Practical Manual

of

M.Sc. (Horticulture) - Vegetable Science

on

Vegetable Crops

Dr. Sanjive Kumar Singh

Dr. H. G. Prakash

Department of Vegetable Science

C. S. Azad Uni. of Ag. & Tech. Kanpur-208024 (U.P.)

Practical Manual

of

M. Sc. (Horticulture) - Vegetable Science

on

Vegetable crops

Dr. Sanjive Kumar Singh

Assistant Professor/Nodal Officer GRM (Horti.)

Dr. H. G. Prakash
Director Research/P.I. NAHEP

Department of Vegetable Science

C. S. Azad Uni. of Ag. & Tech. Kanpur (U.P.)

Patron:

Dr. D. R. Singh

Vice Chancellor

Co Patron:

Dr. Dharma Raj Singh

Dean, College of Agriculture/Horticulture

Authors:

1. Dr. Sanjive Kumar Singh
   Assistant Professor/Nodal Officer GRM (Horti.)

2. Dr. H. G. Prakash
   Director Research/ P.I. NAHEP Project

Citation: Practical Manual 2021

Department of Vegetable Science

C. S. Azad Uni. of Ag. & Tech. Kanpur (U.P.)

No. of Copy: 100

CSAU Website: www.csauk.ac.in

Published by Directorate of Research

Printed by:

University Printing Press CSAU January, 2021

डा. डी. आर. सिंह
कुलपति
Dr. D. R. Singh
Vice-Chancellor

चन्द्रशेखर आजाद कृषि एवं प्रौद्योगिक विश्वविद्यालय
कानपुर-208 002, उत्तर प्रदेश, भारत
Chandra Shekhar Azad University of Agriculture & Technology
Kanpur-208002, Uttar Pradesh, India

FOREWORD

Horticulture is the fastest growing sector within Indian agriculture. There has been a perceptible change in the consumption pattern characterized by decline share of food grains and increasing share of non food grain items in the consumption baskets particularly fruits and vegetables. Vegetable are important constituents and nutritional security due to their short duration, high yield, nutritional richness, economic viability and ability to generate on-farm and off-farm employment.

India has recorded a great progress in vegetable production during post green revolution era. Being the second largest producer of vegetables in the world, it also contributes 15% of the global production.

An atte mpt has been made in this practical manual to compile available all informatio n on vegetable crops and their botany.

I appreciate and congrat ulate to Dr. Sanjive Kumar Singh and Dr. H.G. Prakash for writing this manual in favor of university students and I am sure that, the teaching community and students will be immensely benefited by reading this book for academics.

Vice Chancellor

Dated : January 05. 2021

Phone : +91-512-2534155 (Off.), Fax : +91-512-2533808 E-mail : vc@csauk.ac.in, www.csauk.ac.in

PREFACE

The present practical manual has been prepared mainly for M.Sc. (Vegetable Science) students of C .S. Azad Uni. of Agric. and Tech. Kanpur. An attempt has been made to highlight the practical methods and botany of vegetable crops in a lucid language coupled with relevant information. Tables and figures have been used wherever necessary to make the subject transparent and clearer and hoped that this treatise would continue be helpful to the students.

Vegetables are indispensible components of human diet, as they play vital role for nutritional security, in addition to improve the economy of the people. Recently, there has been revolutionary progress in vegetable production in the country.

Modern living has brought about little change in the food preference of our people, but there has been a significant change in the availability of various foods including vegetables. This is evident from the availability of relatively more and better quality vegetables in the market.

We are thankful to our Hon'ble Vice Chancellor Dr. D. R. Singh for his continuous encouragement and valuable suggestions.

We are grateful to the ICAR, New Delhi for financial assistance under NAHEP Centre for Advanced Agricultural Science and Technology Project.

We hope that the information contained in this manual will be helpful in teaching.

Sanjive Kumar Singh
H. G. Prakash

CONTENTS

Exercise-1

Object- To enlist various books related to vegetable production course.

S.No.	Title of Book	Author	Publisher

Exercise-2

Object- Identification of vegetable seeds.

Vegetable seed presented on spotting is identified with the help of following heads.

1. Name of the crop: Okra
2. Name of the family: *Malvaceae*
3. Scientific/Botanical name: *Abelmoschus esculentus* L.
4. Number of chromosome: 2n=130
5. Type of seed: Dicotyledon
6. Colour of seed: Green
7. Shape of seed: Round
8. Size of seed: 0.2 cm diameter
9. Test weight: 4.900 gm
10. Type of root: Tap root
11. Type of propagation: Direct seed sowing
12. Use as vegetable: Direct
13. Importance: Nutritive, medicinal, industrial

Exercise-3

Object- Identification of vegetable crops.

Any vegetable presented on spotting is identified with the help of following heads.

1. Name of the crop: Chilli/brinjal/tomato/okra
2. Name of the family: *Solanaceae/Malvaceae*
3. Scientific/Botanical name: *Capsicum annuum* L.
4. Number of chromosome: 2n=24
5. Type of pollination nature: Self/cross pollinated
6. Type of crop: Fruit/leafy/seed/salad vegetable
7. Plant characters: Tall/medium/dwarf
8. Leaf character: Palmate/pinnate
9. Type of inflorescence: Cymose/recemose
10. Type of flower: Unisexual/bisexual
11. Number of calyx: 4-5 sepals
12. Number of corolla: 4-5 petals
13. Androecium: 5-10 number of stamen
14. Type of ovary: Superior/inferior
15. Type of fruit: Siliquae/succulent

Exercise-4

Object-Identification of morphological characters of vegetable crop.

Given vegetable crop on spot is morphological identified under following heads.

1. Name of crop:	Bittergourd
2. Name of family:	*Cucurbitaceae*
3. Number of chromosome:	2n=22
4. Botanical name:	*Momordica charantia*
5. Type of crop:	Annual
6. Type of root:	Tap root
7. Type of stem:	Prostate
8. Type of leaf:	Pinnate
9. Type of flower:	Bisexual
10. Type of inflorescence:	Cymose/racemose
11. Number of calyx:	5 sepals
12. Number of corolla:	5 petals
13. Number of androecium:	3-5 stemens
14. Type of ovary:	Inferior
15. Type of fruit:	Pepo
16. Type of pollination:	Cross pollination
17. Yield of fruits:	125-150 q.ha in rainy season
	100-125 in summer season

Exercise-5

Object- Symbol used in floral formula.

