ASI
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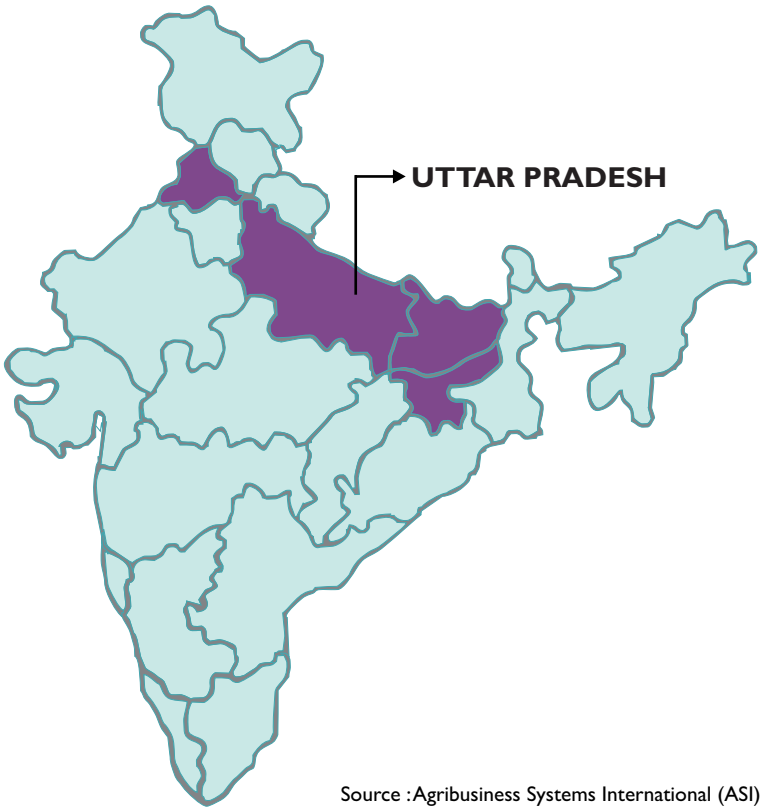
The Good Agricultural Practices
COMPENDIUM

For *Mentha arvensis* Cultivation And Distillation For Uttar Pradesh

December 2015

INTRODUCTION

"The Good Agricultural Practices Compendium for *Mentha Arvensis* Cultivation and Distillation Practices in Uttar Pradesh" is a collection of best agronomic and distillation practices to be tested and validated in Uttar Pradesh, India. All references in this Compendium to mint are to '*Mentha arvensis*' and not other cultivars such as peppermint or spearmint. The information and analysis contained in the compendium was collected through focus group discussions with smallholder farmers in Uttar Pradesh, consultations, field visits and existing literature review. Stakeholders consulted for the compendium included Uttar Pradesh mint farmers, recognized Central Institute for Medicinal and Aromatic Plants experts in business development, plant breeding, plant pathology, distillation design, farm management, and agronomy, and companies specializing in irrigation services, mint oil processing, input supply of planting material, pesticides and fertilizers, and a steam distillation unit fabrication company. Please refer to the Bibliography and Key References at the back of this Compendium for more information.



Source : Agribusiness Systems International (ASI)

All of the agronomic and distillation practices contained in the compendium were evaluated based on their potential to positively impact the socioeconomic condition of mint farmers through their impact on cost of production, ability to improve the quality and quantity of mint oil yield, and conservation of water resources. By working through the production cycle for mint, the agronomic practices were evaluated one by one from selection of the initial plant material through the eventual distillation of the mint oil through locally based steam distillation units. Understanding the impact of cost of production and quality and quantity of yields were selected as criteria for evaluation of the different agronomic and distillation practices as they impact the overall potential profitability of mint production for farmers. Understanding how the different agronomic and distillation practices either utilize water or effect the water retention properties of soils is important to conserve and efficiently use available water.

This Compendium was compiled to present a collection of best agronomic and distillation practices for stakeholders involved in the *Mentha arvensis* value chain. Cost of implementing a specific practice and labor wage assumptions are based on estimated costs in 2015 per acre and are based on a monetary conversion rate of 65 Indian rupee to $1 US dollar. Different crop prices utilized throughout the Compendium are based on data from the Indian Department of Agricultural Marketing in 2014. ASI does not guarantee any results and may update this Compendium based on actual results achieved in the field. Please send any comments, concerns or suggestions to *info@asintl.org*.

This Compendium was made possible thru funding from the Wm. Wrigley Jr. Company, a subsidiary of Mars, Incorporated.

LAND PREPARATION

INTRODUCTION

In Uttar Pradesh the land preparation for mint farming occurs over a one to two day period from January through mid-April, four to five days before planting of the mint crop. The timing of land preparation depends upon the crop rotation cycle of the individual farmer and their availability of land. Prior to land preparation, farmers typically do not perform soil testing of pH, macronutrients, and micronutrients which leads to incorrect dosing and application of fertilizers which decreases the quality of the soils in their fields and reduces the potential yield of mint oil from their crop. Additionally, farmers do not mix farm yard manure into the field during preparation and therefore miss an opportunity to improve mint oil yields by increasing the biomass of their mint plants from increased amounts of organic content in the soil.

TIMING

METHOD	TIME OF APPLICATION
Direct Sowing	January 15 – February 15
Early – Transplanting	February 16 – March 15
Late – Transplanting	March 16 – April 15

PROCESS STEPS

1. Soil is tested for pH, macronutrients (N,P,K) and micronutrients (Z and S)*
2. Field is ploughed by tractor with harrow attachment
3. Farm Yard Manure (FYM) is added to the field*
4. Field is pulverized by rotovator (mixes FYM and aerates soil)
5. Irrigation channels and bunds are reinforced if necessary

* Recommended process step not currently implemented by farmers

LAND PREPARATION COST

SERVICE / LABOR
Soil Testing + Tractor + Rotovator
$3 + $15 + $15 = $ 33 per acre

MATERIAL
Farm Yard Manure
$30 per acre

BENEFITS

SOIL TESTING

Prevents soil damage by reducing excess application of chemicals

Controls costs by preventing excess purchases of fertilizers

Improves yields of mint oil from optimal application of fertilizers

PULVERIZING

Improves yield of mint oil by improving nutrient uptake in mint plants from aeration of soils

Improves yield of mint oil by evenly distributing FYM throughout the soil so benefits from the added nutrients reach the entire mint crop

Improves yield of mint oil by minimizing damage to the crop from the emergence of weeds

