety CO-4 seeds ranged from 82.25- 87.18 days.

Farmers prefer delayed seed setting in coriander for maximum green leaf production and extended vegetative phase can be obtained by early sowing in June (Guha *et al.*, 2013). They also opined that two cuttings may be considered as an important intercultural operation to delay the serration leading to better green leaf harvest.

5.5. EFFECT OF SEASON OF SOWING ON GROWTH, YIELD AND QUALITY OF CORIANDER

The growing season is the period when crops grow successfully and exhibit maximum growth, produce maximum yield. Season of sowing varies with the crop and region of cultivation. Coriander is a cool season crop that can be successfully cultivated during *rabi* season (Gowtham, 2018). The immature plants are highly sensitive to the climatic factors such as rainfall, temperature, humidity *etc*. Coriander can be grown for leaf purpose throughout the year but, the extreme variations in the climatic factors limit the growth and development during vegetative phase which lead to the incidence of pest and disease as well as inferior quality. The present investigations also evaluated the effect of season of sowing on growth, yield and quality of coriander varieties. The crop was grown in two seasons *viz*., July – September and October – December.

The individual effect of season from four experiments *viz*., standardization of seed treatments, standardization of spacing, Standardization of fertilizer schedule and standardization of harvest maturity on growth, yield and quality parameters were pooled and furnished in the Table 32.

The growth parameters such as plant height (Fig. 21) and number of leaves (Fig. 22) at harvest were observed to be significantly highest during October – December in both the varieties. This might be due to the favourable climatic conditions that prevailed during the period which resulted in optimum vegetative growth of coriander. Raj, (2017) reported highest number of leaves per plant at harvest in coriander during July – September, irrespective of the varieties. October sown crop performed better compared to the crop sown on different months both under rain shelter and open field condition (Gowtham, 2018). Delay in sowing from November 5th – December 10th significantly decreased the plant height, number of branches (Sharangi and Roychowdhury, 2014). They also stated that significant decrease in morphological traits associated with the delay in sowing can be related to higher temperature that limits the growing period.

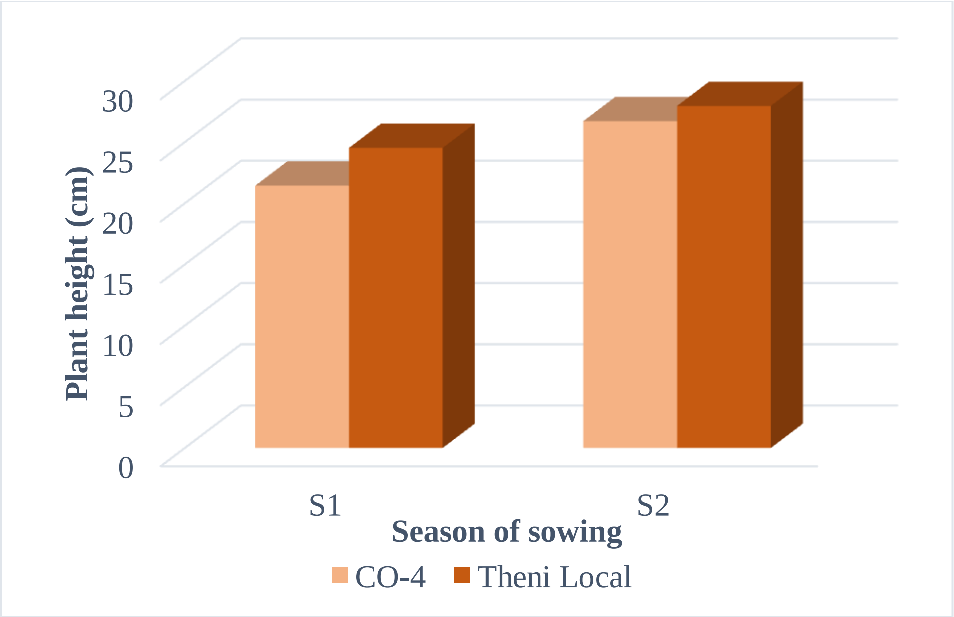
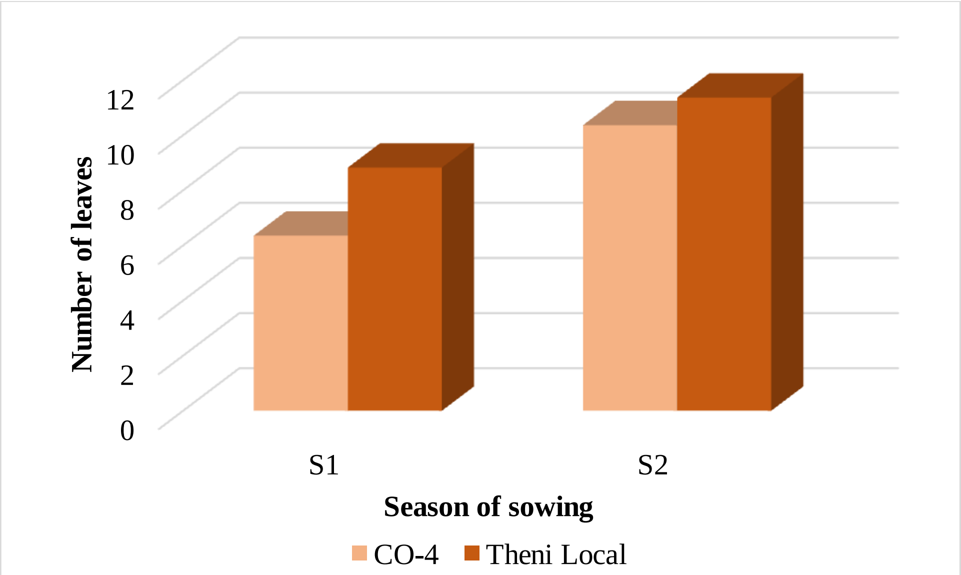