S. No.	Abbreviation	Full form
1.	Br	Bracteate flower (when bracts are present)
2.	Brl	Bracteolate
3.	Ebr	Ebracteate flower
4.	Ebrl	Ebracteolate flower
5.	⊕	Actinomorphic flower
6	o|o	Zygomorphic flower
7	☿	Bisexual
8	♂	Male
9	♀	Female
10	K	Calyx (group of sepals)
11	$K_{(5)}$	Sepals 5 and gamosepalous
12	Epik	Epicalyx
13	C	Corolla (group of petals)
14	$C_{(n)}$	Gamopetalous corolla
15	C_5	Petals 5 and polypertalous
16	$C_{1+2+(2)}$	Two petals fused
17	C_x	Corolla-cruciform
18	P	Parianth (group of tepals)
19	A	Androecium (group of stamens)
20	A_{1+9}	Diadelphous anthers
21	$A_{1+(9)}$	Nine stamens fused and one free
22	A_{4+3+3}	Polyandrous, unequal in length
23	A_{∞}	Indefinite stamens & monoadelphous
24	$A_{(\infty)}$	Stamens indefinite and fused together
25	G	Gynoecium (group of carpels)
26	$\overline{G}$	Inferior ovary
27	$\underline{G}$	Superior ovary
28	G-	Perigyny (half inferior ovary)
29	G_1	Monocarpellary
30	G_2	Bicarpellary ovary
31	G_5	Pentacarpellaryand apocarpous ovary
32	$G_{(5)}$	Syncarpous ovary
33	P⌒A	Epiphyllous stamens
34	C⌒A	Epipetalous stamens
35	G⌒A	Gynostaminous stamens
36	∞	Indefinite number of flower parts in a whorl

Exercise-6

Object- To introduce taxonomical description of important vegetables with their floral formula and floral diagramme.

1. Taxonomical description of Brinjal

(1) Botanical details

(i) English name: Brinjal, egg plant, aubergine

(ii) Hindi name: Baingan

(iii) Botanical name: *Solanum melogena* L.

(iv) Family: *Solanaceae*

(v) Chromosome No.: 2n = 24

(vi) Mode of pollination: Often cross-pollinated

(2) Habitat: Annual herb, sometimes the spines are distributed throughout the plant (stem, mid rib of the leaves, calyx).

(3) Stem: Round, coated with fine soft hairs.

(4) Leaves: Simple, alternate, mid rib often spiny.

(5) Inflorescence: Axillary or sometimes extra-axillary in clusters.

(6) Flower: Regular, hermaphrodite, actinomorphic, hypogynous.

(7) Calyx: Sepals 5, gamosepalous, often spiny, persistent.

(8) Corolla: Petals 5, gamopetalous, usually funnel or cup shaped, aestivation valvate, pink or white.

(9) Androecium: Stamens 5, epipetalous, alternate with corolla lobes, anthers connate and mostly yellow in colour, dehiscence through apical pores.

(10) Gynoecium: Bicarpellary, syncarpous, ovary superior, obliquely placed, bilocular, sometimes 4-celled due to formation of false septum, ovules numerous, placentation axile, fruit berry, variously coloured (purple, white, green, srtiped in green or white background), shape (round, long, oblong, egg shaped).

(11) Floral diagram:

(12) Floral formula: ⊕ ♀ $K_{(5)}\,\overset{\frown}{C_{(5)}}\,A_5\,\underline{G}_{(2)}$

2. Taxonomical description of Bottle gourd

(1) Botanical details

(i) English name: Bottle gourd, calabash cucumber

(ii) Hindi name: Lauki, Ghia, Kaddu

(iii) Botanical name: *Lagenaria siceraria or Cucurbita csiceraria*.

(iv) Family: *Cucurbitaceae*

(v) Chromosome No.: 2n = 22

(vi) Mode of pollination: Cross pollinated due to monoecious nature

(2)Habitat: Large climbing annual rainy/warm season mesophytic herb.

(3) Stem: Ribbed, coaed with minute soft hairs and tendril opposite the leaf and 2-4 fid.

(4) Leaves: Simple alternate, broad and palmately veined, venation multicostate reticulate.

(5) Inflorescence: Axillary, solitary, male flowers appear first and female ones later.

(6) Flower: Regular, unisexual, epigynous, monoecious.

(7) Calyx: Sepals 5, gamosepalous, connate, lobes linear or leafy, deeply lobed.

(8) Corolla: Petals 5, gamopetalous, connate, companulate, inserted on the calyx tube, colour white.

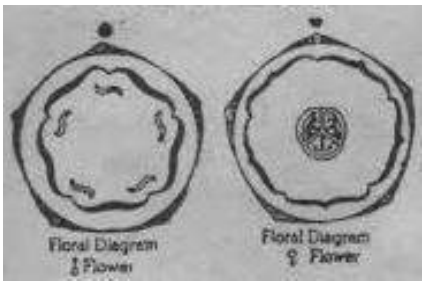
(9) Male flowers:

Androecium: Stamens 3, united in a pair, the odd one remaining free

(10) Female flower

Gynoecium: Carpels 3, syncarpous, ovary inferior, unilocular, placentation parietal, ovules many, style 1, stigma 3 which are often forked, fruit large, fleshy pepo of various shape (long cylindrical, bottle shaped, round with neck, perfectly round) and variously coloured (uniformly green, with green stripes).

(11) Floral diagram: Male flower Female flower



(12) Floral formula: Male flower: ⊕♂ $K_{(5)}\,C_{(5)}\,A_3\,G_0$

Female flower**:** ⊕♀$K_{(5)}\,C_{(5)}\,A_0\,\overline{G}_{(3)}$

3. Taxonomical description of Radish

(1) Botanical details

(i) English name: Radish

(ii) Hindi name: Mooli

(iii) Botanical name: *Raphanus* sativus L**.**

(iv) Family: *Cruciferae*

(v) Chromosome No.: 2n = 18

(vi) Mode of pollination: Cross pollinated due to self incompatibility

(2)Habitat: Annual herb, cultivated throughout the year for green leaves and tuberous roots for vegetable and salad purposes. For seed production purpose, it behaves biennial during first season production of roots and subsequent season for seed production, roots are tuberous, napiform, variously coloured (white, deep red, pink) and of different shape (napiform, round as in case of turnip).

