PRACTICAL MANUAL

Course Title	: **Crop Production Technology - II**
Course No.	: **AGRO – 246 (New)**
Credits	: **2 (1+1)**
Course	: **B.Sc. (Hons.) Agriculture**
Semester	: **IV Semester (New)**

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Experiment No. 1: Sowing Methods of Wheat crop

Date: / /

Objective: To know the different methods of sowing wheat crop

Methods of Sowing: Wheat is sown by different methods:

1. Broadcasting :

It is the scattering of seeds by hand all over the prepared field followed by covering with wooden plank or harrow for contact of seed with soil. Crops like wheat, paddy, Sesamum, Fenugreek, coriander, etc. are sown traditionally by this method.

Advantages:

1) Quickest & cheapest method

2) Skilled labour is not required

3) Seed drill (animal drawn or Machine mounted is not required) is not required

4) Followed in moist condition.

Disadvantages:

1) Seed requirement is more,

2) Crop stand is not uniform.

3) Result in germination gap & defective wherever the adequate moisture is not present in the soil.

4) Spacing is not maintained within rows and plant, hence interculturing is difficult.

2. Behind Local Plough :

This method consists of dropping the seeds by hand into the furrows that have been opened with local plough. When seed is dropped in furrows by hand, it is called 'kera' method and when it is dropped through a *Pora* or *Hazara* a special attachment with local plough it is called 'Pora' method. In this method seeds are dropped at a depth of 5-6 cm and germination is satisfactory.

3. Drilling :

In this method seed is sown by seed drill or Seed-cum-ferti drill. With the help of this implement seed drop at depth and results in uniform germination and regular stand.

Advantages:

1) Seed is placed at proper & uniform depth
2) Along the rows, interculturing can be done,
3) Uniform row to row spacing is maintained and intercropping can be adopted
4) Seed requirement is less than 'broad casting' Method of sowing
5) Sowing is done at proper moisture level.

Disadvantages:

1) Require implement for sowing,
2) Wapsa (Field capacity) condition is must.
3) Plant to plant (Intra row) spacing is not maintained,
4) Skilled person is required for dropping seed through drill.

4. Dibbling :

This method is used in case where supply of seed is limited. Sowing is done with the help of a small implement known as 'Dibbler'. It is a wooden or iron frame with pegs. The frame is pressed in the field and lifted and then one or two seeds are dropped by hand in each of the hole.

Advantages:

1) Distance between both rows & plants is maintained,
2) Seeds can be dibbled at desired depth in the moisture zone,
3) Optimum plant population can be maintained,
4) Seed requirement is less than other methods,
5) Implement is not required for sowing,
6) An intercrop can be taken in wider spaced crops.
7) Cross wise intercultivation is possible.

Disadvantages:

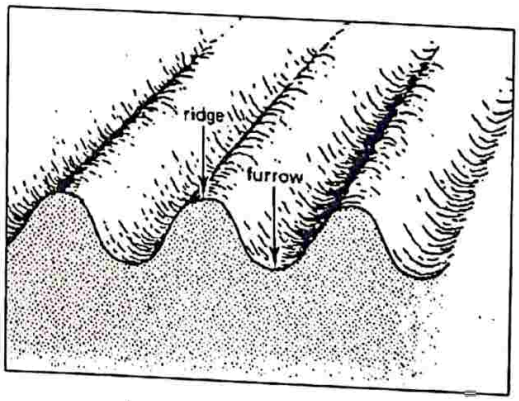
1) Laborious & time consuming method
2) Require more labour, hence increase the cost of cultivation,
3) Only high value & bold seeds are sown,
4) Require strict supervision.

5. Zero-till Seed Drill technique :

This new method is used in Rice-Wheat cropping system where sowing of wheat is delayed beyond 25 November. Sowing is delayed due to multiple reasons, viz. preparation of field, uncertain rainfall and rice harvesting with traditional method. Out of these, the field preparation is one of the most important reasons, which causes delay in wheat sowing. puddling in transplanted rice creates a hard pan in the field. A Zero-till-ferti-seed-drill machine has been developed at G.B.Pant University of Agriculture and Technology, Pantnagar by which direct sowing of wheat is done in Rice field without ploughing. This helps advancing the sowing of wheat as the time required for field preparation is saved.

6. Furrow Irrigated Raised Bed (FIRB) :

This method has been evolved to economize irrigation water in which raised beds of prepared to accommodate 2 or 3 rows of wheat between two furrows. The irrigation is done only in furrows. Thus about half of the irrigation required may be saved by this method without any loss to the productivity of wheat grain. The wheat yield has been found to be higher than conventional method at Directorate of Wheat Research (DWR), Karnal. A machine has been developed to make raised bed and sowing of wheat simultaneously has been developed for this purpose.



Assignment

1. What are different Seed treatment for wheat crop and precaution during seed treatment?

2. Write down seed and sowing wheat crop?

Date: / /

Experiment No.2: Sowing Methods of Sugarcane crop

Objective: To know different planting methods of sugarcane crop

The Followings are important methods of sugarcane planting:

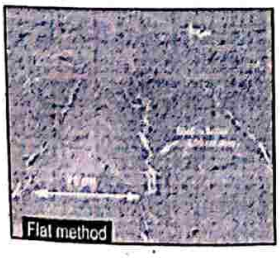
A. Ridge and Furrow Method :

- This is the most common method of sugarcane planting followed in Maharashtra.
- In this method the ridges and furrows are opened with the help of ridger by keeping 120 cm distance between furrows in heavy soil and 105cm distance in light to medium soil.
- Main and sub-irrigation channels are opened at appropriate distance.
- First sets are laid on the top ridges end to end and later planted in furrows by two ways known as wet method and dry method of planting.

Wet Method: This method is followed in light to medium type soil. Irrigation is given to the field before planting. Sets are planted by pressing 2.5 to 5 cm deep in furrows with feet or hand. The sets are placed end to end, in such way that the eye buds on sets are facing by side towards furrow side.

Dry Method: This method is followed in heavy soil to avoid the deep pressing of sets into the soil. Sets are placed in the furrow end to end by facing eye buds on sides and covered by giving a layer of soil. After completion of planting irrigation is given to the field.

B. Flat Bed Method :



Flatbed method of sugarcane planting is followed in North Indian states like U.P., Bihar etc. The land is ploughed, harrowed, leveled and flat beds are prepared. Cane sets are laid down in the flat beds end to end in rows.60 to 90 cm. distance is kept between two rows depending upon soil type. They are pressed into soil with hand or feet to a depth 2.5 to 5 cm and covered with soil. At the time of planting care should be take that buds should face on the sides otherwise lower buds cannot germinate. This method is followed in areas where soil having abundant moisture. Earthing up operation is done in rainy season.