Fig.21. Effect of growing season on plant height of coriander varieties



S_1: July – September S_2: October – December

Fig. 22. Effect of growing season on number of leaves coriander varieties

Table 32. Effect of growing season on growth, yield and quality of coriander varieties

Parameters	CO-4		Theni Local	
	S_1	S_2	S_1	S_2
Plant height at 30 DAS (cm)	12.52	17.74	10.99	14.09
No. of leaves at 30 DAS	4.63	5.85	4.48	5.22
Plant height at harvest (cm)	21.25	27.22	23.31	27.78
No. of leaves at harvest	6.35	10.36	8.17	11.02
Biomass yield/plant (g $plant^{-1}$)	2.20	11.15	6.82	11.75
Biomass yield /plot (g m^{-2})	118.10	594.60	387.72	642.32
Green leaf yield/plant (g $plant^{-1}$)	2.03	10.80	6.53	11.43
Green leaf yield/plot (g m^{-2})	108.58	575.80	374.24	625.38
Vitamin C content (mg/100g)	33.93	79.01	67.71	85.72
Volatile oil content (%)	0.1	0.1	0.1	0.1
Chlorophyll ‘a’ (mg g^{-1})	0.960	1.684	1.287	1.732
Chlorophyll ‘b’(mg g^{-1})	0.364	0.463	0.450	0.458
Total chlorophyll (mg g^{-})	1.326	2.153	1.753	2.190

The height of Fennel plants were decreased in November 14^{th} sown crop when compared to September and October sown crop (Ayub *et al.*, 2008). Mohanalakshmi *et al.* (2019) reported the positive effect of October sowing on plant height and number of leaves of coriander.

The season of sowing is crucial for yield parameters also (Plate 10 and Plate 11). During the best season of sowing, plant tend to exhibit its maximum growth and development which lead to the increase in yield. Similar to the morphological traits, yield parameters also significantly varied between the seasons of sowing which is given in the form of graph in Fig. 23. The highest individual plant weight and plot weight were observed in crop sown during October –December. In variety CO-4, there was 5.06 and 5.32 fold increase in biomass and herbage yield respectively during October – December. In variety Theni Local, there was 1.72 and 1.75 fold increased observed in biomass and herbage yield respectively during October - December. This might be due to the favourable climatic conditions during October – December that lead to the better performance of coriander varieties in terms of yield.

The coriander variety CO-4 grown both under rain shelter and open field condition during October month recorded the highest per plant as well as per plot yield (Gowtham, 2018) .Maximum seed yield of fennel was recorded when the crop was sown on October 14th compared to September 14th and November 14th (Ayub *et al*., 2008).

Pooled mean values of quality parameters during both the seasons revealed that effect of season was significant on quality parameters except essential oil content. Ascorbic acid content of both the coriander varieties, CO-4 as well as Theni Local was affected by the season of growing.

The Fig. 24 revealed that there was 132.86 per cent and 26.59 per cent increase in ascorbic acid content of variety CO-4 and variety Theni Local respectively during October – December. The results on vitamin C content of coriander varieties was in contradiction with the finding of Raj (2017) who found that crops grown during that April – June recorded highest vitamin C content compared to other seasons and lowest vitamin C content was recorded during January – March. The effect of season on essential oil content of both the varieties was non significant. This might be due to the negligible quantity of volatile oil in leaves. Chlorophyll 'a', 'b' and total chlorophyll content of both the varieties significantly varied with the season of sowing. This might be due to the variation in availability of light during the growth and development of plants. Generally, chlorophyll content was highest during October – December. Raj (2017) found that chlorophyll content of July – September sown crop was higher than other seasons of sowing whereas, Gowtham (2018) found that effect of season on chlorophyll content of coriander variety CO-4 was non significant.