(3) Stem: Round, coated with fine to rough hairs.

(4) Leaves: Simple alternate, radical, cauline, lyrate, surface covered with short spines, lamina variously dissected.

(5) Inflorescence: Racemose, opening of flowers in acropetal succession.

(6) Flower: Regular, hermaphrodite, actinomorphic, hypogynous and cruciform, colour white to pink, according to varietal features.

(7) Calyx: Sepals 2+2 free, imbricate, green.

(8) Corolla: Petals 4, free, cruciform, valvate with distinct claw and limb.

(9) Androecium: Stamens 6, free, 4 inner ones long and 2outer short (tetradynamous condition).

(10) Gynoecium: Bicarpellary, syncarpous, ovary superior and divided into two chambers by a false septum, placentation parietal, style long, stigma bifid, fruit narrow pod like siliqua opening into two valves from base upwards, seeds many, small, globose and exalbuminous attached to the replum.

(11) Floral diagram:

(12) Floral formula: ⊕ ♀ $K_{2+2}\, C_4\, A_{2+4}\underline{G}_{(2)}$

4. Taxonomical description of Okra

(1) Botanical details

(i) English name:	Okra, lady's finger
(ii) Hindi name:	Bhindi
(iii) Botanical name:	*Abelmoscus esculentus* L.
(iv)Family:	*Malvaceae*
(v) Chromosome No.:	2n = 72
(vi) Mode of pollination:	Often cross pollinated

(2)Habitat: Annual, summer season plant, grown for green unripe fruits used as vegetable. Fruits with its fibrous stalks are used in paper and gur making industry.

(3) Stem: Much branched, fibrous and mucilaginous.

(4) Leaves: Simple, alternate, palmately three veined at the base, margin serrate, petiole long, colour green and purple, stipules two, free lateral.

(5) Inflorescence: Solitary and axillary.

(6) Flower: Large, axillary and solitary, regular, hermaphrodite, actinomorphic, hypogynous, showy and copiously mucilaginous.

(7) Calyx: Sepals 5, gamosepalous, bracteoles 5 or more found in the form of whorl, known as epicalyx.

(8) Corolla: Petals 5, polypetalous (free), aestivation twisted clockwise, brightly yellow coloured.

(9) Androecium: Stamens infinite, united into a bundle (monadelphous) forming a staminal tube, epipetalous, adnate to the petal at the base, anthers free, reniform, one lobed.

(10) Gynoecium: Pentacarpelary, syncarpous, ovary superior, pentalocular with one to many ovules in each locule, placentation axile, style passing through the staminal column, stigma 5, bright, fruit 5-7 ribbed capsule, ribs often spiny, uniformly green or pink.

(11) Floral diagram:

(12) Floral formula: $\oplus\ \female\ K_{(5)}\ \overbrace{C_5\ A_{(\infty)}}\ \underline{G}_{(5)}$

5. Taxonomical description of Pea

(1) Botanical details

(i) English name:	Field pea, garden pea, sweet pea, table pea
(ii) Hindi name:	Matar
(iii) Botanical name:	Pisum sativum var, arvns L./Pisum arvense L.
(iv) Family:	*Paplionaceae*
(v) Chromosome No.:	2n = 14
(vi) Mode of pollination:	Self-pollinated

(2)Habitat: Winter season, annual herb

(3) Habit: Annual climber herb, garden pea is grown for vegetable purpose, whereas the field pea is grown for grain/pulse purpose. The garden pea is green and wrinkled seeded. On the other hand, the field pea is round and smooth seeded, sometimes dimpled seeded. With reference to water requirement, the field pea is hardy than the garden pea.

(4) Stem: Stem is fistular and glabrous and much branched.

(5) Leaves: Compound, unipinnate, imperipinnate, the terminal leaflets modify into tendrils, stipules two, broad and free, leaflets oval shaped and entire.

(6) Inflorescence: Usually a raceme and axillary.

(7) Flower: Zygomorphic, polypetalous and papilionaceous.

(8) Calyx: Sepals 5 and gamosepalous.

(9) Corolla: Petals 5, polypetalous (free), the posterior one is largest called vexillum which partly covers the two lateral ones called wings which in their turn cover the two inner most ones united into a boat shaped keel; aestivation vexillary.

(10) Androecium: Stamens 10, diadelphous (9 united and 1 free).

(11) Gynoecium: Monocarpellary, 1 chambered with many ovules, placentation marginal, fruit legume or pod, seeds mostly exalbuminous.

(12) Floral diagram:

(13) Floral formula: $o|o\ ♀\ K_{(5)}\ C_{1+2+(2)}\ A_{(9)+1}\underline{G}_{1}$

Exercise-7

Object-Study on economics of vegetable seed production crops. How to calculate B:C ratio.

Description-The income and expenditure of chilli crop cultivation per hectare is given in tabular form.

Economics:

Total cost of cultivation can be calculated on the basis of cost of inputs used. Gross monetary returns are calculated by multiplying the dry fruit yield per hectare (q) with existing market price of chilli. Net monetary returns were calculated by deducting the cost of cultivation from gross returns for each treatment. Benefit cost ratio was calculated by using the formula.

With a view to work out the validity of each treatment, economics was calculated taking into consideration the expenses in each operation. The following aspects of economics were studied.

Cost of cultivation (Rs. ha^{-1}):

Cost of cultivation was calculated in two steps. Firstly as the cost of common to all the treatment and secondly as the variable cost under different treatments, sum of these two were taken as the total cost of cultivation for different treatments.

Gross income (Rs. ha^{-1}):

The treatment wise gross profit was calculated by multiplying the seed and stover yield ha^{-1} with the prevailing market prices of the seed and stover.

Net returns (Rs.):

The relative figures of cost of cultivation for each treatment were deducted from gross profit of the corresponding treatments.