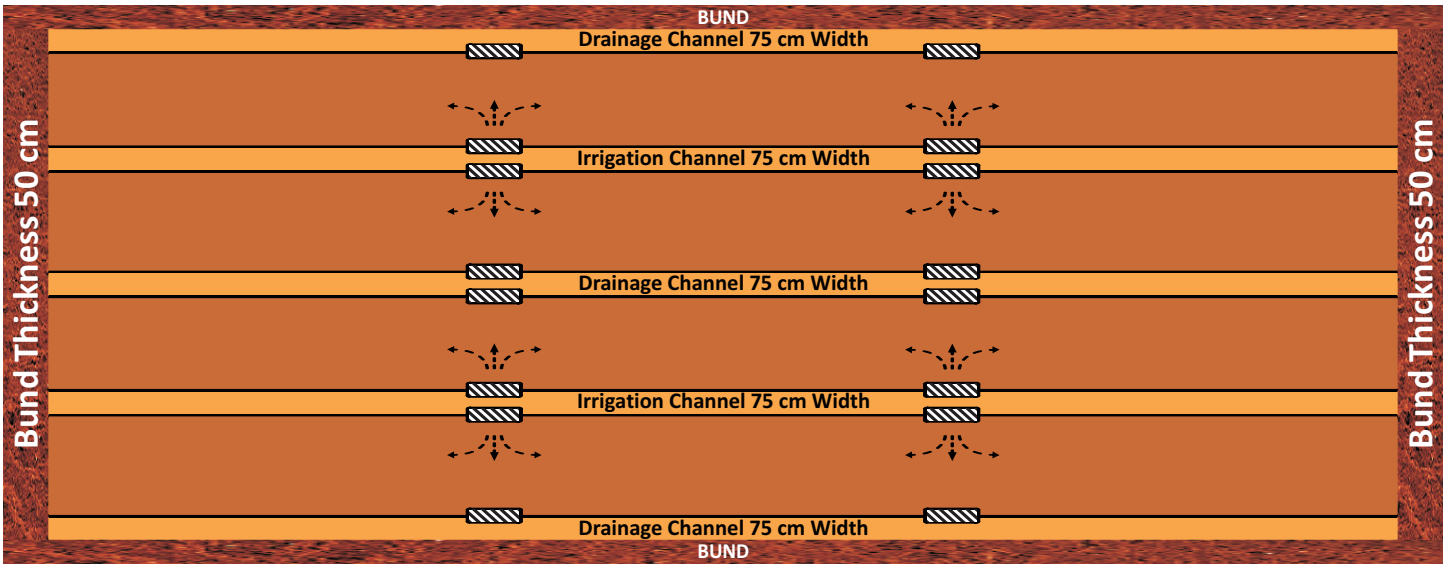
FARM YARD MANURE

Farm Yard Manure (FYM) is prepared using cow dung, cow urine, dairy waste, and other organic material found in the village.

Improves yield of mint oil by increasing the biomass of the mint plant from added organic content and nutrients in the soil

LAND PREPARATION

DIAGRAM OF RECOMMENDED MINT FIELD LAYOUT



NUTRIENT AND FERTILIZER APPLICATION

INTRODUCTION

The three promoted agronomic practices for nutrient and fertilizer application in mint cultivation are soil testing, timely and accurate dosing of organic and chemical fertilizers based on soil composition, and mulching with paddy straw. When utilized together, the three practices result in healthier soils and mint plants, that ultimately lead to increases in the yield of mint oil. The application of these materials occurs in different phases of the mint cycle, typically farmers follow some but not all of the best practices in terms of dosing and timing of the application of organic and chemical fertilizers.

TIMING

See Application Timeline on next page

NUTRIENT AND FERTILIZER APPLICATION

Soil Testing

LABOR
No labor cost*

TESTING
$ 3 per test
($ 70 per test kit)

Farm Yard Manure

LABOR
Frequency x Person days x wage
1 x 0.5 x $ 3 = $ 1.5

MATERIAL
4 tonnes = $ 30

Basal Application

LABOR
Frequency x Person days x wage
1 x 0.5 x $ 3 = $ 1.5

MATERIAL
Chemical = $ 67.2

Top Dressing

LABOR
Frequency x Person days x wage
4 x 0.5 x $ 3 = $ 6

MATERIAL
Chemical cost = $ 6.15

*The labor cost charged for the soil test is included in the testing cost.

NUTRIENT AND FERTILIZER APPLICATION

APPLICATION TIMELINE





	LAND PREPARATION & PLANTING			PLANT GROWTH STAGE		FIRST HARVEST	PLANT GROWTH STAGE		SECOND HARVEST
	SOIL TESTING	FYM APPLICATION	BASAL APPLICATION AFTER LAND PREPARATION	MULCHING	FIRST TOP DRESSING	SECOND TOP DRESSING	THIRD TOP DRESSING	FOURTH TOP DRESSING	
DAY	1	10	17	37	57	82	127	140	182
MONTH	JANUARY/ FEBRUARY	JANUARY/ FEBRUARY	JANUARY/ FEBRUARY	FEBRUARY/ MARCH	FEBRUARY/ MARCH	APRIL	MAY	JUNE	JULY
QUANTITY/ ACRE	N/A	10 TONNES	UREA-44 KG SSP-50 KG P_2O_5-20 KG K_2O-27 KG	RICE STRAW (400 KG)	UREA 55 KG	UREA 55 KG	UREA 55 KG	UREA 55 KG	N/A

BENEFITS

FARM YARD MANURE	Improves yield of mint oil by increasing biomass of the mint plant from increased organic material and nutrients in the soil
BASAL APPLICATION AND TOP DRESSING	Application of fertilizer contributes to healthier soil and improves yield of mint oil by increasing biomass of the mint plant from increased availability of nutrients in the soil

SELECTION OF VARIETIES

INTRODUCTION

Since the introduction of *Mentha arvensis* in India in the early 1950s, nine varieties of mint have been developed by CIMAP of which two high oil yielding varieties, Kosi and CIM-Kranthi, are still available. Both of these varieties have evolved properties that make them agronomically suitable for the growing conditions in Uttar Pradesh including disease and pest resistance, and in the case of CIM-Kranthi, cold resistance. Currently, most farmers in Uttar Pradesh obtain planting material of a mixed variety from local markets or from their leftover mint plants from the previous season. These mixed varieties do not offer the same benefits as the certified varieties and often lead to inconsistent yields. While mixed varieties typically yield between 40 -55 Kg of mint oil depending upon the planting method, CIMAP studies have indicated that the pure Kosi variety can yield as much as 80 Kg of mint oil per acre and the pure variety of CIM Kranthi can yield as much as 100 Kg per acre.