In general, October – December season was found to be the best for the growth, yield and quality of coriander for leaf purpose, irrespective of the varieties and the agronomic package adopted. A perusal of the weather data (Appendix 1) during the experimental period clearly shows that the total rainfall received, number of rainy days and the relative humidity were lower during October – December when compared to July – September season. On the other hand, the total sunshine h recorded was on the high during October – December. A combined effect of these

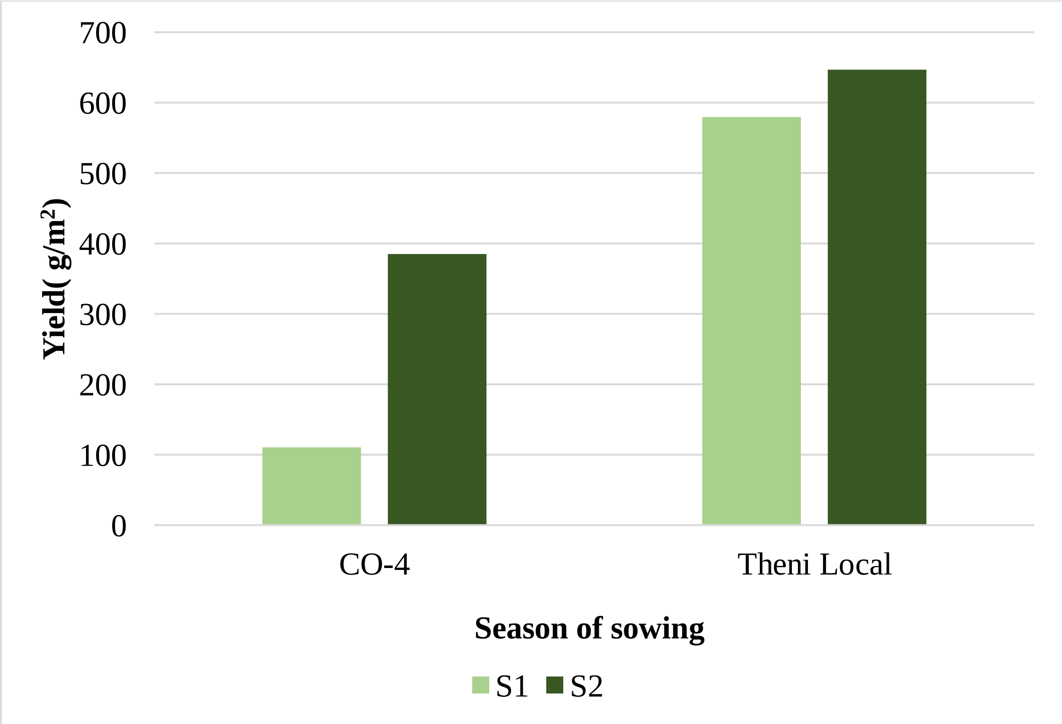
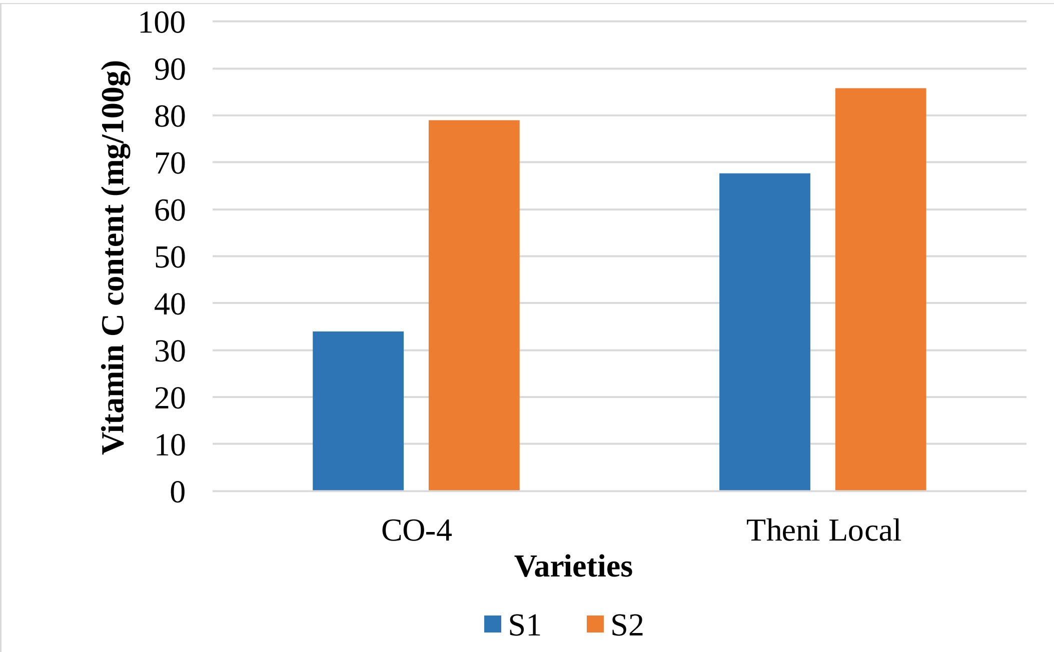


Fig.23. Effect of growing season on yield of coriander varieties



S_1: July – September **S_2**: October – December

Fig.24. Effect of growing season on vitamin C on coriander varieties

July – September

October – December

Plate 10. CO-4 during two growing seasons

July – September

October – December

Plate 11. Theni local during two growing seasons

weather parameters might be responsible for the better performance of coriander during this season.