It is expressed in following formula:

$$\text{B:C Ratio} = \frac{\text{Net return hectare}^{-1}\text{ (Rs.)}}{\text{Cost of cultivation hectare}^{-1}\text{(Rs.)}}$$

Cost of cultivation of chilli for one hectare (common cost of cultivation)

S. No.	Particular	Unit	Rates	Expenditure (Rs. ha^{-1})
1.	Preparation of land			
a.	Ploughing by soil turning plough	1	@ Rs. 1800/ha/plough	1800
b.	Ploughing by cultivator	2	@ Rs. 900/ha/plough	1800
c.	Labour charge	4 L*	@Rs. 165/L/day	660
2.	Cost of seed	1.5 kg	@ Rs.350/kg	525
3.	Nursery raising	5L	@ Rs. 165/L/day	825
4.	FYM/Fertlizers	200 q.	@ Rs. 40/q	8000
5.	Irrigation charge + water rent	4 L 10 h	@ Rs. 165/L/day @Rs. 50/hour	660 500
6.	Intercultural practices	20 L	@ Rs. 165/L/day	3300
7.	Plant protection			
a.	One spray of rogor @ 0.2 %/ha		@Rs.480/L	480
b.	Application charges	2 L	@ Rs. 165/L/day	330
8.	Picking, packing and transportation upto	120 L	@ 165/L/day	19800
9.	Rental value of land (July to March)	9 month	@ Rs. 10680/year	8000
10.	Other expenditure	-	-	5000
Total				**51,680**

***L = Labour**

Cost of cultivation, gross and net returns (Rs. ha^{-1}) and benefit cost ratio of chilli.

Treatments	Rs. ha^{-1}			B:C Ratio
	Cost of cultivation	Gross income	Net income	
T_1	33098	52530	19432	0:59
T_2	34013	65880	30967	0:89
T_3	36067	71000	35033	0:97
T_4	37204	85560	48356	1:30
T_5	41257	103650	62393	1:51

T_6	42264	121148	78884	1:86
T_7	45344	146940	101596	2:24
T_8	46447	147600	101153	2:18
T_9	43917	135600	91803	2:09

Exercise-8

Object- Introduction of different types of leaf apex, leaf margin, leaf surface, leaf shape and leaf incision.

Leaf blade characteristics: The characteristics of the leaf blade may be described in respect of leaf apex, leaf margin, leaf surface and leaf shape. Taking all these traits some of the leaves have been given in figure. However, the individual trait is being illustrated below.

1. Leaf apex: The leaf apices are of various types as illustrated below.

(a) Obtuse: When it is round or has obtuse angle e.g.,banyan 

(b) Acute: When the angle is less than 90^0 or pointed but not stiff e.g., China rose 

(c) Acuminate: When it makes long slender tail e.g., peepal 

(d) Cuspidate: When it ends in a long, rigid and sharp point e.g., pineapple 

(e) Retuse: When it is truncate as in pistia 

(f) Emarginate: When it is provided with deep notch as in Bauhania (kachnar)

(g) Mucronate: When round apex abruptly ends in a short point as in Ixora 

(h) Cirrhose: When it ends in tendril as in banana 

2. Leaf margin: Similar to leaf apex the leaf margin of different types found in angiospermare given below.

(a) **Entire:** It may be even or smooth as in mango, jackfruit, ficus 

(b) **Sinuate:** It may be undulated as in case of Ashok, coffee 

(c) **Dentate**: When teeth are directed outward at right angle to the margin as in melon, neem

(d) Crenate: With round teeth as in Bryophyllum 

(e) Spinous: With pointed spine on the margin as in prickly poppy 

(f) Serrate: It is cut like teething of saw as in China rose 

3. Leaf surface: Various categories of leaf surface are found in fauna**.**

(a) Glabrous: When it is smooth and free from any hairs or growth as in case of ashok and mango.

(b) Rough: When it is some-what harsh to touch as in case of pearl millet. 

(c) Glutinous: When the surface is covered with sticky exudation as in case of tobacco. 

(d) Glaucous: When the surface is green and shining as in peepal, lotus. 

(e) Spiny: When it is provided with spines or prickles as in case of prickly poppy.

(f) Hairy: When it is covered with densely or sparsely hairs as in case of Napier grass. 

4. Leaf shape: Leaf shapes are variable in plant spp.

(a) Acicular: When it is linear with acute and pointed apex. e.g., wheat 

(b) Linear: When it is cylindrical as in case of onion 

(c) Lanceolate: When the shape of the leaf is like lence as in case of lemon, banana 

(d) Oval: When it is more or less of eclipse as in case of Vinca rosa 

(e) Ovate: When the blade is egg shaped as in case of almond, jackfruit, *Ficus* 

(f) Obovate: When the shape is errevrsely egg shaped as in jackfruit 

(g) Oblong: When the blade is wide and oblong and the two margins running straight as in case of banana 

(h) Orbicular round: When the blade is more or less circular in outline as in lotus or garden Nasturtium, lotus 

(i) Reni-form: When the leaf is kidney shaped as in Indian penniwort, colocasia 

(j) Cordate: When the leaf blade is heart shaped as in betel, giloy 

(k) Obcordate: As in wood sorrel 

(l) Oblique: When two halves of the leaves are unequal as in begonia, Neem 

(m) Spathulate: When the shape is like that of spatula as in sundrew 

(n) Sagitate: When the blade is like arrow head as in arrow root 

(o) Hastate: When the two lobes of the sagitate are directed outward as in Ipomea pulcherima, pothas 

(p) Cuneate: When the lamina is under shaped as in pistia 

(q) Lyrate: When the upper most (terminal) lobe is large as in case of radish

(r) Pendate: When the leaf blade dissected several times and the sets are directed outward as in Vitis pendata 

5. Leaf incision: According to the depth of incision(less than half of leaf margin-partide, mid rib, upto mid rib-fid and beyond half mid rib-sect) **(Fig.).**

(1) Pinnate type of leaves

(a) Pinnatifid: When the incision of the margin is half or nearly half way down towards the margin as in poppy.

Pinnatifidleaf incision in poppy

(b) Pinnati-partite:When the incision is more than half way down as in case of crucifers.

Pinnati-partite leaf incision in mustard

(c) Pinnatisect: When the incision is carried down to near the mid rib as in case of fern, gram, peas.

Pinnatisect leaf incision in chickpea

(d) Pinnati-compound: When incision of the margin reaches the mid rib, then dividing the leaf into number of segments or leaflets as in pea, gram, soybean, kidneybean, moongbean, urd etc.