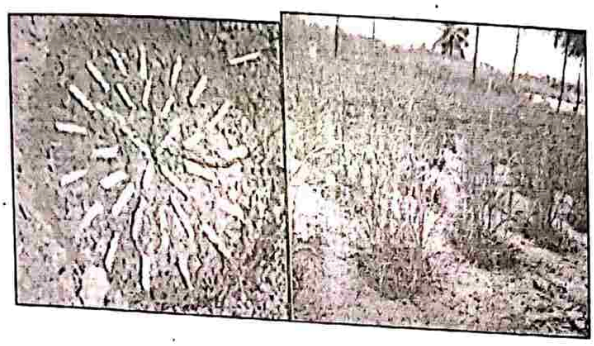
C. Rayungan Method :

Rayungan method is followed for adsali sugarcane planting at river side's fields in heavy rainfall areas of Kolhapur district. In these areas usually cane fields get flooded during rainy season which affects on germination. In such cases set cannot be planted directly in main field. Single bud sets are planted vertically in nurseries which are prepared high lying area of the farm in the month of June – July. After six weeks the sprouted sets are transplanted in the main field when the danger of flooding is over.

D. Trench or Jawa Method :

- This method is practiced in Jawa and Mauritius.
- Trenches are made about 90 to 120 cm. apart and 22 to 30 cm. deep.
- The soil at bottom is loosened and mixed with manures.
- The sets are planted in the middle of the trenches and covered with soil.
- Irrigation is given after completion of planting.
- This method produces large clumps of cane which do not lodge when tied together.
- The damage from wild animals is also less.
- This method has not given good results with Indian varieties hence not followed in India.

E. Pit method of sugarcane under drip fertigation system :

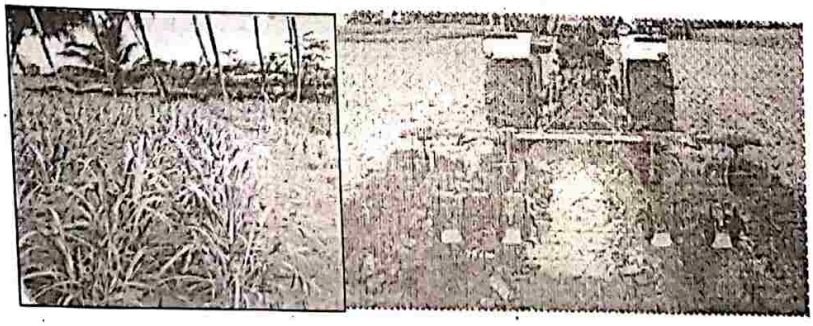


Dimension:

Pit to pit spacing- 1.5x1.5 m **Number of pits/ha**- 4,444 pits,
Pit diameter – 90 to 120 cm **Pit depth** – 38 to 045 cm,
Number of budded setts – 32 (Single budded setts) or
16 number of double budded setts.

Fill the pits to a depth of 15 cm with compost and native soil and mix it well. Place the healthy setts in circular fashion (like spokes of bicycle) leaving 10 cm from the outer boundary of the pits with equal spacing between each set and cover the set with the soil. Partial earthing up (50 to 60 days after planting) by sliding the soil from the outer boundary of the pit and full earthing up should be given leaving a depression of 2.5 cm from the ground level (90 to 100 days after planting).

F. Wider or dual row planting / Paired row planting :



To facilitate mechanization in sugarcane cultivation, wide row planting adopting a spacing of 150 cm is becoming popular. Further improve the cane yield under wide rows, a new technology; 'dual row planting' has been developed. Broad furrows are formed at a spacing of 150 cm and in the middle of the furrows sugarcane setts are planted in two rows adopting a spacing of 30 cm between them.

G. Spaced transplanting (STP) method with single eye set :

Recently in STP (Spaced transplanting) method single eye budded sets are used for planting. Either direct sets or seedlings raised in polybag nurseries are transplanted into the field after 50-55 days. For both furrow and flat method rows are made 90cm apart and settlings are spaced at 45 – 90cm.If any settlings fails to establish it is required to replace by the extra stock maintain in the nursery. This method saves seed cost by 60-70%. In this method distance between two sets kept at 30cm.

H. Poly bag seedling transplanting :

This technique is also more or less same as STP technique. Here the seedlings are raised in perforated plastic bags of size 10x15 cm filled with FYM or pressmud, soil and sand 1:1:1 proportion. In this technique field establishment of seedlings is better, around 95-99%, as there is no damage to the root system. In this method, a small pit is dug out at specified spacing (45cm). A small quantity of phosphatic fertilizer is placed and covered with some soil. Then the settling is planted after clipping the green leaves.

I. Chip-bud' or 'bud-chip' technique/Scoop Method :

In this technique the bud along with a portion of the nodal region is chipped off using a bud chipping machine. The bud chips are treated with fungicide and planted in the raised bed nursery or in polythene bags filled with FYM/press mud, soil and sand in 1:1:1 proportion. Seedlings are transplanted as in case of STP technique. The advantages are that the quantity of seed material (chip buds) required is only around 1 to 1.5 tonnes and the cane after taking chips can be sent to sugarcane factory.

J. Tissue culture :

Micro-propagation of seed cane through Tissue Culture technology is useful in developing large scale production of true to type and disease free sugarcane plantlets using apical meristem culture technique. Faster multiplication of a sugarcane variety can be done. Apical meristem (growing part of sugarcane) is dissected and inoculated on a growth medium having definite nutrient composition. The apical meristem starts producing tillers in the laboratory after about 45 days of incubation in temperature and light controlled conditions. One apical meristem one can develop millions of plantlets in a period of seven to eight months. The plantlets well established and hardened in plastic bags are transplanted to field condition.

Calculate Labour unit for planting of sugarcane:

$$L = \frac{atl}{AT}$$

Where,

L = Labour unit/ha

a = Actual area covered

t = Actual time required

l = Actual labour required

A = Unit area (10,000 m^2)

T = Unit Time (8 hrs / day)

Assignment :

Planting of sugarcane at your experimental field with any one planting methods of sugarcane.

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Date: / /

Experiment No 3: Identification of weeds in *Rabi* season crops

Objective: 1.To get familiarized with weeds associated in *Rabi* crops

2. To differentiate weed from field crop one should understand morphology of weed

Introduction:

Weeds are unwanted and undesirable plants which interfere with the utilization of land and water resources and thus adversely affect human welfare. Weed can also be referred as plants out of place. **Jethro Tull** first time define the term weed **"as weeds are the plants which can be grow where they are not wanted"** in book **Horse Hoeing Husbandry.** Weeds compete with the beneficial and desired vegetation in crop lands, forests, aquatic systems etc. and poses great problem in non-cropped areas like industrial sites, road/rail lines, air fields, landscape plantings, water tanks and water ways etc., Weeds are an important factor in the management of all land and water resources, but its effect is greatest on agriculture. The losses caused by weeds exceed the losses caused by any other category of agricultural pests. The total annual loss in agriculture produce by weeds account for **45%**, insect 30%, disease 20% and other pests 5%.Therefore in crop production identification and management of weed in field crop one of important task.

Based on the morphology of the plant, the weeds are also classified in to three categories

a. Grasses: All the weeds come under the family Poaceae are called as grasses which are characteristically having long narrow spiny leaves.