TIMING

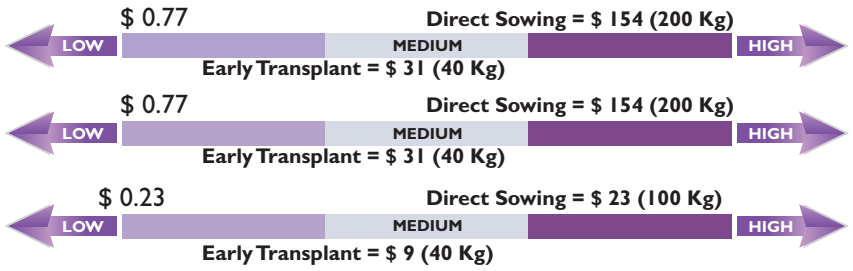
Kosi	Available in January with CIMAP after placing an order at least 3 months in advance
CIM-Kranthi	Available in January with CIMAP after placing an order at least 3 months in advance

COST

KOSI
Stolon Cost per Kg
$ 0.77

CIM KRANTHI
Stolon Cost per Kg
$ 0.77

LOCAL MIXED
Stolon Cost per Kg
$ 0.23



BENEFITS*

KOSI

- Resistant to common mint diseases including leaf spot and powdery mildew
- Pest resistant
- Produces a mint oil yield of 80 Kg per acre
- Menthol content is 80%

CIM KRANTHI

- Resistant to common mint diseases including leaf spot and powdery mildew
- Pest resistant
- Cold resistant
- Produces a mint oil yield of 100 Kg per acre
- Menthol content is 80%

*All listed benefits of the improved varieties are sourced from CIMAP

PLANT FEATURES

PLANTING

INTRODUCTION

The two methods for sowing mint into the field are direct planting of mint stolons and transplanting of nursery raised seedlings either early or late in the season. The selection of sowing method depends upon both the availability of land and the crop rotation cycle of the individual farmer. Direct sowing is utilized when a field is available on or around January 15 to February 15, early transplanting from a nursery occurs when a field is available on or around February 16 to March 15, and late transplanting from a nursery occurs when a field is available on or around March 16 to April 15. Based on the crop cycle in Uttar Pradesh, farmers utilizing direct sowing or early transplanting are able to harvest mint two times on the same piece of land during the year (at 110 days and 175 days after planting), while farmers practicing late transplanting will only achieve one harvest per season. Consequently, the yields from mint oil are typically the highest from direct sowing (50 -55 Kg per acre) followed by the yields from early transplanting (45 – 50 Kg per acre) and the yields from late transplanting (40 – 45 Kg per acre).

TIMING

Direct Sowing	January 15 - February 15
Early – Transplanting	February 16 - March 15
Late – Transplanting	March16 - April 15

PROCESS STEPS

DIRECT SOWING

1. Stolons are cut from existing mint plants or purchased in the market place. Stolons should be cut to a size of 1 inch.
2. Cut stolons are dipped into a fungicide water solution mixed in a drum with either Captan* or Thiram* (.2%).
3. Furrows are opened 6 - 8 cm deep at a distance of 60 cm between furrows. Basal dose of fertilizer is placed in the furrows and covered with thin layer of soil.
4. Cut stolons are directly sown into the prepared furrows at a plant to plant distance of less than 5 cm.
5. Irrigation is performed immediately after direct sowing of the stolons.

* Name of Chemical

TRANSPLANTING

1. Seedlings are raised in the nursery for 30-35 days (refer to nursery section for details).
2. The field is irrigated and seedlings are then planted maintaining a row to row distance of 45 cm for early transplanting and 30 cm for late transplanting and a plant to plant distance of 15 cm for early transplanting and 10 cm for late transplanting.
3. Irrigation is performed 2-3 days after transplanting.

DIRECT SOWING COST*

MATERIAL
Stolons per acre x Price per Kg
200 Kg x $ 0.77 = $ 154

LABOR
Frequency x Person days x Wage
1 x 7 x $ 3 = $ 21

TRANSPLANTING*

MATERIAL
Nursery = $ 39
(See Nursery Raising section)

LABOR
Frequency x Person days x Wage
1 x 7 x $ 3 = $ 21

*Costs for direct sowing and transplanting are annual.

PLANTING

BENEFITS

DIRECT SOWING	Allows the crop to spend the maximum time in the field up to 185 days. Provides the highest mint oil yield of all the methods of sowing and it guarantees two harvests (50 - 55KG per acre) In the event of crop failure in the previous season, allows a farmer to recoup some of their lost investment
EARLY TRANSPLANTING	Although not as high yielding as direct sowing, early transplanting normally allows a farmer to achieve two harvests (45 – 50 Kg per acre) although it is not guaranteed. Allows farmers with food security concerns and limited land availability to get one additional crop out of their rotation cycle
LATE TRANSPLANTING	Although it does not allow the potential for two harvests, late transplanting allows farmers with food security and limited land availability to let their food crops fully mature and still allows for one mint harvest in their rotation cycle to provide much needed cash.

NURSERY RAISING

INTRODUCTION

Due to food security pressure and lack of available land, most mint farmers use nurseries to grow mint seedlings for transplanting as opposed to direct sowing of mint stolons into their fields. By raising mint seedlings in nurseries on a small section of their land, farmers are able to keep an additional crop in their crop rotation cycle. Although nursery raising of seedlings is a common practice, very few farmers utilize the full range of best practices in nursery management that lead to increased mint oil yields from improved plant growth.

TIMING

Nursery Raising	January 15 – March 15 (30-35 days before transplanting)

PROCESS STEPS

1. Section off a plot of land 80m^2 for each acre of mint to be planted.
2. Forty Kg Mint Stolons are purchased from the market or cut from remaining stock of mint from the previous season. The mint stolons are cut into 1" pieces.
3. The cut stolons are placed into a jute bag.
4. Water is mixed with fungicide (Capton/ Thirum) in the ratio of 2 grams of fungicide to 1 liters of water.
5. Cut stolons are dipped in the fungicide solution for 2 minutes.
6. Treated stolons are kept in a jute bag and placed in the shade for 8 to 10 days.
7. Plough the nursery space using a harrow (tractor).
8. Pulverize the soil in the nursery using a rotovator .
9. Manually prepare a bed covering the entire nursery space.
10. 2.5 kg of farm yard manure, 15 grams of Diammonium phosphate (DAP) and 10 grams of Potassium each per square meter is mixed with the soil.
11. Irrigate the nursery bed before planting the stolons.
12. A stick is used to draw straight lines in the nursery bed (less than 5 cm row to row and plant to plant).
13. Stolons are placed ½" into the soil, minimal spacing is required between stolons.
14. Cover the nursery bed with farm yard manure.
15. Irrigation is required 10 to 12 days after the planting.
16. 1 % urea solution is sprayed after 20 - 25 days.
17. Mint stolons are ready for transplant after 30 to 35 days.