(2) Palmate type of leaf

(a) Palmatifid as in case of cotton, cucurbit. 

(b) Palmati-partite as in case of carrot, papaya. 

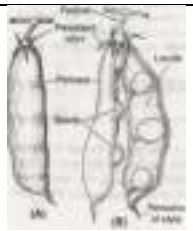
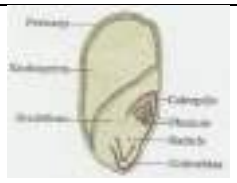
(c) Palmatisect: As in case of tapioca, hemp, ganja. 

(d) Palmati-compound: As in silk cotton tree, chitwan. 

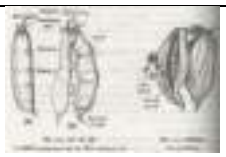
Exersice-9

Object- Introduction of different categories of fruits with their example.

Categories of fruits with examples and diagrammatically illustration

Major category	sub-category	Kind	Example	Diagrammatic illustration
Simple fruit	1.Capsular fruit	1.Legume	Pea	
		2.Follicle	Calotropis (madar)	
		3.Siliqua	Mustard	
		4.Capsule	Datura	
1.Indehiscent fruit	2.Achenal fruit	1.Achene	Mirabilis	
		2.Caryopsis	Maize	
		3.Cypsela	Sunflower	

		4.Nut	Cashewnut	
2.Dehiscent fruit	3.Schezocarpic Fruit	1.Lomntum	Groundnut	
		2.Cremocarp	Coriander	
		3.Samara	Hiptage	
		4.Regma	Castor	
3.Fleshy fruit		1.Drupe	Mango	
		2.Berry	Tomato	
		3.Pepo	Bottle gourd	
		4.Pome	Apple	
		5.Hesperidium	Citrus	

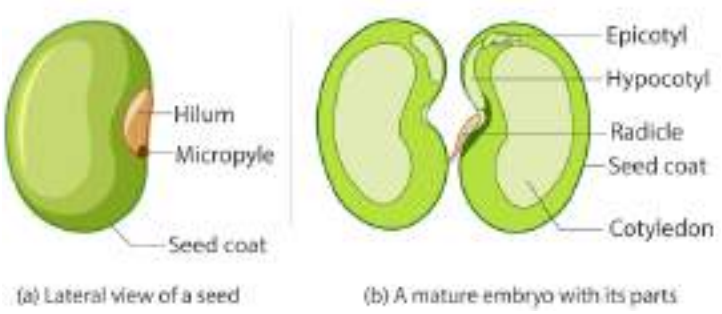
4.Aggregate fruit		1.Etaerio of ollicles	Madar	
		2.Etaerio of achenes	Rose	
		3.Etaerio of drupes	Raspberry	
		4.Etaerio of berries	Annona	
5.Multiple fruit	Composite fruit	1.Sorosis	Pine apple	

Exercise-10

Object- Introduction of morphology of dicotyledonous and monocotyledonous seeds.

The seed is the fertilized ovule, on the other hand, the ovule containing ovary after fertilization develops into fruit. The fruit may contain one seed as in case of cereals and millets or many seeds in case of dicots. The parts of the seed have been described as follows for dicot and monocot separately.

Dicot seeds: There are several species or families which are dicots. For describing the dicot seeds kidney bean has been taken as in dicot seed**.**



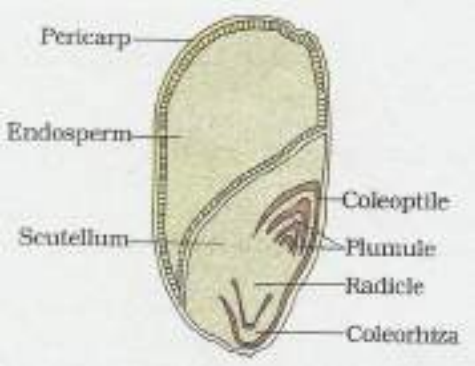
Parts of kidney bean seed (whole seed, cotyledon, embryo after removal of seed coat)

1. Seed coat: The seed is covered by the seed coat which is variously coloured in this legume (brownish, cream, yellow, pink, black, green, mosaic, etc). It is made up of two layers or integuments; the outer one is called testa and the inner one tegmen. As mentioned above, the testa is of variously coloured and comparatively thick, whereas the tegmen is membranous and fused with testa. The seed coat provides necessary protection to the embryo which lies within one side of the seed, a small oval depression is seen which is known as hilum. The hilum represents the point of attachment of the seed to the stalk. Just below the hilum, there is minute slit (opening) which is known as micropyle. Above the hilum the stalk is continuous with the seed coat, forming a sort of ridge, called the raphie.

2. Embryo: The seed without seed coat is embryo or baby plant. The embryo is composed of two white fleshy bodies called cotyledons or seed leaves and a short axis to which the cotyledons are attached. The part of the axis lying towards pointed end of the seed is radical (a little root), while the other end lying between the two cotyledons is called plumule. The plumule is surrounded at the apex by a number of minute leaves. As the seed germinates the radical gives rise to the root and the plumule to the shoot. The cotyledons store up the food material.

Barring few exceptions the structure of pea, rajma, castor, mustard, soybean is similar to that of chickpea.

Monocot seeds: The monocotyledons have seeds with single cotyledon. Most of the cereals millets, *Liliaceae* family come under this category. The ovary of such plants after fertilization produces grains i.e., small one seeded fruit. Such fruit (grain) remains enclosed in a husk of variable colour which is comprised of two layers, one partially enveloping the other, the outer layer is called flowering glumes (lemma), while the inner and smaller one is called palea. The grain along with husk is called fruit, popularly known as cariopsis or kernel. Here the structure of rice grain has been discussed **(Fig.)**.



Structure of caryyopsis (monocot)

1. Seed coat: Just below the husk, there is membranous layer which remains adherent to the grain. This layer is made up of seed coat and wall of the fruit fused together.

2. Endosperm: This forms bulk of the grain and food storage tissue laden with starch. In the longitudinal section of the grain **(Fig.).** It is distinctly separated from embryo by a definite layer known as epithelium.