Examples:*Echinocloacolonum*, *Cynodondactylon*

b. Sedges: The weeds belonging to the family Cyperaceae come under this group. The leaves are mostly from the base having modified stem with or without tubers.

Examples:*Cyperusrotundus*, *Fimbrystylismiliaceae*

c. Broad leaved weeds: This is the major group of weeds as all other family weeds come under this except that is discussed earlier. All dicotyledon weeds are broad leaved weeds.

Examples:*Flavariaaustralacica, Digeraarvensis, Tridax procumbent*

Table No-1. Common *Rabi*weeds associated with crops

Local Name	English Name	Botanical Name	Family	Habitat	Life period/ season
Mahkuaa	Chick Weed	*Ageratum conyzoides L.*	Asteraceae	Noxious weed	Annual/ *Rabi*
Krishnaal	Red Scarlet	*Anagallisarvensis L.*	Primulaceae	Roadsides, pastures, waste grounds	Annual/ *Rabi*
Bhukat	Onion Weed	*Asphodelustenuifolius Cav.*	Liliaceae	Wheat and Chic kpea	Annual/ *Rabi*
Wild safflower	Wild Safflower	*Carthamusoxycantha M. Bieb*	Asteraceae	Dry, open areas, plains, mountains.	Annual/ *Rabi*
Bathuwa	Lambs avortor	*Chenopodium album L.*	Chenopodiaceae	Wheat, Chickpea, Barley, Winter Vegetables,	Annual/ *Rabi*
Goosefoot	Goosefoot	*Chenopodiummurale L.*	Chenopodiaceae	Wheat and Chic kpea	Annual/ *Rabi*
Kasni	Blue daisy	*Cichoriumintybus L.*	Asteraceae	Roadsides, Railroad right of ways, and uncultivated fields	Perennial
Chandvel,Hiran khuri.	Field Bindweed	*Convolvulus arvensis L.*	Convolvulaceae	Wheat,Gram,Pea	Perennial
Pitpapra	Swinecress	*Coronopusdidymus (L.) Sm*	Brassicaceae	Potatoes, Carrots, Lucerne, Orchards, Peas, Sugar beets and Wheat	Annual/ *Rabi*
Doob; duba; hariali	Bahama grass; couch grass	*Cynodondactylon (L.) Pers.*	Poaceae	All kinds of crops and modified ecosystems,	Annual/ *Rabi*

Bhringry, Maka	Falbe daisy	*Ecliptaerecta*	Compositae	In Paddy growing areas of India, it occur as common weed	Annual/ *Rabi*
Kafirkanda	devil's thorn	*Emexspinosa (L.) Campd.*	Polygonaceae	Farming, building of roads and railways	Annual/ *Rabi*
Dudhghas, dudhi	Asthma-plan	*Euphorbia hirta L*	Euphorbiaceae	Cultivated fields, perennial crops, grasslands, roadsides, gardens, lawns, fallow lands, ditch banks and waste places.	Annual/ *Rabi*
Pitpada	Earth smoke	*Fumariaindica (Haussk.) Pugsley*	Fumariaceae	Wild	Annual/ *Rabi*
BalRaksha	Cudweed	*Gnaphaliumluteo- album L*	Asteráceae.	bank of rivers, hillsides, wetlands, drainage areas, near temporary water bodies	Annual/ *Rabi*
Porvlina	Yellow vetchling	*Lathyrusaphaca L.*	Fabaceae	Dry places on sand, gravel and chalk,Cultivated Beds	Annual/ *Rabi*
Van gobhi,	wild Gobhi	*Launaeafallax L.*	Asteraceae	Occurs in moist and sandy soil, cultivated fields, gardens, forest and waste-places	Annual/ *Rabi*
Marram Grass,	Thyme-leaf Sandwort	*Arenariaserpyllifolia L*	Caryophyllaceae	Bare ground, arable fields, walls, bare soil on chalk downs, cliffs etc.	Annual/ *Rabi*
Toothed medick	Bur Clover	*Medicagopolymorpha*	Fabaceae	Lawns and turf, roadsides, fields, grasslands, pastures, agricultural sites	Annual/ *Rabi*
Nafal	Honey clover	*Melilotus alba Medic*	Fabaceae	Roadside edges, railway rights-of-way, pastures and disturbed areas	Annual/ *Rabi*

LevanaiSenji	Yellow sweet clover	*MelilotusIndica L.*	Fabaceae	Roadside edges, railway rights-of-way, pastures and disturbed areas	Annual/ *Rabi*
Gajargavath	Congress grass	*Partheniumhystrophorus L*	Compositeae	Wild spread	Perwnial
Canary grass/ Gulidanda	Canary grass	*philaris minor*	Poaceae	Wheat	Annual/ *Rabi*
Toothed dock and aegean dock	Sorrel dock	*Rumexdentatus L.*	Polygonaceae	Moist Valley and Mountain slops, cultivated beds	Annual/ *Rabi*
Catchfly	weed silene	*Sileneconoidea L.*	Caryophyllaceae	cultivated beds	Annual/ *Rabi*
Rough milk thistle	prickly sow-thistle	*Sonchusasper Hill*	Asteraceae		Annual/ *Rabi*
Jangljdhania, Mun-muna, pittpapra	Stickwort, Starwort	*Spergulaarvensis L.*	Caryophyllaceae	Anthropogenic (man-made or disturbed habitat s), meadows and fields	Annual/ *Rabi*
Buch-bucha	common chickweed	*Stellaria media L.*	Caryophyllaceae	Cultivated fields, pastures, gardens, shady lawns, roadsides and wasteland.	Annual/ *Rabi*
Ran methi	Indian sweet clover	*MelilotusIndicus*	Fabaceae or Leguminosae	*Rabi* crop	Annual/ *Rabi*
Musna	Cow Cockle, Cow soapwort	*Vaccariapyramidata Medic*	Caryophyllaceae	In any well-drained soil in a sunny position	Annual/ *Rabi*
Chatri, Gegla	Winter Tares, Garden vetch, Subterranean vetch	*Vicia sativa L.*	Fabaceae or Leguminosae	Hedges and grassy places, avoiding acid soils or shady positions	Annual/ *Rabi*
Ran erandi	Wild Castor	*Crozophorarottleri*	Euphorbiaceae		Annual/ *Rabi*
Dog fennel	Mayweed	*Anthemiscotula*	Composites	nurseries, and agricultural crops	Annual/ *Rabi*
	Wheat grass	*Eremopyrumtriticeum*	Gramineae		Annual/ *Rabi*
Pathari	Field sow Thistle	*Sonchusarvensis*	Compositeae	Barley, Wheat and Jowar	Annual/ *Rabi*
Pan kanis	Cat tail	*Typhalatifolia*	Typhaceae	Water bodies	Perennial

KansKunda	Tiger grass	*Saccharumspontaneum*	Gramineae	Garden	Annual/ *Rabi*
Zakham Jodi	Mexican daisy	*Tridasprocubens*	Asteraceae	waste land	Annual/ *Rabi*

Assignment:

List out dominant weeds in crop fields and other habitats and prepare *Rabi*season weed album

Sr. no	Habitat/ Crop	Weed Observed		
		Common name	Botanical Name	Life period
1	Wheat			
2	*Rabi* Sorghum			
3	Chickpea			
4	Sugarcane			

Date: / /

Experiment No. 4 & 5: Study of Morphological Characteristics of *Rabi* Crops

The *Rabi* season usually starts in November and lasts up to March or April. *Rabi*crops are mainly cultivated using irrigation since monsoons are already over by November. In fact, unseasonal showers in November or December can ruin the crops. The seeds are sown at the beginning of autumn, which results in a spring harvest. Wheat, barley, mustard and green peas are some of the major *Rabi* types of crops that grow in India.