NURSERY COST

MATERIAL
Stolon + Fungicide+ FYM[@]+DAP[#]+ MOP*
$ 31 + $ 0.5 + $ 3 + $ 1 + $ 0.5 = $ 36.5

IRRIGATION
Frequency x Price
1 x $1 = $ 1

LABOR
Frequency x Person days x Wage
1 x 0.5 x $ 3 = $1.5

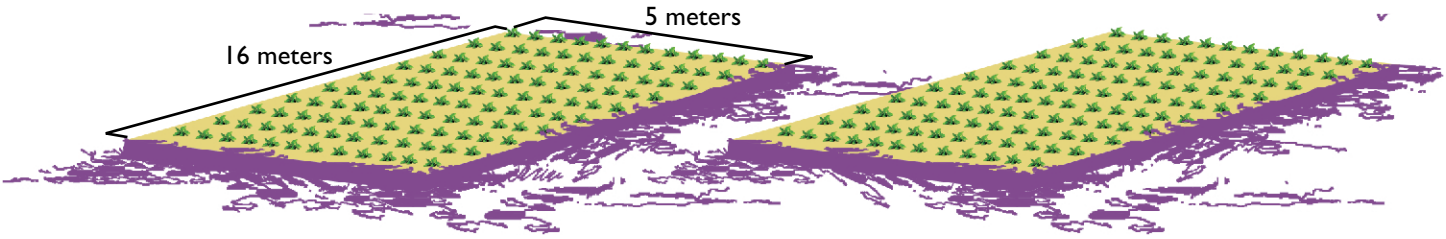
[@]Farm Yard Manure + [#]Diammonium phosphate + *Muriate of Potash

NURSERY RAISING

BENEFITS

Allows farmers to grow an additional crop in their crop rotation cycle and still receive cash from the mint crop

SAMPLE NURSERY LAYOUT



IRRIGATION

INTRODUCTION

There are three available potential options for farmers in India for irrigation of mint.These include:

Surface Irrigation: The surface method is the method practiced by farmers in Uttar Pradesh. Farmers rent a gasoline powered pump used to the flood the field and one person is required to direct the flow of the water. It is the least expensive of the three methods but also the least water efficient.

Drip Irrigation: In the irrigation method water is supplied slowly over time through a series of valves, pipes and tubing directly to the root system of a crop.The drip method requires pumps that can be powered manually or through solar, electricity or gasoline. Drip irrigation is the most efficient in terms of water usage but also the most costly, and is well out of the price range for most farmers. Little is known about the yield impacts on mint oil with drip irrigation for mint farming in the region.

Sprinkler Irrigation: In the sprinkler method water is supplied through pipes to a sprinkler head where it is sprayed into the air over the crop. The sprinkler method requires pumps powered by gasoline, solar or electricity. Little is known about the yield impacts on mint oil with sprinkler irrigation for mint farming in the region.

TIMING

METHOD	TIME OF APPLICATION
Surface flood	Every 10 - 12 days after planting until 7-10 days before harvest
Drip irrigation	1.25 hour every day until 7-10 days before harvest
Sprinkler	1 hour every other day 2-3 hours, until 7-10 days before harvesting

SURFACE COST

MATERIAL
Pump Rental x Frequency
$ 2 X 12 = $ 24 per acre
Diesel x Frequency
$ 4 x 12 = $ 48 per acre

LABOR
Person Days x Wage x Frequency
0.5 x $ 3 x 12 = $ 18 per acre

DRIP COST*

MATERIAL
Kit Cost = $ 615 per acre
Pump Rental + Diesel
$ 110 + $ 63 = $ 173 per acre

LABOR
Person Days x Wage x Frequency

SPRINKLER COST*

MATERIAL
Kit Cost = $ 500 per acre
Pump Rental + Diesel
$ 110 + $ 36 = $ 146 per acre

LABOR
Person Days x Wage x Frequency

*The material costs for sprinkler and drip irrigation are calculated based on the assumption that the cost of the pump rental and diesel fuel will be 1/3 less than the cost of pump rental and diesel fuel for surface irrigation. Although data is not available on the cost of fuel and pump rental over a season for drip or sprinkler irrigation, it is presumed to be lower than the surface method as the amount of land irrigated is lower for both methods.

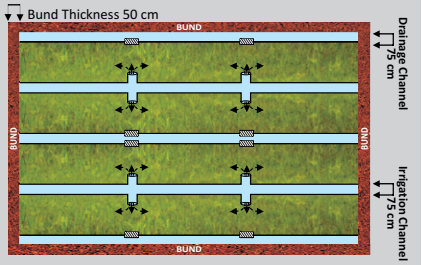
IRRIGATION

BENEFITS

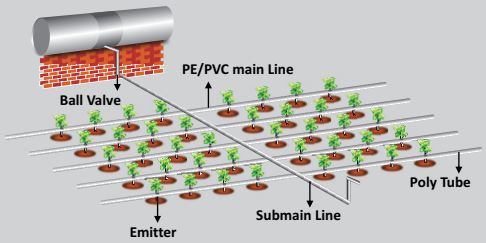
SURFACE	Low capital expenditure Low technical complexity
DRIP	Improve mint oil yield through improved application of fertilizer through fertigation Reduces water usage by decreasing the amount of land necessary to irrigate by delivering water directly to the plants Low labor requirements after installation
SPRINKLER	Reduces water usage by decreasing the water volume necessary to irrigate the field Portability of sprinkler means it can be used for other fields

IRRIGATION SYSTEM LAYOUTS

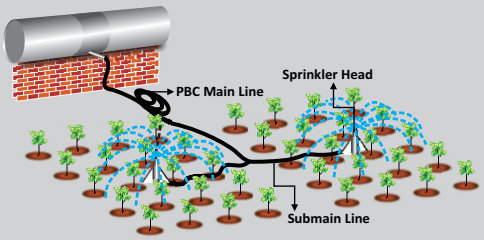
SURFACE IRRIGATION



DRIP IRRIGATION



SPRINKLER IRRIGATION



PEST AND DISEASE MANAGEMENT

INTRODUCTION

Disease and pest management practices are important control mint farmers as pest and disease outbreaks can lead to crop failures that severely impact farmer livelihoods. By planting the disease and pest resistant pure varieties of Kosi and CIM Kranti farmers will reduce incidence of pests and disease. For integrated pest management a preventative combination of organic methods is recommended including spraying of neem oil after planting and the placement of twelve sticky cards on bamboo poles per acre throughout the field. If pests are identified in the crop, early treatment of Dimethoate will prevent further damage to the crop. For disease management, applying Capton or Thirum prior to planting will reduce later incidence of fungus damage in *Mentha arvensis*. If powdery mildew, leaf spot, or rust is identified in the field, immediate application of Carbendazim or Mancozeb will reduce crop loss.