5.6. INTERACTION EFFECT OF SEASON WITH SEED TREATMENTS, SPACING AND FERTILIZER SCHEDULE ON GROWTH, YIELD AND QUALITY OF CORIANDER VARIETIES

5.6.1. Season and seed treatments

In all the experiments we have done during two seasons seasonal influence was evident irrespective of the treatments applied in both the two varieties used. With regard to seed treatments and season, in CO-4, tallest plants were observed in the seeds hydro primed for 24 h during October – December whereas in Theni Local, plant height was independent indicating no interaction of season and seed treatments.

In the case of number of leaves, synergistic effect of season and seed treatments at harvest was more evident in PGR treated seeds during October – December in variety CO-4 whereas in Theni Local, seed treatment with 50 mg L^{-1} GA_3 during the same season gave highest number of leaves.

When it comes to yield, hydro priming for 24 h was found to yield highest biomass and herbage per plant as well as per plot in variety CO-4 whereas, this treatment along with priming with GA_3 for 8 h recorded the best results in Theni Local both during October – December.

With respect to vitamin C content in fresh leaves, the combination of seed priming with GA_3 for 8 h and October – December season was the best in variety CO-4 whereas, hydro priming for 24 h and October – December season was the suitable combination in variety Theni Local.

The chlorophyll ‘a’ and total chlorophyll content were highest in the combination of hydro priming for 24 h and October – December season in variety CO-4 whereas, in Theni Local, hydro priming for 12 h in the same season gave the best results.

5.6.2. Season and spacing

There was no interaction effect observed between spacing and season of sowing with respect to sprouting of seeds, emergence of first, second and third leaf in both the varieties.

In both the varieties, tallest plants at 30 DAS were found in closer spacing of 10 x 10 cm during October – December while, at harvest, tallest plants were recorded in closer as well as medium spacing during the same season. The non significance of interaction effect between date of sowing and spacing on plant height was reported by Namdev (2017) in coriander at all stages of growth.

The variety CO-4 produced highest number of leaves at harvest in closer as well as medium spacing during October – December whereas, this trait was unaffected by the interaction of season and spacing in the variety Theni Local.

The biomass and herbage yield per plant was the highest under medium spacing in October – December in variety CO-4 whereas, in Theni Local, closer spacing gave the best results in the same season. When it comes to plot wise biomass and herbage yield, closer spacing of 10 cm x 10 cm gave the best results, again during the same season in both the varieties.

Coming to the interaction effect, of season and spacing, in both the varieties, ascorbic acid was highest in medium spacing of 20 cm x 10 cm during October – December. The same combination also gave highest chlorophyll ‘a’, ‘b’ and total chlorophyll in CO-4.

5.8. Season and fertilizer schedule

The sprouting, emergence of first, second and third leaf was not influenced by the interaction effect of fertilizer schedule and season of sowing.

The fertilizer combinations applied during October – December recorded significant increase in growth and yield parameters in both the varieties. The highest plant height and number of leaves was found in 5 t ha^{-1} FYM (basal) during October December in the variety CO-4. In the variety Theni Local, fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+1.5 per cent urea (foliar) at 20 DAS and

October – December season gave the highest plant height and number of leaves at harvest.

The individual effect of fertilizer schedule on yield was also manifested in the interaction effect of season and fertilizer schedule also. The same treatments applied during October – December was the best combination to yield maximum biomass and herbage yield.

Vitamin C content was also influenced by the interaction of season and fertilizer schedule, the best combination being 2.5t ha^{-1} Vermicompost (basal) followed by 5 t ha^{-1} FYM (basal) and 2.5 t ha^{-1} Vermicompost+20:10:10 kg ha^{-1} NPK (basal)+1.5 per cent Urea (foliar) at 20 DAS during October – December in variety CO-4. In Theni Local, the same fertilizer schedule which gave highest yield gave highest vitamin C content in the same season. The same treatment applied during October – December was found to be the best combination for recording highest chlorophyll 'a', 'b' and total chlorophyll in variety Theni Local.

5.6.4. Season and harvest maturity

In both the seasons the physiological maturity for leaf purpose was attained in 40 DAS in the variety CO-4. In Theni Local, the plants did not enter into reproductive phase until 60 DAS during both the seasons. However, the growth parameters, yield, quality and the seed yield obtained were best during October – December season.

Summary

6. SUMMARY

The present study entitled **Standardization of package of practices for leaf coriander (*Coriandrum sativum* L.) under rain shelter** was carried out at the Department of Plantation Crops and Spices, College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur, during the period from 2019 July to 2020 March. The objective of the study was to standardize seed treatments, spacing, fertilizer schedule and harvest maturity of coriander for herbage yield and quality in two seasons.