1. Wheat:

Wheat plant can be divided into two parts namely root system and shoot system.

A. **Root system:** Wheat plant consists of two sets of roots that is seminal or seedling roots and clonal roots. The first set of roots (seminal roots) are produced by the germinating seedling in order to absorb nutrients for the young seedlings. These are generally five in number and are also called primary root system.

The second set of roots (clonal roots) arise from the basal nodes of the plants and form the compact vegetation mass 'crown' which is the principle organ of absorption as the young seedling progresses to maturity. It is the permanent root system and also known as secondary root system.

B. **Shoot system:** It collectively applies to the plant parts visible above the ground i.e. the aerial portion of the plant. These are stem, leaves, inflorescence, grain etc.

C. **Stem:** Cylindrical, round having nodes

D. **Leaf :**Parallel variation, tapering towards tip and having sheath, blade, ligule and auricle.

E. **Inflorescence:** called as ear, spike or head.

2. Mustard :

It is an herbaceous annual plant. The plant is shorter in height (45-150 cm) than mustard (rai). The roots are more or less confined to surface layers with an extensive lateral spread. The stem is usually covered with a waxy deposit. In rape,

leaves are borne sessile and are glabrous and hairy. Fruits are thicker than those of mustard (rai) and are laterally compressed, with a beak one-third to half their length. Seeds are either yellow or brown with a smooth seed coat. Rape is self-pollinated, but cross pollination also takes place to some extent.

3. Chickpea :

An herbaceous annual plant which branches from the base. It is almost a small bush with diffused, spreading branches. The plant is mostly covered with glandular or non-glandular hairs but some genotypes do not possess hair. Based on seed size and color, cultivated chickpeas are of two types.

Kabuli type - The seeds of this type are large (100-seed mass >25 g), round or ram head, and cream-colored. The plant is medium to tall in height, with large leaflets and white flowers, and contains no anthocyanin.

Desi type- The seeds of this type are small and angular in shape. The seed color varies from cream, black, brown, yellow to green. There are 2-3 ovules pod but on an average 1-2 seeds pod are produced. The plants are short with small leaflets and purplish flowers, and contain anthocyanin.

4. Barley

A. Roots: As with wheat and oats, barley also presents two types of root systems. In the first, the seedling roots develop from germination to the tillering stage; in the second, which starts at tillering, the secondary crown roots, or adventitious roots, appear. These will serve to anchor the plant, and to provide it with water and nutrients.

B. Stems: The stems of the barley plant are erect and made up of 5 to 7 hollow, cylindrical internodes or joints, separated by the nodes, which bear the leaves. As in all Gramineae, the leaves are placed opposite their neighbours along the stem.

C. Leaves: The leaves are linear lanceolate and formed of sheath, blade, auricles and ligule. The sheaths surround the stem completely. The ligules, and especially

the auricles, distinguish barley from other cereal grains: they are glabrous, envelop the stem and can be pigment with anthocyanins.

D. Flowers-Spikes: The last internodes of the stem extend as a rachis, which bears the spicules alternating on its nodes. Spikes of distich barleys do not have a terminal spicule as do those of wheat. Spikes can be awned or hooded, and also can be smooth or toothed.

The spikes can have two or six rows of grain, depending on the fertility of the lateral spikes. The rachis has 10 to 30 nodes, so the ears of six-row barleys can have from 25 up to 60 grains, and two-row barleys 25 to 30.

E. Fruits: The fruit is an oval, ridged caryopsis with rounded ends. The spike may be long or short, according to the plant type, but it always has several glumes with awns that may diverge.

F. Seeds: Grains are generally covered, with the palea and the lemma adhered to them, or can be open. Grains can be white in colour, blue, black, etc

5. Sugarcane:

A tall perennial plant growing erect even up to 5 to 6 meters. The plant is composed of four principle parts, the root system, the stalk, the leaves and the inflorescence. Description of each of these parts is given as follows:

A. Root System

The root system is fibrous and consists of two types of roots namely, 'set roots' and 'shoot roots'.

B. Stem:

Sugarcane stalk is roughly cylindrical and is composed of many distinct nodes and internodes.

C. Leaves

The leaves of the cane plant grow alternately on opposite sides of the cane stalk from the nodes. Leaf of sugarcane consists of a sheath and the blade with the ligule in between. The sheath is attached to the stalk by a basal ring and

completely clasps the stalk. It is normally a light green color. The outer surface of sheath is often hairy. The leaf edges are generally serrated. At the junction of the sheath and blade there is a membranous attachment known as the ligule which bears long hairs.

D. Inflorescence

The inflorescence of sugarcane generally called the **'arrow'** is an open panicle. It is long (30 centimeters or more) and tapering. The arrangement of the spikelets is racemose, that is, the oldest flowers are at the bottom and the youngest at the top.

Assignment:

1. Draw net sketch showing different morphological character of Wheat, Sugarcane and chickpea crop.
2. Visit crop cafeteria and give following details:

Sr. No.	Crop Observation	Crop stage and DAS	Name of *Rabi* crops in crop cafeteria						
1	Plant height								
2	No of leaves								
3	No of branches								
4	No of panicle/pod/fruits								

Date: / /

Experiment No.6: Calculation of Plant population, Seed rate and Fertilizer doses

Objectives: To study calculation of Plant population, seed rate and fertilizer doses

Plant Population

Optimum plant population is prerequisite for better yield levels. Very dense plant population results in reduction in per plant yield while wider spacing and thin plant population results in reduction in per unit area yield. In conduct of studies to evaluate crop performance, the determination of optimum spacing and plant population per hectare is necessary.

Seed rate: The seed rate per unit area depends on germination of the seed, size of the seed, growing habit of the crop etc. Extremes from the recommended seed rate (i.e. too high or too low) affect the plant population & then yield of crop. **E.g.** Higher seed rate will influence higher plant population/unit area. It results in heavy competition within the crop plants and suppresses the crop growth. Lower seed rate will result lower plant population thereby lowers the yield/unit area.

The seed rate is governed by the ultimate stand desired. Most crops are seeded at smaller rates under dry land than under irrigated condition. Seed rate depends on size, germination, growing habit, type of farming, time of sowing, variety, etc.

Recommended dose of fertilizer : On the basis of soil testing results, the recommended fertilizer does for the crops are modified for making fertilizer recommendations to the farmers.