3. Embryo: It is very small structure lying in a groove at the end of the endosperm. It comprises of any one shield shaped cotyledon which is known as scutellum and a short axis which has an upper portion, plumule and the lower portion, radical. The plumule is surrounded by minute leaves and the radical is protected by cap known as root cap. The plumule is surrounded by sheath called coleoptiles and similarly, radical is surrounded by coleorhizae. The surface layer of the scutellum lying alongwith in contact with endosperm is the epithelium whose function is to digest and absorb food material stored in the endosperm.

Similar to rice the structure of other monocot grains (maize, sorghum, pearl millet) is the same excepting minor variations.

Difference between dicotyledon and moncotyedon plants

S.No.	Particulars	Dicotyledons	Monocotyledons
1.	Embryo	With two cotyledons	With one cotyledon
2.	Root	Tap root	Fibrous root

3.	Venation	Reticulate with free ending of veinlets	Parallel with no free ending of veinlets
4.	Flower	Mostly pentamerous	Trimerous
5.	Vascular bundles	In stem collateral and open, arranged in a ring; in roots radial, xylem bundles usually 2 to 6.	In stem collateral and closed, scattered; in roots radial, xylem bundles usually many, rarely few (3-5).
6	Secondary growth	Present both in stem and root	Absent but with few exceptions

Exercise-11

Object- Hybrid seed production technique in vegetable crops, information regarding breeder seed and PPVFRA.

Historical back ground

With the exploitation of hybrid vigour it will not be an exaggeration that future of agriculture would depend on hybrids. It is expected that hybrids will replace homozygous progenies in self-pollinated crops and heterozygous ones in cross-pollinated ones in next 25-30 years. It is surprising that maximum vegetable crops have come in the field of hybrid development. The private seed companies have played greater role in this direction.

Fig. Photograph of hybrid pumpkin with heavy fruiting

In India, C.T. Patel of Gujarat Agricultural University, Anand developed first cotton hybrid H_4. Today, in India more than 3 million ha area is planted with hybrid cotton, also India has become largest producer of cotton fibre in the world. Because of this, the country switched over from cotton importer to exporter.

Similarly, T.S. Venkataraman in 1938 developed several hybrids of sugarcane by crossing *Saccharamum officenarum* with ready relative *Saccharum spontaneum.*These new hybrids spreaded rapidly in the country. Since sugarcane is vegetatively propagated, hybrid seed production is not a problem.

Like wise, China has taken lead in the development of hybrid rice-a self-pollinated plant. Now out of 34 m ha area under rice about 18 m ha is under hybrid rice. Particularly, hybrids are most superior (66 q/ha yield) to varieties (44 q/ha yield). Taking lesion from China, India has also launched network project on hybrid rice and more than a dozen hybrids have been bred by private and public Organizations.

Hybrid seed production in vegetable crops

Tremendous progress has been made by public and private sectors in the development of hybrids in several vegetable crops, including tomato, brinjal, chilli,

capsicum, cabbage, cucumber, musk-melon, etc and about 90 hybrids have been recommended for cultivation in various parts of the country. However, only about 10% area is covered under tomato and cabbage hybrids.

In India, seeds of vegetable hybrids are produced by private companies. Commercial hybrid seed production in public sector is comparatively less organized. Generally, hybrids are produced in open fields except that of capsicum of which seeds are produced in glass houses. Hybrid seed production of temperate vegetables like cauliflower, cabbage, carrot and radish is restricted to the high land of Jammu and Kashmir.

Technology for hybrid development and hybrid seed production

There are several methods which can be employed for quality seed production of hybrids. These methods are:

(i) Hand emasculation and pollination method

(ii) Use of genetic and genic-cytoplasmic male sterility

(iii) Use of self-incompatibility

(iv) Use of gynoecious lines

(v) Use of growth substances (Ethrel,GA and silver nitrate)

(a) Use of hand emasculation and pollination

This method is globally used in tomato, brinjal, pepper and okra. By this method, Punjab Agricultural University has developed two hybrids each of tomato and brinjal.

Fig. Brinjal flower showing process of hand emasculation

Hybrids of tomato and brinjal developed by emasculation pollination method.

Vegetable	Hybrid	Female parent	Male parent
1.Tomato	TH 802	Acc 2	Acc3
	TH 2312	Punjab Chhuhara	VNF 8

2.Brinjal	BH 1	Punjab Barsati	Jamuni Gola
	BH 2	Punjab Barsati	Punjab Neelam

a b

Fig. Hybrid plant of tomato (a) and brinjal (b) with luxuriant growth and heavy fruiting

The hybrid seed production by this method is costly as individual flower has to be emasculated and pollinated. However, in south India, like Karnataka, Maharashtra and Tamil Nadu the hybrid seed production in tomato and other vegetables is very successful and economical because of long pollination period and cheap labor.

(b) Use of self-incompatibility

Sporophytic system (SI) is being used in cabbage and Chinese cabbage. SI is maintained either by bud pollination, CO_2 treatment, and weak electric current or with spray of 2-3% Nacl. However, it does not have much scope for the development of hybrids in India by using SI lines.

(c) Use of male sterility

The gene-cytoplasmic male sterility system in onion and sugar beet has first of all been discovered in1912 for hybrid seed production. The genetic male sterility is used in tomato, chilli and musk melon.

Vegetable hybrids based on genetic male sterility

Vegetable	Hybrid	Parentage
Chilli	CH 1	ms 12 x LLS
	CH 3	ms 12 x S2430
Musk melon	Punjab Hybrid	ms 1 x Hara-madhu

Fig. Hybrid Chilli plant showing heavy fruiting

The seed production of these hybrids is very easy and quite cheap. Due to this reason, many progressive farmers along with public and private institutions have taken up seed production of hybrids. The seeds of both male and female lines of both these hybrids are supplied by PAU, Ludhiana to the farmers and F_1 seeds are produced by the farmers on large scale. This university also organizes training of the farmers on the utilization of male sterility for the production of F_1 hybrids in these vegetables. Thus plenty of hybrid seed is available at nominal cost to the growers, therefore, making it viable commercial production.

(d) Use of gynoecious lines

The gynoecious lines have been developed in cucumber, musk melon and *Cucurbita pepo,* etc. These lines are pistillate having no stamens or very rudimentary or non-functional stamens. Such lines are being used for the development of hybrids.The PAU has developed a hybrid in musk melon: MH 10 with the use of gynoecious line (WL 998). The line Pb. Sunhari was male parent. In cucumber, Pusa Synyog (Japanese gynoecious x Green Long Naples) hybrid was identified for general cultivation.