The entire research work comprised of four experiments *viz.*, standardization of seed treatments, standardization of spacing, standardization of fertilizer schedule and standardization of harvest maturity. Two coriander varieties used for the study were CO-4, a short duration dual purpose variety released from Tamil Nadu Agricultural University (TNAU) and another variety Theni Local, a local long duration variety from Theni District of Tamil Nadu. The field study was laid out under rain shelter in the farm of Department of Plantation Crops and Spices. The seeds were split and soaked in water for 12 h in all experiments except the one for standardization of seed treatments. The general spacing followed in all experiments was 20 cm x 10 cm except in experiment for standardization of spacing. Similarly, common fertilizer schedule of lime 600 kg ha^{-1}+ 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+10 kg ha^{-1} N (top dressing) at 20 DAS was followed in all the experiments except the one for standardization of fertilizer schedule. The coriander variety CO-4 was harvested at 40 DAS and Theni Local at 60 DAS. Some plants of the variety CO-4 were left in field to study the flowering and seed set. The salient findings from the study are summarized here.

Seed treatments had significant influence on sprouting and emergence of leaves. The seeds subjected to priming with PGRs and water germinated earlier than untreated seeds. In CO-4 , the first leaf emergence in was independent of seed treatments whereas, PGR treatments for 8 h and hydro priming for 24 h resulted in early emergence of first leaf in Theni Local. Second and third leaf emergence in both the varieties was earlier in seeds subjected to priming.

Plant height and number of leaves were highest in seeds subjected to hydro priming for 24 h and seed treatments with 50 mg L^{-1} GA_3 for 8 h. Soaking of seeds in 20 mg L^{-1} NAA for 8 h also resulted in better growth and development in both the varieties compared to control and hydro priming for 12 h.

Both the varieties responded very well to seed treatments in terms of yield. The seeds hydro primed for 24 h recorded highest biomass (6.24 g $plant^{-1}$) and herbage (5.98 g $plant^{-1}$) yield in variety CO-4. Same treatment along with 50 mg L^{-1} GA_3 for 8 h (9.04 g $plant^{-1}$ and 8.73 g $plant^{-1}$) and hydro priming for 24 h (8.61 g $plant^{-1}$ and 8.33 g $plant^{-1}$) were found to be the best seed treatments for Theni Local for higher yield. Same trend was observed in per plot yield too.

The vitamin C content varied with the seed treatments. Seeds treated with 50 mg L^{-1} GA_3 for 8 h resulted in highest vitamin C content (65.54 mg per 100g) in variety CO-4 whereas, hydro priming for 24 h was the best seed treatment which recorded highest vitamin C content in Theni Local (106.51 mg per 100g).

The chlorophyll ‘a’, ‘b’ and total chlorophyll content of CO-4 was highest in the seed treated with hydro priming for 24 h whereas, the hydro priming for 12 h recorded highest chlorophyll content in Theni Local.

In the spacing experiment, sprouting, emergence of first, second and third leaf were unaffected by the spacing adopted in both the varieties. In CO-4, plant height and number of leaves at 30 DAS as well at harvest were highest in the closer spacing of 10 cm x 10 cm. Close as well as wider spacing produced tallest plants at 30 DAS in Theni Local whereas at harvest, tallest plants with highest number of leaves were observed in closer spacing.

Spacing also influenced the biomass and herbage yield of coriander varieties. Medium spacing of 20 cm x 10 cm recorded highest biomass (7.81 g $plant^{-1}$) and herbage (7.56 g $plant^{-1}$) yield per plant in CO-4 whereas, closer spacing of 10 cm x 10 cm emerged as the best spacing in Theni Local for biomass (14.77 g $plant^{-1}$) and herbage (14.48 g $plant^{-1}$) yield per plant. The yield from unit area was also the highest in closer spacing in both the varieties as the plant density per unit area was maximum in closer spacing.

Plants of both closer spacing (65.16 mg per 100g) and medium spacing (64.62 mg per 100g) recorded highest vitamin C content in CO-4 whereas, plants of medium spacing (81.18 mg per 100g) recorded significantly highest vitamin C content in Theni Local.

Chlorophyll ‘a’, ‘b’ and total chlorophyll content in CO-4 was highest in medium spacing. The chlorophyll ‘a’ and total chlorophyll content in variety Theni Local was unaffected by the spacings whereas, chlorophyll ‘b’ content was highest in closer spacing of 10 cm x 10 cm.

In the fertilizer experiment, the sprouting and emergence of first and second leaf were not influenced by the fertilizer schedules in both the varieties. Majority of the fertilizer schedules including control exhibited early emergence of third leaf.

Basal application of 5 t ha^{-1} FYM alone recorded tallest plants with highest number of leaves in CO-4 followed by basal application of 2.5t ha^{-1} vermicompost alone. At initial stages, plant height and number of leaves were highest in a fertilizer schedule of 5 t ha^{-1} FYM+19:19:19 (foliar) at 15 and 30 DAS in Theni Local. But at harvest, taller plants with highest number of leaves were observed in a fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+1.5 per cent urea (foliar) at 20 DAS .