Formula:

1. Plant population per Unit Area $= \frac{\text{Unit Area}}{\text{Spacing}} = \frac{10000}{\text{Spacing}}$

2. Seed Rate (kg/ha) $= \frac{\text{Area Sown x test weight x 100 x 100}}{\text{Spacing X Germination \% X Purity X 100 x 100}}$

3. Amount of fertilizer to be applied = $\frac{100}{\text{Nutrient Content in fertilizer material}}$ x Recommended dose

Recommended Spacing, seed rate & RDF for important *Rabi* crop

Assignment:

1. Calculate Plant Population per hectare with the help of following data.

Sr. No	Crop	Spacing (cm)	Seed Rate (kg/ha)	Fertilizer doses (kg/ha)			Plant Population (No/ha)
				N	P	K	
1	Wheat	22.5	100-125	120	60	40	
2	Maize grain	75 x 20, 60 x 20	20	150-180	70-80	70-80	
4	Maize fodder	30 x 10	50				
5	*Rabi* sorghum	45 x 15	8-10	40	20	20	
6	Chickpea	30x10, 45	70-100	20	40	0	
7	Sunflower	60x30, 45x30	Variety-7-8, Hybrid 5-6	60	30	30	
8	Safflower	60x30, 45x30	10-15	40	60	40	
91	Sugarbeet	45-60 x 20-25	8-10	100-120	80-120	100 -120	

2. Find out the seed rate required for the Jowar crop in kg/ha from following data, spacing-45 X 15cm, Germination-90%, Purity-95%, Test weight-45 gm.

3. Calculate quantity of urea, mop & SSP require to apply above mention fertilizer dose for *Rabi*crop

4. Calculate 10:26:26 mixed and urea as straight fertilizer for wheat crop to meet their nutrient requirement as given above for per ha.

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Date: / /

Experiment No. 7 & 8: Study of Yield Contributing Characters of *Rabi* Season Crop

Yield:

One of the metrics used to determine the efficiency of food production is crop yield. Simply put, crop yield is the amount of crop harvested per area of land. Typically, it is used in reference to corn, cereals, grains, or legumes, and it may be reported in kilograms/hectare or metric tons/hectare. Sometimes crop yield is referred to as **'agricultural output'**.

Yield Attributes:

Economic yield expressed as a function of factors which contribute to yield. These yield contributing factors are known as yield attributes

$$Y = a \times b \times c \times d$$

Where,

Y= Economic yield' a= Final plant population at harvest

b=Number of grains per plant c=single grain weight

d=test weight

Grain yield

The weight of grain from each net plot was recorded. The data was converted and reported as grain yield ha^{-1} as kg ha^{-1}. The moisture percentage of grains of each net plot was determined by moisture meter and final grain yield was adjusted at 14% moisture level by following formula. The thousand grains weight was expressed in gram (gm).

$$\text{Grain yield } \left(kg\ ha^{-1}\right) \text{ at 14 \% moisture}$$

$$= \frac{(100 - MC)\ X\ plot\ yield\ (kg) x 1000 (m^2)}{(100 - 14) x A}$$

Where,

MC = Moisture content of grain (%) just before weighing the bulk

Y = Net plot yield (kg)

A = Net plot area (m^2)

(100-MC) / (100-14) = Conversion factor for grain yield at 14% moisture content.

(1000) / A = Conversion factor for actual harvested area into hectare basis.

Straw yield

The straw obtained from the net plot area of each plots were sun dried for 3-4 days and weighed. The yields so obtained were translated into ton per hectare.

Grain: straw ratio

Grain: straw ratio was obtained by dividing grain yield by straw yield;

$$Grain : straw\ ratio = \frac{Grain\ yield(kg)}{Straw\ yield(kg)}$$

Yield contributing characters of *Rabi* season crop:

- **Number of tillers hill^{-1}**

  Significant variations were also observed for number of tillers hill^{-1} with the highest tiller number in plant followed by plant number respectively and the lowest tiller number was recorded in plant number. The rest of the progenies had different values but were statistically similar. It indicates that tiller number of new progenies is similar. With decreasing tillers hill^{-1}, yield will be decreased considerably.

- **Panicle length**

  Increasing panicle length might have increased grain yield indirectly by increasing panicle length.

- **Panicles hill^{-1}**

  Highly significant variations were recorded in number of panicle per hill with the highest in plant number followed by plant number and the lowest tiller number was seen in plant number. The rest of the progenies had different values but were statistically non-significant.

- **Percentage of filled grains**

  Number of filled grains panicle^{-1} is the most important yield attributing traits differed significantly among the progenies.

- **Grain yield per hill**
- **Yield per unit** = Yield per plant x Spacing per plant x100
- **Yield per ha** = Yield per plant x Plant population
- **100 seed weight (g)**

  Thousand-grain weight, an important yield determining component, is a genetic character least influenced by environment (Ashraf; Khalid; Ali, 1999). Results revealed that the

100 seed weight of all progenies had no significant difference. It means that seed weight did not affect by environmental factors

Harvest index (HI)

Harvest index is the ratio of grain yield and the total above ground biomass which indicates the efficiency of plant to assimilate partition to the economic parts (example: rice grain). Higher the harvest index means plant is capable to deposit assimilates having economic importance from the source (leaf, leaf sheath, stem, flag leaf) to the panicle (sink) especially grain in case of cereals. Harvest index (HI) was computed by as per the following formula.

$$\text{Harvest index (HI)} = \frac{\text{Economic yield (Grain yield)}}{\text{Biological yield (Grain yield + Straw yield)}}$$

Table No.1. : Following are some characters that contribute to yield in different *Rabi* crops

Sr. No	Crop	Yield contributing characters
1	Wheat	1. Length and width of ear head 2. Effective tillers per plant (no.) 3. Length of spike (cm) 4. Grains/spike (no.) 5. Grain yield per plant 6. Test weight 7. No. of tillers per meter
2	Maize	1. Length cob 2. No. of seeds per cob 3. No of cob per plant 4. Size of cob 5. Test weight
3	Sorghum	1. Length and width of ear head 2. No. of seeds per earhead 3. Grain yield per plant 4. Test weight
4	Chickpea	1. No of pod per plant 2. No. of seeds per pod 3. Grain yield per plant 4. Test weight 5. No of branches per plant 6. Pod size
5	Sunflower	1. Capitulum diameter 2. Leaf area Index 3. Test weight 4. No. of seeds per capitulum

Date: / /

Experiment No. 9: Study of Sugarcane Yield and Quality Analysis of Sugarcane

Objective:

1. To know the proper Maturity stage for timely harvesting of sugarcane
2. To study the quality parameters that reflects sugarcane maturity
3. To study different harvesting methods.

Harvesting of sugarcane at a proper time i.e., peak maturity, by adopting right technique is necessary to realize maximum weight of the millable canes (thus sugar) produced with least possible field losses under the given growing environment.

Harvesting of sugarcane either under-aged or over-aged cane with improper method of harvesting leads to loss in cane yield, sugar recovery, poor juice quality and problems in milling due to extraneous matter.