TIMING

Integrated Pest Management	Neem Oil – a preventative organic treatment (2000 – 3000 PPM water solution) 20 to 25 days after planting Sticky Cards – a preventative treatment sticky cards are placed on poles and spread throughout the field within the first month after planting (12 per acre)
Chemical Pest Management	Dimethoate* – a post incidence treatment applied immediately after pests are located on the plants (0.2% water solution)
Chemical Disease Management	Capton/Thirum* – a preventative treatment applied to stolons prior to planting (0.02% water solution) Carbendazim/Mancozeb* – a post incidence treatment applied immediately after identification of powdery mildew, leaf spot & rust disease on the plants (0.2% water solution)

*Name of Chemical

PROCESS STEPS

1. If direct sowing dip stolons in Capton / Thirum solution for 2 minutes prior to planting in the field. Before planting into the nursery, stolons are dipped in Capton/Thirum solution for 2 minutes and placed in a jute bag for 8 -10 days in the shade (0.02% water solution)
2. 20 – 25 days after planting apply Neem Oil directly to plants (2000 – 3000 ppm water solution)
3. Immediately after pests are identified spray Dimethoate directly onto the plants (0.2% water solution) and immediately after the disease is identified spray Carbendozim/Mancozeb directly onto the plants (0.2% water solution)

PEST MANAGEMENT COST*

IPM
MATERIAL
Neem Oil x Frequency
$ 5 x 1 = $ 5
Sticky Card X Frequency
$ 0.25 x 12 = $ 3

POST PLANTING
Chemical
Dimethoate x Frequency
$ 3 x 1 = $ 3

PEST AND DISEASE MANAGEMENT

DISEASE MANAGEMENT COST*

PRE PLANTING
Fungicide x Frequency
$ 3 x 1 = $ 3

$ 3

LOW | MEDIUM | HIGH

POST INCIDENCE
Carbendazim/Mancozeb = Fungicide x Frequency
$ 4 x 1 = $ 4

$ 4

LOW | MEDIUM | HIGH

*All costs are per acre

BENEFITS

PEST IPM	**Prevents soil damage from excess application of chemicals by preventing pest incidence** **Protects from lower mint oil yields from crop loss** **Low cost**	**CHEMICAL PEST CONTROL**	**Prevention of crop loss If sprayed immediately after identification of pests** **Low cost**	**CHEMICAL DISEASE CONTROL (PRE AND POST)**	**Prevention of crop loss If sprayed immediately after identification of disease** **Low cost**

COMMON PESTS

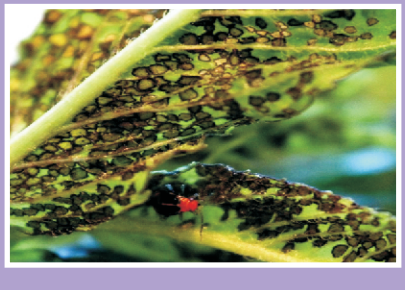
White Fly

Lace Bug

Bihar Hairy Caterpillar

COMMON DISEASES

Powdery Mildew



Rust

Leaf Spot

WEEDING

INTRODUCTION

The three different methods for weed control available to farmers in Uttar Pradesh are manual, chemical, and mulching. Each method is utilized at a different point in the season either as a precautionary method or in the event of weed emergence. Studies by CIMAP have shown that unchecked weed growth lowers yields of mint oil by 5.2 litres per acre in the first harvest and up to 1 litre per acre in the second harvest. By implementing best practices around manual weeding and application of weedicide immediately after planting, and mulching of the field with paddy straw, farmers will reduce the loss of mint oil yield by eliminating competition for nutrients from weeds.

TIMING

METHOD	TIME OF APPLICATION
PRE-EMERGENCE	Chemical weedicide Pendimethalin (0.006 %) is applied immediately after planting as a preventative. The field is covered with mulch 20 days after planting to prevent the emergence of weeds.
POST-EMERGENCE	Manual weeding performed twice with a hand hoe between 40-90 days as the weeds emerge Chemical weedicide (Gramoxone) is applied 60 days after the first weedicide application. Gramoxone treats the six most common weeds.

PRE EMERGENCE COST

MULCHING

MATERIAL
400 Kg paddy straw= $ 12 per acre

LABOR
Frequency x Person days x wage
1 x 2 x $3= $ 6 per acre

CHEMICAL

MATERIAL
Chemical cost = $ 6.15 per acre
(1.2 liter per acre)

LABOR
Frequency x Person days x wage
1 x 1 x $ 3= $ 3 per acre

POST EMERGENCE COST

MANUAL

MATERIAL
No material cost

LABOR
Frequency x Person days x wage
2 x 15 x $3= $ 90 per acre

CHEMICAL

MATERIAL
Chemical cost = $ 9.2 per acre

LABOR
Frequency x Person days x wage
1 x 1 x $3= $ 3 per acre

WEEDING

BENEFITS

MANUAL	Improves yield of mint oil by increasing biomass of the mint plants from aeration of the soils increasing the uptake of nutrients from the mint plant
CHEMICAL	Requires low amounts of labor & cost Easy mixing and application
MULCHING	In relation to weeding, reduces loss of mint oil yields by preventing the emergence of weeds competing with mint plants for nutrients Easy to apply as a technique and low cost Improvements to oil yield from increased nutrients and organic matter in the soil and reduction in soil temperature Reduces water usage by increasing water retention in soils

SIX MOST COMMON WEEDS

WEEDS			
Scientific Name	*Cyperus rotundus*	*Parthenium hysterophorus*	*Cynodon dactylon*
Damage Intensity	High	High	High

WEEDS			
Scientific Name	*Melilotus indica*	*Asphodelus tenuifolium*	*Anagalis arvensis*
Damage Intensity	Medium	Medium	Medium

HARVESTING

INTRODUCTION

Mint harvesting in Uttar Pradesh occurs in the months of May - August. Two important visual signs that the mint crop is ready to harvest are the leaves at the bottom of the plant turn yellow and the leaves at the top of the plant start to shrink. After harvesting the mint biomass is left to dry in the field for 24 hours before transportation to the distillation unit.