Similar to plant height and number of leaves, the biomass (10.27 g $plant^{-1}$) and herbage (10.02 g $plant^{-1}$) yield of CO-4 was highest in the plants supplemented with basal application of 5 t ha^{-1} FYM followed by 2.5 t ha^{-1} vermicompost. Biomass (14.30 g $plant^{-1}$) and herbage (13.96 g $plant^{-1}$) yield of Theni Local was highest in a fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK+ 1.5 per cent urea (foliar) at 20 DAS.

Basal application of 2.5t ha^{-1} vermicompost alone (65.78 mg per 100g) and 5t ha^{-1} FYM alone (65.17 mg per 100g) recorded highest vitamin C content in CO-4 whereas, a fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+ 1.5 per cent urea (foliar) at 20 DAS (87.05 mg per 100g) and 2.5t ha^{-1} vermicompost+20:10:10 kg ha^{-1} NPK (basal)+ 10 kg ha^{-1} N (topdress) at 20 DAS (86.57 mg per 100g) recorded highest vitamin C content in Theni Local .

Chlorophyll ‘a’, ‘b’ and total chlorophyll content of variety CO-4 was highest in a fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK+ 10 kg ha^{-1} N (top dress) at 20 DAS. In Theni Local, highest vitamin C content was observed in a fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK+10 kg ha^{-1} N (top dress) at 20 DAS (1.643 mg g^{-1}) as well as basal application of 5 t ha^{-1} FYM alone (1.627 mg g^{-1}).

The standardization of harvest maturity of coriander varieties revealed that harvesting at different days significantly influenced the growth and yield of coriander. In the variety CO-4, the serrated leaf was visible thirty seven days after sprouting and hence the plants were uprooted at 40 DAS i.e., when 50 per cent of the plants showed serrated leaf. The variety Theni Local did not flower at all up to 60DAS.

The growth and yield parameters of coriander variety Theni Local harvested at different intervals showed that with the delay in harvest growth, yield and quality improved. Harvesting of plants at 60 DAS recorded significantly highest growth, yield and quality parameters.

There was 28.88, 84.33, 35.99 and 35.89 per cent increase in plant height, number of leaves, biomass yield per plant and herbage yield per plant respectively by 60^{th} day after sprouting. Similarly the vitamin C content of Theni Local was increased by 1.53 fold when the plants reached a maturity of 60 days. Chlorophyll ‘a’, chlorophyll ‘b’ and total chlorophyll content were increased by 1.60, 2.04 and 1.71 fold respectively when the plants reached 60^{th} day.

The growth of coriander variety Theni Local was indefinite and withering of leaves started after 60 days. So, it was concluded that the variety can be cut for leaf purpose at 60 days after sprouting for obtaining maximum herbage yield.

The growing season had significant influence on growth, yield and quality of coriander varieties, irrespective of the different seed treatments, spacings, fertilizer schedules and harvesting days. In all the experiments, both the varieties performed best during October – December. Morphological parameters such as plant height and number of leaves, yield parameters such as biomass and herbage yield were found be highest during October – December in all the experiments.

There was 5.06 and 5.32 fold increase in biomass and herbage yield respectively during October – December in coriander variety CO-4. Similarly, 1.72 and 1.75 fold increase in biomass and herbage yield respectively was recorded in variety Theni Local during October – December.

The ascorbic acid content also varied with the season of cultivation. The ascorbic content of variety CO-4 was increased by 132.86 per cent during October – December, whereas there was 26.59 per cent increase in ascorbic acid content of coriander variety Theni Local during the same season.

The volatile oil present in the leaves of both the varieties was not affected by the seasons of sowing, whereas Chlorophyll ‘a’, ‘b’ and total chlorophyll content both the varieties were significantly higher during October – December.

Among the two varieties, flowering was observed only in CO-4, and the plants started producing serrated leaf at 37.33- 37.75 DAS irrespective of the growing seasons. Similarly, seasonal variation was not observed in flowering and fruit set in this variety. Days to flowering ranged from 43.75-44.50 DAS and days to fruit set ranged from 57.41-57.50 DAS. Early fruit maturity was observed during July – September compared to October – December. Seed yield was highest during October – December.

With regard to the interaction effect of seed treatments and season on growth and yield parameters, variety CO-4 subjected to hydro priming for 24 h and Theni Local subjected to seed treatment with 50 mg L^{-1} GA_3 for 8 h during October – December recorded best results.

In both the varieties, plant height at harvest was unaffected by the interaction effect of seed treatments and season whereas, number of leaves at harvest was highest in the seeds treated with PGRs during October – December.