Care should be taken while harvesting sugarcane:

- To harvest the cane at peak
- Cutting cane to ground level so that the bottom sugar rich internodes are harvested which add to yield and sugar
- De-topping (removal of upper green shoot) at appropriate height so that the top immature internodes are eliminated.
- Proper cleaning of the cane i.e., removing the extraneous matter such as leaves, trash, roots etc.
- Quick disposal of the harvested cane to factory to reduce cane moisture,yield and recovery loss

A. Manual Harvesting

In many countries even today harvesting is done manually using various types of specially designed hand knives or hand axes. Among the several tools the cutting blade is usually heavier and facilitates easier and efficient cutting of cane. Manual harvesting requires skilled laborers.

B. Mechanical Harvesting

A sugarcane harvester is a large piece of agriculture machinery used to harvest and partially process sugarcane. The machine originally developed in 1920s, remains similar in function and design to the combine harvester. The machine cuts the base, strips, the leaves off and then deposited into either the on board container or a separate vehicle travelling alongside. Waste material is then ejected back into the field, where it acts as fertilizer.

The limitation of mechanical harvesters is

Use of such machines in small, irregular and fragmented holdings, diversified cropping patterns is limited.

Maturity Signs of sugarcane

Maturity of sugarcane depends on duration of variety, time/season of sugarcane cultivation (preseasonal, seasonal, adsali) or planting, irrigation management and ripening of sugarcane. Ripening defined as rapid accumulation of sucrose in storage tissues of the sugarcane stalk. Sucrose as a percentage of dry weight is 50-60% at harvest and similarly reducing sugar drop from 81% at dry weight in immature cane to 2% with maturity.

A. Visual Symptoms

Yellowing and drying of leaves, metallic sound of mature canes when tapped, appearance of sugar crystal glistening when a mature cane is cut in a slanting way and held against the sun are some of the visual indices of assessing maturity of cane.

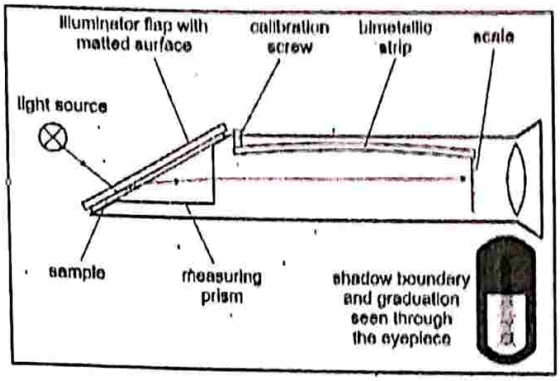
B. Quality Parameters

Important sugarcane quality parameters for assessing cane maturity are the juice Brix, pol or sucrose percentage and purity.

1. Brix (%):

Juice Brix refers to the total solids content present in the juice expressed in percentage. Brix includes sugars as well as non-sugars. Brix can be measured in

the field itself in the standing cane crop using a **Hand Refractometer**. Then place a drop of the composite juice sample in the Hand Refractometer and measure the Brix reading.The HR Brix meter has graduations **from 0 to 32 per cent**.



- **A narrow range** indicates **ripeness of the cane**, while a **wide** difference indicates that the cane is yet too ripe.
- On the other-hand if the bottom portion of the cane has lower Brix value than the top, it means that the cane is over-ripened and reversion of sugar is taking place.
- In general, brix reading in range of **18-21** is supposed as proper harvesting stage of sugarcane.

2. Juice Sucrose or Pol (%): The juice sucrose per cent is the actual cane sugar present in the juice. Pol % in juice is determined from the brix uncorrected and corresponding pol reading taken is **poloriscope** observation tube by referring to the Schmitz table.Now aday's an instrument called **sucrolyser** is also available for determining sucrose % in juice.

A higher purity indicates the presence of higher sucrose content out of the total solids present in juice. The purity percentage along with sucrose percent aids in determining maturity time.

Purity Percentage = (Sucrose % / HR Brix) X 100

A cane crop is considered fit for harvesting if it has attained a minimum of **16% sucrose and 85% purity.**

3. Reducing Sugars: The reducing sugars refer to the percentage of other sugars (fructose and glucose) in the juice. A lower reducing sugars value indicates that much of the sugars have been converted into sucrose.

4.Commercial Cane Sugar (CCS): The commercial cane sugar (CCS) refers to the total recoverable sugar percent in the cane. This could be calculated by the following formula:

CCS (%)= [Yield (t/ha) x Sugar Recovery (%)] /100**or**

CCS (t/ha)= (Cane yield x CCS %)

Sugar Recovery (%) = [S - 0.4 (B - S)] x 0.73

Where, S= Sucrose % in juice and B= Corrected Brix (%)

5. Sheath moisture (%) : It is the percentage moisture in sheath determined by fresh weight and dry weight of sheath.

Assignment:

Measure or record the brix reading of sugarcane stem from bottom, mid and top portion.

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Date: / /

Experiment No. 10 & 11 : Study of Important Agronomic Experiments of *Rabi* Crop at Experimental Farms

Objective: To study the important agronomic experiments of *Rabi* crops at experimental farms

Sr. No.	Name of Experiment	Treatment details					
		Crop	Date of sowing	Variety	RDF (NPK kg/ha)	Crop stage (at the time of visit)	Any Other important regarding crop

Date: / /

Experiment No. 12: Study of Forage Experiments

Objective: To study the forage experiment on experimental farm.

Fodder crops are the plant species that are cultivated and harvested for feeding the animals in the form of forage (cut green and fed fresh), silage (preserved under anaerobic condition) and hay (dehydrated green fodder). The total area under cultivated fodders is **8.3 million ha**. Amongst the *Rabi* crops Berseem (Egyptian clover) occupy about (1.9 million ha) **54%** of the total cultivated fodder cropped area.

Significance of feed and Fodder Table:

India has a huge livestock population of over **582 million**, therefore demand for fodder is huge. In this age of market economy, the agri-economy and milk production has to compete for growing fodder on good quality land, required for high productivity and reproductive efficiency of dairy animals. Hence, its significance can be understood from the following points.

- **Economy in production**: Feed and fodder cost constitute about 60-70% of cost of milk production thus cultivated fodder has an important role in meeting requirement of various nutrients and roughage in our country to produce milk most economically as compared to concentrates.
- **Better feeding for ruminants**: In view of the peculiar digestive system, provided by nature, ruminants need feeds, which not only meet their nutritional requirements but also fill the rumen and satisfy the animal. The fodder crops meet these requirements very effectively and hence are important for ruminant production system.
- **Good source of critical elements**: Fodder from common cereal crops like Maize, Sorghum and Oats are rich in energy and the leguminous crops like Lucerne, Berseem & Cowpea are rich in proteins. These leguminous crops are good source

of major and micro minerals, which are critical for rumen microbes as well as animal system.

Constraints in Achieving Higher Fodder Productivity

India is presently under heavy stress on account of a large-scale exploitation for fuel wood, timber and fodder, mismanagement of forest resources and frequent fires. There is acute shortage of fodder especially green nutritious fodder, which is major cause of low productivity of livestock, especially in hilly area. The main constraints can be described as:

1. **Reduced area under fodder crops**: The division of the families has fragmented the land. At present land holdings are very small and farmers are always biased in choice of the crops. Due to these reasons agricultural land ratio does not permit diversion of land from food production to cultivated fodder.