TIMING

	First harvest	Second harvest
Direct Sowing	110 Days after planting	175 Days after planting
Early – Transplanting	100 Days after planting	175 Days after planting
Late – Transplanting	110 Days after planting	Not Possible

PROCESS STEPS

1. If expecting a second harvest, approximately 110 days after planting, cut the mint plant approximately 10 cm above the ground with a sickle. If not expecting a second harvest or during the second harvest, approximately 175 days after planting, cut the mint plant 5 cm above the ground with a sickle. In the event of rain or after an irrigation, wait 7-10 days before harvesting to allow the soil and the mint to dry.
2. Spread the biomass in the field and allow to dry for 24 hours prior to transporting for distillation

HARVESTING COST

LABOR
Frequency x Person Days x Wage
1 x 10 x $3 = $30 per acre

BENEFITS

Harvesting after allowing the mint to fully mature provides a higher oil yield

Allowing the mint plant to dry after irrigation or rain prior to harvesting provides a higher oil yield

Spreading the harvested mint as opposed to heaping the mint in the field prior to distillation will allow for a reduction in the plants moisture content which improves oil extraction

HARVEST PICTORIAL

Lower leaves turning yellow

Shrinking top leaves

Spreading biomass after harvest

DISTILLATION

INTRODUCTION

Distillation is the final phase for the farmer in the mint cycle. In Uttar Pradesh, after harvesting and drying the mint, farmers transport the crop to a local village distiller who charges a small fee for extraction of the mint oil. The non-water soluble mint oil is distilled from the harvested mint biomass through a locally constructed steam distillation unit. Problems with the current local steam distillation unit include 1) biomass is sometimes charred from the heat in the distillation still producing discoloration and reduction in the quality of the mint oil 2) a percentage of the mint oil is lost when steam escapes from the condenser and 3) mint oil is lost when it spills from the water outlet in the oil receiver. However, with a few minor modifications to the distillation equipment, the quality and quantity of the oil extracted can be improved. Three modifications to the distillation equipment developed by CIMAP and detailed below have yet to be commercially adopted on a wide scale that will reduce charring from the heat in the distillation still and improve the percentage of oil extraction from the processes involving the condenser and oil receiver. After distillation the oil is stored in stainless steel galvanized iron containers. The container must be sealed tightly to prevent contact with air.

TIMING

Distillation occurs the day after harvesting in May - August

Total distillation time is 15 - 18 hours per acre of mint harvested

PROCESS STEPS

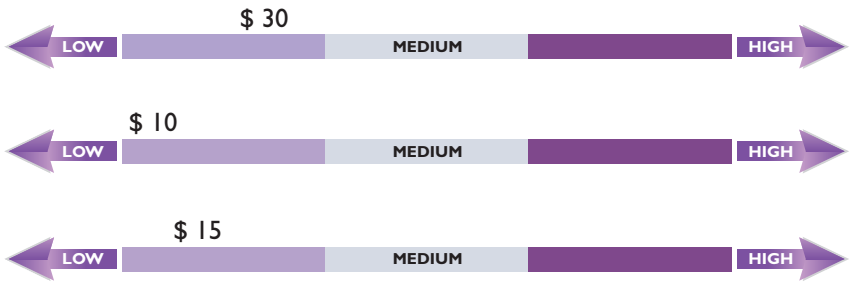
1. Lower portion of distillation still is filled with water.
2. Distillation still is filled with mint biomass and heated from the bottom by a simple furnace.
3. The steam produced from the water captures oil from the mint biomass.
4. Steam passes into the condenser through tubes that interact with cold water converting the steam to a liquid and separating the mint oil from the water.
5. The oil is collected in a small oil receiver.

DISTILLATION COST

RENTAL
Frequency x Price
2 x $ 15 = $ 30

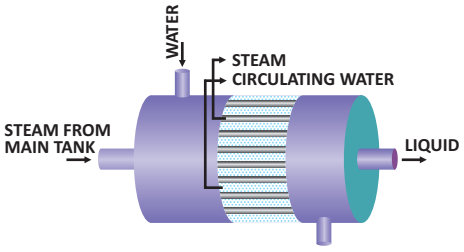
TRANSPORTATION
Frequency x Price
2 x $ 5 = $ 10