Hydro priming for 24 h during October – December yielded highest biomass (10.56 g $plant^{-1}$) as well herbage (10.26 g $plant^{-1}$) in CO-4 whereas, seed treatment with 50 mg L^{-1} GA_3 for 8 h recorded highest biomass (11.56 g $plant^{-1}$) and herbage (11.23 g $plant^{-1}$) yield during same season.

With regard to vitamin C content, the seeds treated with 50 mg $L^{-1}GA_3$ for 8 h during October – December recorded highest vitamin C content (81.33 mg per 100g) in CO-4 leaves whereas, a combination of hydropriming for 24 h and October – December season was best in Theni Local (141.33 mg per 100g). Chlorophyll content in CO-4 was highest in the seeds subjected to hydropriming for 24 h and PGRs treatments for 8 h during October – December whereas, in Theni Local, a combination of hydropriming for 12 h and October – December season recorded highest chlorophyll content.

Closer spacing with 100 plant m^{-2} during October – December was found to be the best plant density for growth parameters such as plant height and number of leaves and per plot yield in both the varieties. biomass (12.84 g $plant^{-1}$) and herbage (12.52 g $plant^{-1}$) yield of single plant in CO-4 was highest in medium spacing of 20 cm x 10 cm during October – December whereas, closer spacing was best in Theni Local to get highest biomass (16.72 g $plant^{-1}$) and herbage (16.37 g $plant^{-1}$) yield during same season.

In both the varieties, highest vitamin C content was recorded in medium spacing of 20 cm x 10 cm. Same combination resulted in highest chlorophyll 'a' and total chlorophyll content in CO-4.

Application of 5 t ha^{-1} FYM in CO-4 and a fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal)+ 1.5 per cent urea (foliar) at 20 DAS in Theni Local during October – December recorded highest growth and yield .

The individual effect of fertilizer schedule on growth and yield was also seen in interaction effect of season and fertilizer schedule. The same fertilizer schedule supplemented during October – December recorded highest biomass and herbage yield in both the varieties.

The fertilizer combinations such as 2.5 t ha^{-1}vermicompost (basal), 5 t ha^{-1} FYM (basal) and 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK (basal) +1.5 per cent urea (foliar) 20 DAS supplemented during October – December recorded highest vitamin C content in CO-4. Similar to the biomass and herbage yield per plant in Theni Local, the same fertilizer schedule followed during October – December recorded highest vitamin C content. Similar to the individual effect of fertilizer schedule on chlorophyll content of Theni Local, same treatment applied during October – December recorded highest chlorophyll ‘a’ and total chlorophyll content in the same variety.

Volatile oil content of both the varieties remained unaffected by any individual effect or interaction effect of treatments in all experiments.

The study clearly revealed that the varieties CO-4 and Theni Local are suitable for cultivation under rain shelter. Hydro priming for 24 h and seed treatment with 50 mg L^{-1} GA_3 for 8 h are cost effective methods which can be adopted in both the varieties to improve growth and yield. Closer spacing of 10 cm x 10 cm will be more effective in both the varieties to get maximum yield from unit area. Organic fertilizer, 5 t ha^{-1} FYM can be supplemented to the short duration coriander variety CO-4 for better growth, yield and quality. The fertilizer schedule of 5 t ha^{-1} FYM+ 20:10:10 kg ha^{-1} NPK (basal)+1.5 per cent urea (foliar spray) could increase the growth and yield parameters of long duration variety Theni Local. Irrespective of seasons of sowing, coriander variety CO-4 can be harvested at 40 DAS for leaf purpose. Harvesting at sixty days after sprouting can be recommended in Theni Local for getting maximum herbage yield. The ideal season for coriander cultivation under rain shelter is October – December in the tropical moist humid conditions.

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Appendix

Appendix 1. Monthly mean weather data during the crop growing period from March 2019 to May 2020

Year	Month	Max. Temperature °C	Min. Temperature °C	Mean Relative Humidity (RH) (%)	Mean sunshine hours (h)	Rainfall (mm)	Number of rainy days (Mean)	Evaporation (cm)
2019	March	36.8	24.8	65	8.6	0.0	0	4.8
	April	36.1	25.5	70	8.0	76.4	3	4.7
	May	34.6	24.9	74	6.8	48.8	4	4.0
	June	32.2	23.5	83	3.7	324.4	15	2.8
	July	30.4	22.8	85	2.6	654.4	21	2.4
	August	29.5	21.7	89	1.5	977.5	24	1.9
	September	31.2	22.0	85	3.3	419.0	19	2.5
	October	32.4	21.4	80	5.5	418.4	16	.7
	November	32.9	21.7	71	7.5	205.0	5	3.4
	December	32.3	22.1	63	6.7	4.4	1	4.5
2020	January	34.1	22.4	60	9.4	0.0	0	4.9
	February	35.5	23.2	54	9.5	0.0	0	5.9
	March	36.4	24.4	65	8.5	33.4	2	4.8
	April	36.4	24.7	71	8.1	44.7	4	4.6
	May	35.0	25.2	77	6.1	59.6	5	3.7

STANDARDIZATION OF PACKAGE OF PRACTICES FOR LEAF CORIANDER (*Coriandrum sativum* L.) UNDER RAIN SHELTER

By

ANJUKRISHNA V. U.