2. **Uncontrolled grazing of dairy animals:** Uncontrolled grazing has led to a decline in biomass availability. The grazing pattern has created manifold problems in these pastures. Obnoxious weeds have invaded the pastures. Excessive and continuous grazing has severely damaged these lands.

3. **Poor Management Practices:** Management practices play an important role in determining productivity of grasslands. Presence of inferior and unproductive grass species, lack of fertilizer application, and absence of legume component, improper cutting and indiscriminate grazing are some of the important factors responsible for poor productivity of grasslands.

4. **Intense livestock population:** Due to religious beliefs, population of unproductive cattle is increasing. It is a fact that considerable fodder resources are wasted on maintenance of an excessive number of poorly fed and low yielding animals, which contributed to process of pasture destruction.

5. **Fodder tree use:** Indian sub-continent is one of the richest in biodiversity on the globe. For instance, Himalaya supports about 84 trees and 40 shrubs of fodder value, yet

not more than 20 trees are extensively used by farmers. Over exploitation and unscientific management of fodder trees has depleted this resource at huge environmental cost.

Assignment : Study of important Forage experiment at experimental farm:

Study and complete the information on important forage experiment at experimental farm in following table

Sr. no	Name of Experiment	Treatment Details				
		Crop	Date of sowing	Variety	RDF (NPK kg/ha)	Any Other important regarding crop

Date: / /

Experiment No. 13 &14: Extraction of Essential Oil

Objective: To know the suitable methods of essential oil extraction

Essential oils are used in a wide variety of consumer goods such as detergents, soaps, toilet products, cosmetics, pharmaceuticals, perfumes, confectionery food products, soft drinks, distilled alcoholic beverages (hard drinks) and insecticides. The world production and consumption of essential oils and perfumes are increasing very fast. Production technology is an essential element to improve the overall yield and quality of essential oil. The traditional technologies pertaining to essential oil processing are of great significance and are still being used in many parts of the globe. Water distillation, water and steam distillation, steam distillation, cohobation, maceration and effleurage are the most traditional and commonly used methods.

- Maceration is adaptable when oil yield from distillation is poor.
- Distillation methods are good for powdered almonds, rose petals and rose blossoms.
- Solvent extraction is suitable for expensive, delicate and thermally unstable materials like jasmine, tuberose, and hyacinth.
- Water distillation is the most favored method of production of citronella oil from plant material.

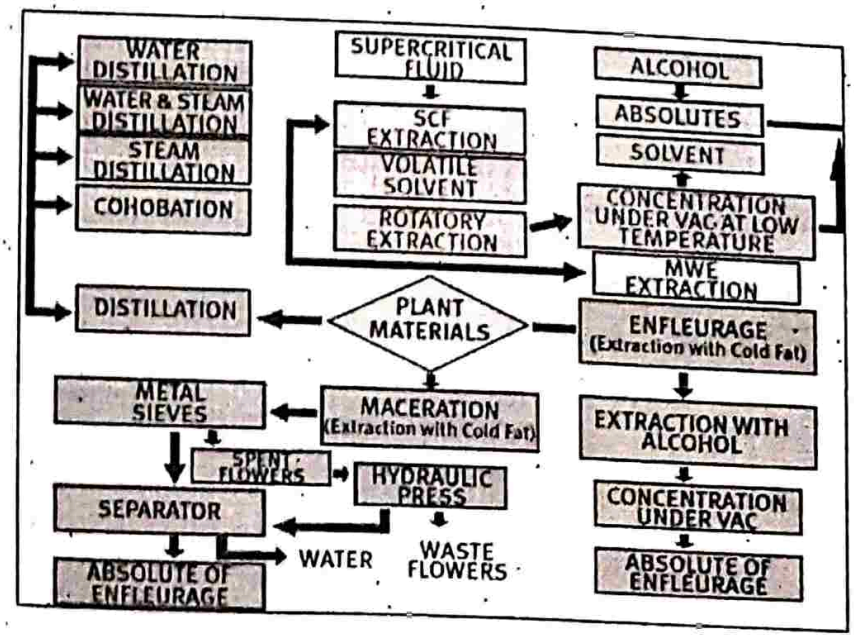

Fig.1: Different Methods of Oil extraction

Hydrodistillation :

In order to isolate essential oils by hydrodistillation, the aromatic plant material is packed in a still and a sufficient quantity of water is added and brought to a boil; alternatively, live steam is injected into the plant charge. Due to the influence of hot water and steam, the essential oil is freed from the oil glands in the plant tissue. The vapor mixture of water and oil is condensed by indirect cooling with water. From the condenser, distillate flows into a separator, where oil separates automatically from the distillate water.

Three Types of Hydro distillation

Three types of hydro distillation for isolating essential oils from plant materials:

1. **Water Distillation:**

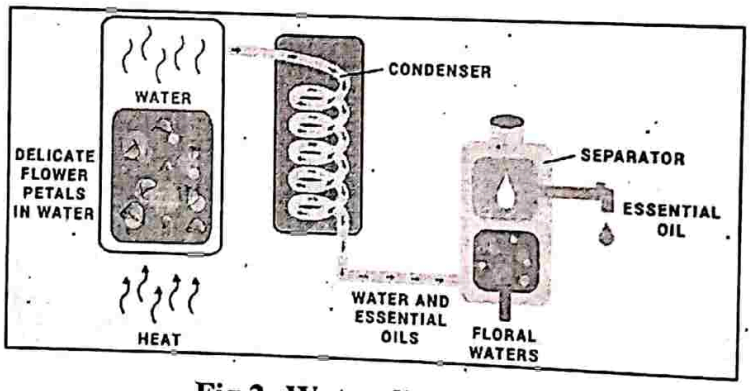

Fig.2: Water distillation

2. **Water and Steam Distillation:**

In this method that can be employed with herb and leaf material, the plant material is immersed in water in a Still to which heat is applied. Steam is fed into the main Still from outside.

3. Direct steam distillation

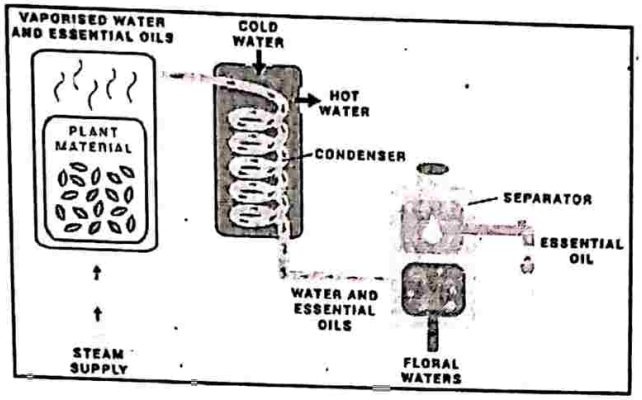

Fig. 3: Direct steam distillation

Solvent extraction:

This method employs food grade solvents like hexane and ethanol to isolate essential oils from plant material. It is best suited for plant materials that yield low amounts of essential oil, that are largely resinous, or that are delicate aromatics unable to withstand the pressure and distress of steam distillation. This method also produces a finer fragrance than any type of distillation method.