LABOUR
Frequency x Person days x Wage
1 x 5 x $ 3 = $ 15

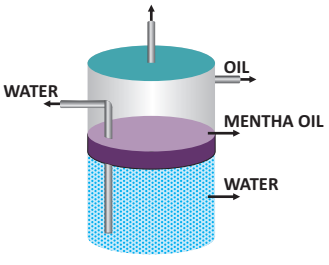


MODIFIED COMPONENTS

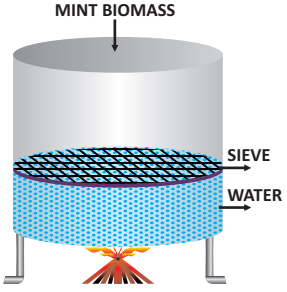
CONDENSER



OIL RECEIVER

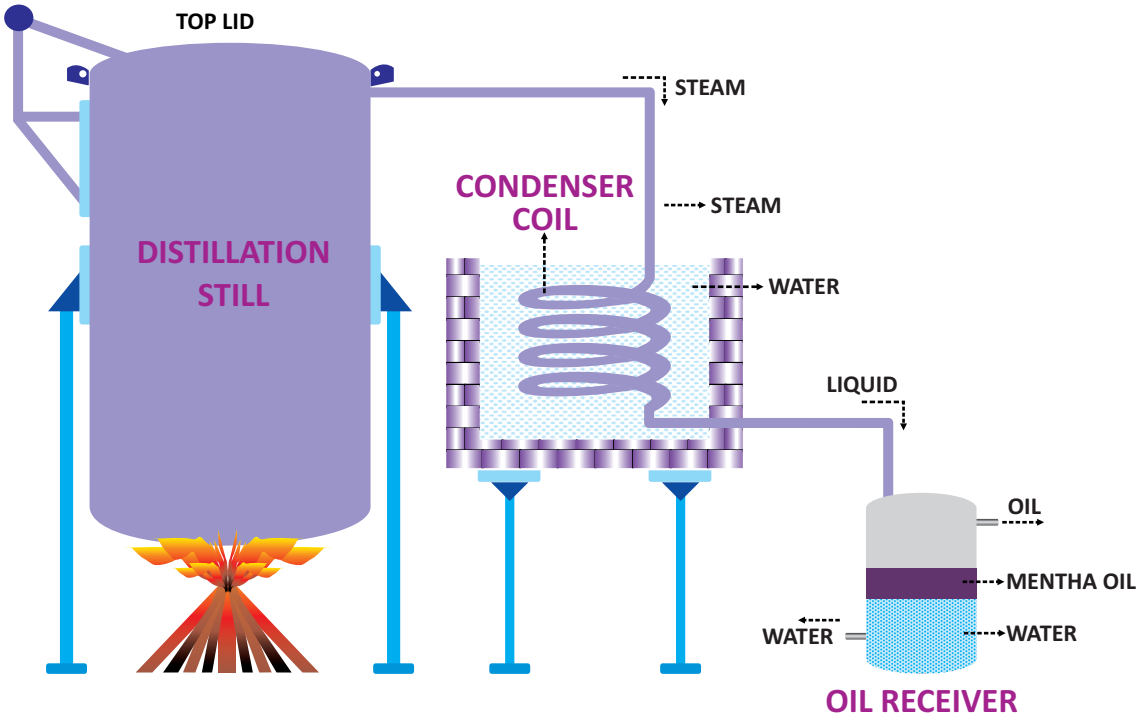


DISTILLATION STILL

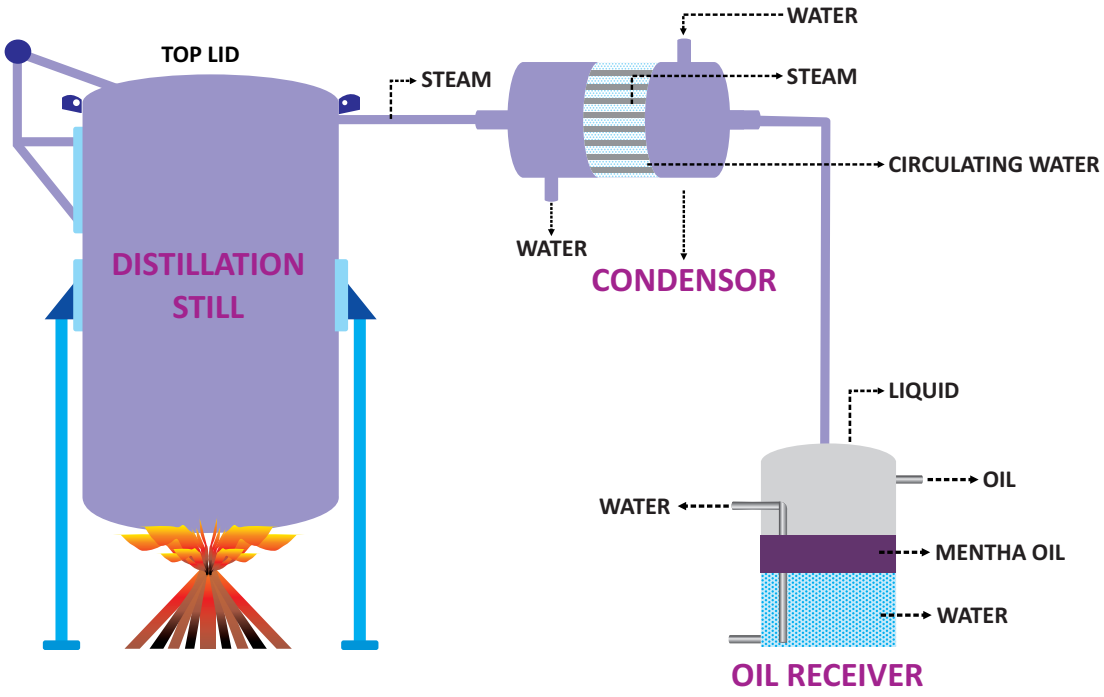


DISTILLATION

TRADITIONAL DISTILLATION SYSTEM



IMPROVED DISTILLATION SYSTEM



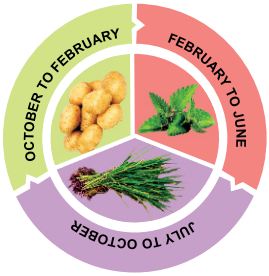
CROP ROTATION

INTRODUCTION

Crop Rotation is the practice of using the same land for growing a series of different crops in sequenced seasons. Crop rotation replenishes nitrogen to maintain soil health and prevents pathogens and pests from attacking the crops. The majority of mint farmers in Uttar Pradesh rotate their crops throughout the year in one of the following six cycles listed below. In these six crop rotation cycles* mint is either planted early, before February 15, or late, after February 15 until April 15. Factors for selection of the rotation cycle by farmers include food security concerns, availability of cash, agro - climactic conditions of their fields, and their familiarity and experience with the crops. The six crop rotation cycles below include the cost of production (COP) from conversations with farmers, the potential revenue based on 2014 prices, and the estimated water requirements for each of the crops.

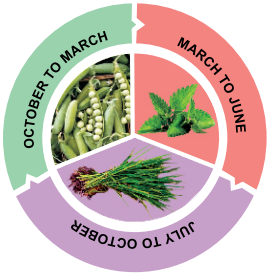
CROP CYCLES - EARLY PLANTING OF MINT IN FEBRUARY

PADDY-POTATO-MINT



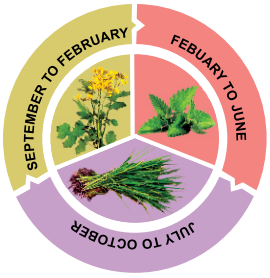
YIELD (KG/ACRE)	COP (USD/ACRE)	REVENUE (USD/ACRE)	WATER (MM/ACRE)
Paddy - 2,200	$ 1,445	$ 2,416	1,250 - 2,100
Potato - 10,000			
Mint - 55			

PADDY-SWEET PEA-MINT



YIELD (KG/ACRE)	COP (USD/ACRE)	REVENUE (USD/ACRE)	WATER (MM/ACRE)
Paddy - 2,200	$ 1,091	$ 2,079	1,100 - 1,950
Sweet Pea - 1,200			
Mint - 55			

PADDY-MUSTARD-MINT



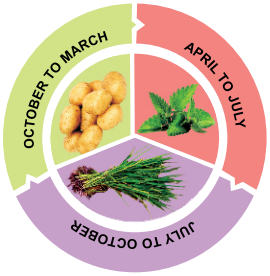
YIELD (KG/ACRE)	COP (USD/ACRE)	REVENUE (USD/ACRE)	WATER (MM/ACRE)
Paddy - 2,200	$ 952	$ 1,454	1,150 - 1,750
Mustard - 800			
Mint - 55			

*Other crops, including sugar cane or pulses, have the potential to be intercropped with *Mentha arvensis* but were not evaluated as part of the compendium.