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ABSTRACT OF THE THESIS

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Abstract

Coriander (*Coriandrum sativum* L.) is an annual seed as well as herbal spice which belongs to the family Apiaceae. Whole part of the plant possesses specific aroma and flavour. Apart from the use of coriander as a flavouring and preservative agent, consumption of coriander leaves have multiple health benefits too. Coriander cultivation is confined to specific regions as it needs cool and dry climate for flowering and seed set. But for leaf purpose, cultivation is possible in non-conventional areas too with the advent of protected cultivation under rainshelter. The present study entitled **"Standardization of package of practices for leaf coriander (*Coriandrum sativum* L.) under rainshelter"** was carried out in the Dept. of Plantation Crops and Spices, College of Horticulture, Kerala Agricultural University during July 2019 to March 2020 with four experiments to standardize seed treatment, spacing, manurial schedule and harvest maturity of coriander . Two varieties *viz*. CO-4 and Theni Local were used in the study and all the experiments were conducted in two seasons *ie* July-September and October - December.

Results indicated that presowing seed treatments can be adopted in coriander as priming of seeds significantly enhanced the sprouting, growth and yield. Hydropriming for 24 h and seed treatment with 50 mg L^{-1} GA_3 for 8 h enhanced the growth, yield and quality of both the varieties. Priming with NAA for 8 h and hydropriming for 12 h also improved the growth and yield of coriander than untreated seeds. Highest vitamin C content in CO-4 and Theni Local was recorded in seed treatment with 50 mg L^{-1} GA_3 for 8 h and hydropriming for 24 h respectively.

Medium spacing of 20 cm x 10 cm significantly increased the single plant biomass and herbage yield in coriander variety CO-4, whereas closer spacing of 10 cm x 10 cm spacing was found to be the best spacing for Theni Local. Highest herbage yield and biomass yield of CO-4 (683.43 g m^{-2} and 653.00 g m^{-2}) as well as Theni Local (1477.57 g m^{-2} and 1448.00 g m^{-2}) from unit area was obtained from the closer spacing which accommodated maximum number of plants per unit area. Vitamin C content in CO-4 was highest in closer as well as medium spacings in both the varieties compared to wider spacing.

Growth parameters such as plant height and number of leaves and, yield parameters such as biomass (10.27 g plant^{-1}) and herbage (10.04 g plant^{-1}) yield were highest with the application of 5 t ha^{-1} FYM alone followed by 2.5 t ha^{-1} vermicompost alone in the variety CO-4. The vitamin C content of CO-4 was highest in the plants supplemented with basal application of 2.5 t ha^{-1} vermicompost (65.78 mg per 100g). A fertilizer schedule of 5 t ha^{-1} FYM+20:10:10 kg ha^{-1} NPK+ 1.5 per cent urea (foliar) was found to the best for improving the biomass (14.30 g plant^{-1}), herbage (13.96 g plant^{-1}) and vitamin C content (87.05 mg per 100g) in the variety Theni Local.

The harvest maturity was indicated by emergence of serrated leaf. The plants of CO-4 entered to reproductive phase by the emergence of serrated leaf on 37 DAS and completed the life cycle within 75 DAS. Harvest maturity of CO4 for leaf purpose was concluded as 40 DAS. The variety Theni Local exhibited infinite growth and the crop was harvested at 60 DAS for leaf purpose. The harvesting on 60th day exhibited a percentage increase of 35.89 per cent in herbage yield from 40th day yield. Quality parameters were also found to be highest at 60th day harvest.

Irrespective of the seed treatments, spacing, fertilizer schedule and harvest maturity, both the varieties performed well during during October – December under rainshelter. There was 5.06 and 1.72 fold increase in herbage yield of CO-4 and Theni Local respectively during October – December. The quality parameters were also found to be highest during the same season.

The best treatments in all experiments and October – December season was found to be the best combination in both the varieties for getting better growth, yield and quality coriander leaves.

From this study, it was concluded that the early variety CO-4 and late variety Theni Local are suitable for rainshelter cultivation. Presowing seed treatments with 50 mg L^{-1} GA_3 for 8 h and hydropriming for 24 h are effective for both the varieties to improve growth and yield. A closer spacing of 10 x 10 cm can be adopted in both the varieties for getting maximum yield from unit area. Basal application organic fertilizer such as 5 t ha^{-1} FYM and 2.5 t ha^{-1} vermicompost alone is enough for better performance of CO-4. The fertilizer schedule of 5 t ha^{-1} FYM+ 20:10:10 kg ha^{-1} NPK+ 1.5 per cent urea (foliar) at 20 DAS is best for Theni Local. Harvest at 40 DAS and 60 DAS respectively is ideal in CO-4 and Theni local for getting maximum herbage yield. The ideal season for coriander cultivation under rainshelter is October – December in Kerala.