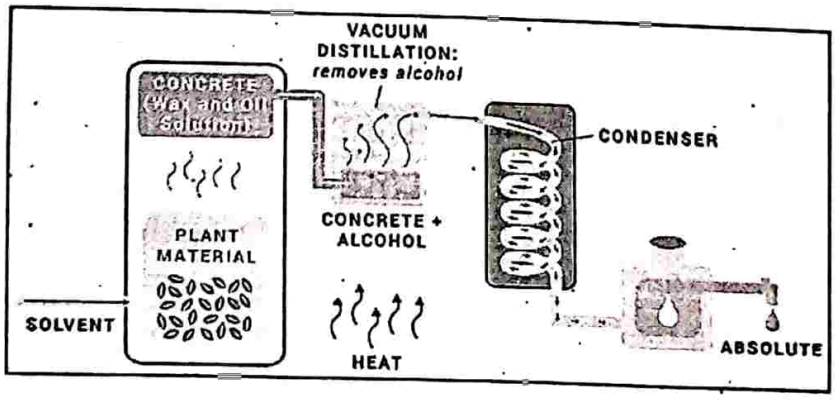

Fig. 4:Solvent Extraction

CO_2 Extraction :

Essential oils derived from the supercritical CO_2 extraction of herbs are similar to the oils produced through distillation in that they can be used in aromatherapy and natural perfumery.

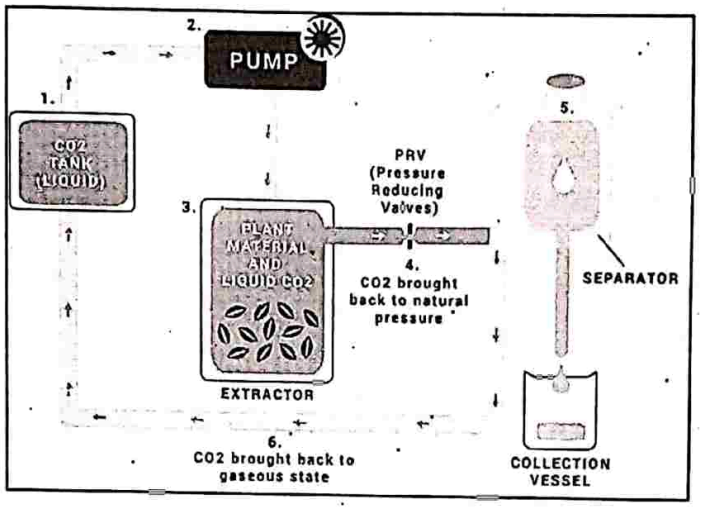

Fig.5: CO_2 Extraction

Maceration:

Macerated oils are also referred to as infused oils. They are created when carrier oils are used as solvents to extract therapeutic properties from plant material. The benefit of macerated oil above distilled oil is that more of a plant's essence is captured in the oil.

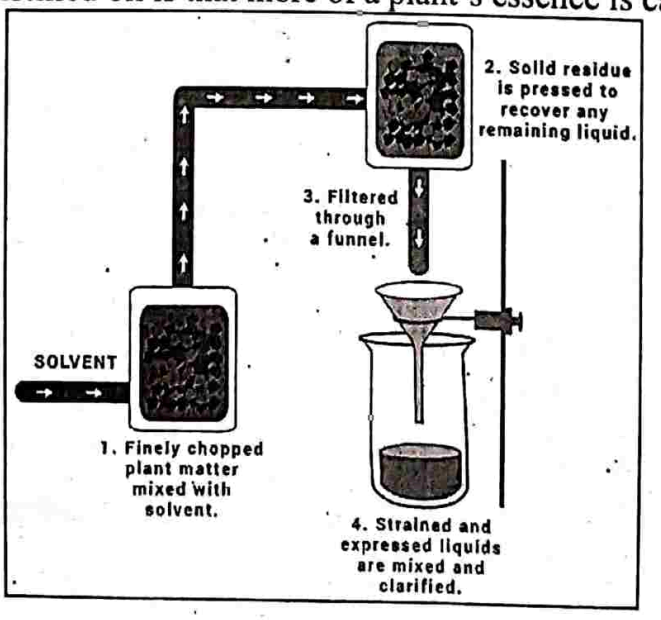

Fig.5: Maceration

Enfleurage:

Enfleurage is not commonly used today, but it is one of the oldest methods of essential oil extraction that implements the use of fat. The enfleurage process can be done either "hot" or "cold." In both instances, the fat that is saturated with fragrance is called "enfleurage pomade."

Cold-Press Extraction:

This method is also called Expression or Scarification and is used for citrus peels in particular.

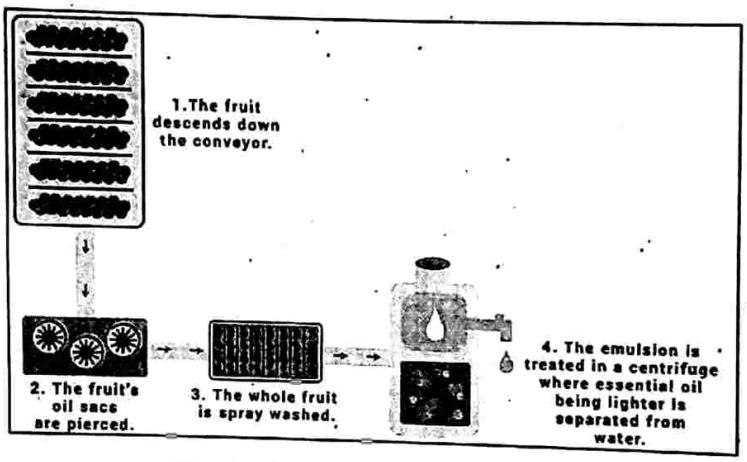

Fig.6: Cold-Press Extraction

Extraction of *Mentha* essential oil

The Steam-distilled extraction method for the extraction of *Mentha* oil from its plant material is carry out in an extraction tank and in that the condensate formation of essential oil plus water, is recover at the floor of the platform. Then this extracted material is refrigerated or put into a chiller. The aim to examine in details the essential oil extraction process in sense of calculation of ideal period and withdrawal time. The subject was proposed to hydro-distillation and the collection of oil was done at various times (1 to 3, 4, 6, 12 to 24 h) on three discrete days of separate months (July, August and September). The yield was totally various on all days of extraction and separation gaps. The yields in August and September were significantly greater as compared to that of July. The largest amounts of the extracted oil were achieved in the initial three and for the duration of the final twelve hours.

Date: / /

Experiment No. 15: Visit to Research Station of Related Crops

Objective:

To visit and introduced with research on important *Rabi* crops at respective research centres.

Assignment:

Visit to different research centers at VNMKV, Campus Parbhani and collect information about package and practices of important *Rabi* crops and ongoing research experiments and other objectives.