The gynoecous lines are maintained by spraying silver nitrate (Ag No_3) in 500-100 ppm or silver thiosulphate in 25-50 ppm concentration at 2-3 true leaf stage. This produces lot of staminate flowers which can be used for selfing.

(e) Through chemical sex expression

With the advent of growth regulators very significant results were obtained with regard to sex modification in cucurbits. It has now been possible to prove that the two leaf stage is most responsive for the application of chemicals for sex modification. Specific chemicals are known to induce femaleness or maleness as desired. In cucurbits like bottle gourd, pumpkin, summer squash F_1 seeds can be produced by the application of ethrel (2-dichlorothyl phosphoric acid) at the rate of 200-300 ppm at two true leaf stage. Another application is useful at flowering time: Ethrel helps in suppressing the staminate flowers and initiating the pistillate flowers successfully in the first few flowering nodes on the female parent. The row of male

parent is grown by the side of the male parent and is allowed natural cross pollination. In the absence of pollinators, hand pollination is possible when the two sexes are separate. Four to five fruit set at initial nodes containing hybrid seeds would get sufficient seed yield. The complete suppression of male flowers can be achieved at higher dose of 400-500 ppm of ethrel applied twice and has made hybrid seed production easier in summer squash.

Details of anthesis, pollen dehiscence and fertility and stigma receptivity in gourds

Name of gourd	**Antheis**	**Dehiscence**	**Pollen fertility**	**Stigma receptivity**
1.Ash ourd	9-12.30 hr	7-8 hr	7-12hr	One day before and one day after anthesis
2.Bitter gourd	9-13.30 hr	7-8 hr	5-12 hr	One day before and one day after anthesis
3.Bottle gourd	17-20 hr	13-14.30 hr	On the daty of anthesis till next morning	36 hr before and 60 hr after anthesis
4.Ridge gourd	17-20 hr	17-20 hr	On the day of anthesis to 2 to 3 days in cool period and11.5 day in rainy season	6 hrs before and 84 hrs after anthess
5.Snake gourd	12-21 hr	Shortly before anthesis	10 hr before to 49 hr before dehiscence	7 hr before to 51 hr after anthesis
6.Sponge gourd	4-8 hr	4-8 hr	On the day of anthesis	10 hr before to 120 hr after anthesis

Import and sale of hybrid seeds of vegetables in India

S.No.	**Vegetable crop**	**All India sale (t)**	**Value Million US $**	**%Imported seed**
1.	Okra	500	8.16	0
2.	Brinjal	15	1.84	0
3.	Tomato	28	8.57	2
4.	Chilli	15	5.50	50
5.	Capsicum	1.0	1.02	40
6.	Cabbage	40	6.12	100
7.	Cauliflower	10	3.27	70
8.	Cucumber	3	9.42	15
9.	Melons	5.5	0.84	20
10.	Watermelon	40	3.27	15

11.	Gourds (total)	30	1.44	30
12.	Total	637.5	40.45	--

Source: Extracted from—Training program "Quality seed production in vegetable crops- An entrepreneurial perspective at Zonal Technology Management and Business Planning and Development unit", IARI, New Delhi-110012

Number of grains (seeds)/10 g sample

0-500	**700-2400**	**2500-4500**	**5000-15000**	**20000-and above**
Broad-bean-8	Salsify-700	Fenel-2500	Turnip-5000	Celery-25000
Lima bean-8	Gardenbeet-750	Onion-2700	Parsley-5400	Watercess-38000
Pumpkin-30	Radish-1100	Cabbage-2800	Chicory-6000	----------
Common bean-35	Pepper-1400	Knolkhol-3100	Lettuce-8600	----------
Sweet corn-50	Brinjal-2200	Tomato-3200	----------	----------
Squash-70	Sprouting broccoli-2300	Cauliflower-3500	----------	----------
Watermelon-225	----------	Onion-4500	----------	----------
Okra-170	----------	----------	----------	----------
Cucumber-3500	----------	----------	----------	----------
Melon-3500	----------	----------	----------	----------
Artichoke-250	----------	----------	----------	----------
Asparagus-500	----------	----------	----------	----------

Isolation requirement for quality seed production in vegetable crops

S.No.	**Vegetable crop**	**Isolation distance(m)**		**Remarks**
		F.S	**C.S.**	
1.	Asparagus bean	50	10	Isolate from other varieties of cowpea by the same distance
2.	Yard long bean	50	10	
3.	Cowpea	50	10	
4.	Ash gourd	1000	500	
5.	Bitter gourd	1000	500	

6.	Cluster bean	50	10	
7.	Cowpea(*Vigna snensis*	50	10	
8.	Dolichos bean	50	10	
9.	French bean	50	10	
10.	Lima bean	150	50	
11	Garden pea	50	10	
12.	Cauliflower	1600	1000	Isolate from other cole crop varieties by the same distance
13.	Cabbage	1600	1000	" "
14.	Knol khol	1600	1000	" "
15.	Brussel's sprout	1600	1000	" "
16.	Sprouting broccoli	1600	1000	" "
17.	Kale	1600	1000	" "
18.	Chinese cabbage (heading type)	1600	1000	Isolate from turnip by the same distance
19.	Chinese cabbage (non-heading type)	1600	1000	" "
20.	Amaranths	400	200	Isolate from wild amaranth
21.	Lettuce	50	25	
22.	Feenu-greek (maithi)	50	10	
23.	Beet leaf	400	200	Isolate from garden beet, sugar beet, swiss chard
24.	Carrot Stage I	5	5	
24	Carrot Stage II	10900	800	
25.	Onion Stage I	5	5	
26.	Onion Stage II	1000	500	
27.	Radish	1000	800	
28.	Turnip	1000	800	Isolate from Chinese cabbage by same distance
29.	Tomato	50	20	
30.	Hot pepper (chilli)	400	200	Isolate from sweet pepper by same distance
31.	Sweet pepper	400	200	Isolate from chilli by same distance
32.	Brinjal	200	100	
33.	Okra (bhindi)	400	200	Isolate from wild species