CROP ROTATION

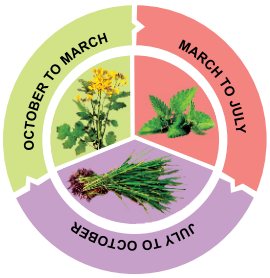
CROP CYCLES - LATE PLANTING MINT IN MARCH

PADDY-POTATO-MINT



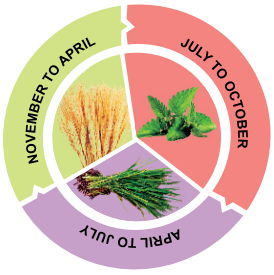
YIELD (KG/ACRE)	COP (USD/ACRE)	REVENUE (USD/ACRE)	WATER (MM/ACRE)
Paddy - 2,200	$ 1,520	$ 2,310	1,250 - 2,100
Potato - 10,200			
Mint - 45			

PADDY-MUSTARD-MINT



YIELD (KG/ACRE)	COP (USD/ACRE)	REVENUE (USD/ACRE)	WATER (MM/ACRE)
Paddy - 2,200	$ 982	$ 1,266	1,150 - 1,750
Mustard - 800			
Mint - 45			

PADDY-WHEAT-MINT



YIELD (KG/ACRE)	COP (USD/ACRE)	REVENUE (USD/ACRE)	WATER (MM/ACRE)
Paddy - 2,200	$ 1,166	$ 1,344	1,200 - 2,050
Wheat - 2,100			
Mint - 45			

INTERCROPPING

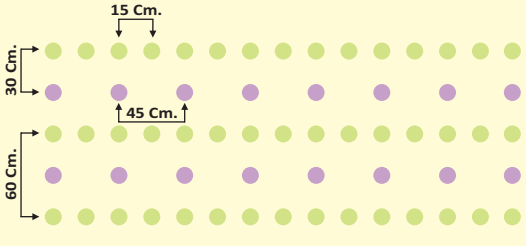
INTRODUCTION

Intercropping is the process of growing two compatible crops on the same land during the same agricultural season. Intercropping offers farmers the opportunity to increase their farm revenue per acre. Four compatible crops have been identified as agronomically suitable to intercrop with mint in Uttar Pradesh. The four identified crops are vetiver, wheat, onion and radish*. When intercropping with wheat or vetiver, they are considered the primary crop and mint is considered the secondary crop. The revenue from mint is therefore considered to be additional revenue for the farmer. For wheat and vetiver intercropping, there is a lower plant population of mint per acre than if only mint is grown. When intercropping with radish and onion, mint is considered the primary crop and radish and onion are considered to be the secondary crop. When intercropping with radish and onion, the revenue from radish and onion is considered to be additional revenue for the farmer. For radish and onion intercropping, the plant population of mint per acre is the same as if only mint is grown.

MINT AS SECONDARY CROP

PRIMARY CROP: VETIVER
SECONDARY CROP: MINT

SPACING

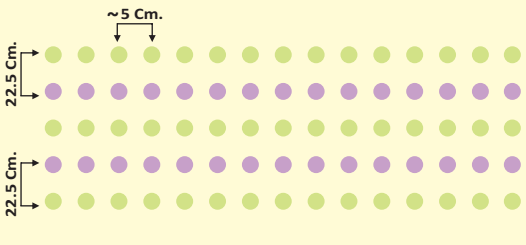


PLANTING TIME	HARVESTING TIME
MINT : FEBRUARY VETIVER : FEBRUARY	MINT : JUNE - JULY VETIVER : DECEMBER

ESTIMATED MINT OIL YIELD	41.25 Kgs per acre
ESTIMATED MINT OIL REVENUE	$ 488.65
ESTIMATED VETIVER REVENUE	$ 1661.54

PRIMARY CROP: WHEAT
SECONDARY CROP: MINT

SPACING



PLANTING TIME	HARVESTING TIME
MINT : JANUARY WHEAT : NOVEMBER	MINT : JUNE - JULY WHEAT : MAY

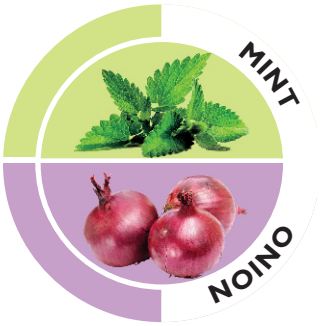
ESTIMATED MINT OIL YIELD	40 Kgs per acre
ESTIMATED MINT OIL REVENUE	$ 473.80
ESTIMATED WHEAT REVENUE	$ 468.50

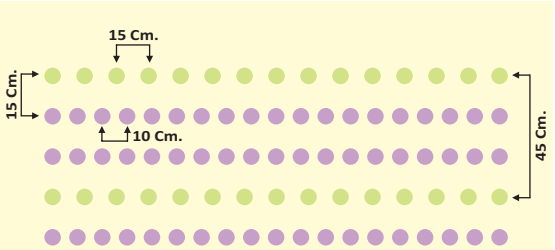
*Although other crops are possible, these six make rotation cycle are in practice by the majority of mint farmers in Uttar Pradesh.

INTERCROPPING

MINT AS PRIMARY CROP

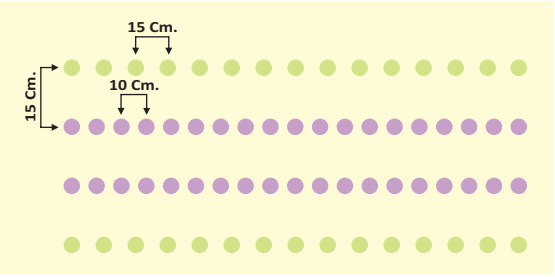
PRIMARY CROP: MINT
SECONDARY CROP: ONION



SPACING	PLANTING TIME	HARVESTING TIME
	MINT : FEBRUARY ONION : NOVEMBER	MINT : JUNE - JULY ONION : MAR - APRIL

ESTIMATED MINT OIL YIELD	56 Kgs of mint oil per acre
ESTIMATED MINT OIL REVENUE	$ 663.40
ESTIMATED ONION REVENUE	$ 913.84

PRIMARY CROP: MINT
SECONDARY CROP: RADISH

SPACING	PLANTING TIME	HARVESTING TIME
	MINT : FEBRUARY RADISH : NOVEMBER	MINT : JUNE - JULY RADISH : MAR - APRIL

ESTIMATED MINT OIL YIELD	56 Kgs of mint oil per acre
ESTIMATED MINT OIL REVENUE	$ 663.40
ESTIMATED RADISH REVENUE	$ 199.40

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3		Herbochem Industries	Shop no- B9, Chemical Complex, Jahangirabad Road, Barabanki Pincode-225123(UP)	8853058222
4		Sharp Mint Limited	Sharp House, Plot no. 9, LSC, Gujranwala Town-1, Delhi – 110009, INDIA	T: 91-11- 42290700. F: 91-11-27226406 Email : sales@sharpglobal.in customer.support@sharpglobal.in

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