34.	Musk melon	800	400	Isolate from long melon by the same distance
35.	Pumpkin	800	400	Isolate from squashes by the same distance
36.	Potato (tuber)	5	5	
37.	Potato (TPS)	50	10	
38.	Potato(TPShybrid)	50	5	
39.	Spinach	800	500	
49,	Beet leaf	2000	1000	
50.	Asparagus	1500	1000	
51.	Garden beet	2000	1000	
52.	Sugar beet	2000	1000	
53.	Broad bean	50	10	
54.	Cauliflower	1600	1000	
55.	Chicory	1600	1000	
56.	Colocasia	10	5	
57.	Coriander	3	3	
58.	Garden pea	50	10	
59.	Garlic	10	5	
60.	Ginger	10	5	
61.	Turmeric	10	5	
62.	Leek	1000	400	
63.	Parsley	1000	800	
64.	Prsnip	1000	800	
65.	Sweet potato	25	10	

Plant varieties and farmer' Right Act 2001 (PPVFRA-2001)

The Act, 2001 was passed on August 9, 2001 by the Lok Sabha. The main features of the Act are:

1. Registration of farmer's varieties, extant varieties and new varieties, of such genera and species as notified in the Official Gazette by the central Govt. A Farmer's variety is a variety thathas been traditionally cultivated and evolved by farmers, or is a wild relative or land race in common knowledge of farmers. An extant variety is a notified variety or farmer's that is in the public domain. The registration of the extant varieties will be done within a specified period and subject to their meeting the criteria of distinctiveness, uniformity and stability.
2. A new variety shall be registered if it meets the criteria of vovelty, distinctiveness, uniformity and stabiklity. The criterion of novelty requires a variety to be in a commercial use for less than one year in India, or 4 years (6 years in case of trees and vines) out side India.

3. The variety must be distingable for at least one essential characteristic from any other variety whose existence is a common knowledge in any country (distinctiveness). Essential characteristic is a heritable trait that contributes to the principal feature, performance or value o the plant variety. Further, a variety in common knowledge, means any variety for which an application for grant of PBR r for entering the variety in the official register of varieties has been filed in any convention country.
4. Any variety that involves any technology including' gene use restriction' and termination technologies which is injurious to life or health of human beings, animals or plants shall bbot be registered.
5. A variety that has been essentially derived from an initial variety, can be registered as new variety. The breeder of such variety must obtain authorization from the breeder of the initial variety, since the essentially derived variety is subject to the PBr of the initial variety. The definition of an essentially derived variety is that such a variety must be distinguishable from the initial variety and otherwise conform to the latter in the expression of heritable essential characteristics.
6. The duration of protection o the varieties will be 15 years for the extant varieties, 18 years for varieties of trees and vines and 15 years for varieties of other crops
7. The registration of a variety confers on the breeder of that variety or the successor or his agent orlicensee an exclusive right to produce, sell, market, distribute, import or export the variety.
8. The provision of researcher's rights allows any person to use any registered variety for research and for creation of new varieties, except essentially derived varieties, without paying any royalty to the PbR holder.
9. The Act recognizes the farmer's rights in the followingaspects
   (a) Recognition of farmer's varieties
   (b) Reward from the national gene bank for those farmers whoare engaged in the conservation of genetic resources of land races and wid relatives of economic plants and their improvement through selectionand preservation, provided that the material so selected and preserved have used as donors ofgenes o varieties registered under this Act.
   (c) Freedom of farmers, to save, use, sow, resow, exchange, share or sell their farproduce, including seed of a variety protected under the Act in some manner, as theywere entitled before the coming into force of this Act
   (d) Requirement for he breeder to disclose to the farmersthe expected performance of the varietyunder given conditions, the farmers can claim the compensation if this expectation is not fulfilled.
10. The procedure for making a claim attributable to the contribution in the evolution of any variety and seeking reward from the gene fund has been specified
11. The Central Govt. shall establish a plant varieties Registry for the registration ofplant varieties.

12. The breeder shall be required to deposite the specified quantities of the seeds/propagules of the registered variety as well as its parental lines in the National Gene Bank as specified by the Protection of Plant Varieties and Farmer's Rights Authority.
13. The cizens of convention countries will have the same rights as citizens of India under the Act.
14. Applications for registration of a variety may be made to India within12 months from the date of application for registration of the same plant variety made in a convention country..
15. The rights of PNRholder shall not be deemed infringed by a farmer who at the timeof suchinfringment was not aware of the existence of such right.

Details of breeder seed production of vegetable crops during last 9 years

Year	Indent (kg.)	Production (kg.)	% excess production
2005-06	15831	22815	55.88
2006-07	21062	22684	8.33
2007-08	37541	34191	-8.12
2008-09	35574	37482	5.16
2009-10	7822.78	13348.5	58.60
2010-11	36786.640	37886.640	3.00
2011-12	2302.070	3022.070	30.3
2012-13	13579.980	13805.040	1.63
2013-14	6967.900	Not available	--

With the increase in the breeder seed production and collaborative efforts of public seed producing organizations and private seed companies which are involved in R&D of vegetable crops, there has been commendable increase in the production of certified seed, the last unit of the seed production chain, the India is well of in the vegetable seed required by growers. This can be seen in **Table** given below.

Table-: Vegetable seed (BS, FS & CS) requirement in India

Vegetable crops	Area (kg/ha)	Seed Requirement (kg)			Total BS Production (kg)
		Breeder	Foundation	Certified	
Tomato	879630	11.00	2199.08	439815	173.200
Brinjal	722070	5.78	1444.14	361035	258.410
Chilli	794120	15.88	3176.48	635296	81.320
Okra	530790	1769.30	106158.00	6369480	2976.000
Onion	1051530	262.88	52576.50	10515300	1975.700
Garlic	247520	3094000.00	24752000.00	198016000	5933.000
Cauliflower	402200	0.64	321.76	160880	0.100
Cabbage	372360	0.17	139.64	111708	2.300
Vegetable Pea	420900	657656.25	5261250.00	42090000	52413.000
Beans	123510	21957.33	329360.00	4940400	7371.700
Cowpea	102500	960.94	38437.50	1537500	911.000
Bottle gourd	113920	56.96	5696.00	569600	319.450

Bitter gourd	83220	41.61	4161.00	416100	292.500
Pumpkin	16170	8.09	808.50	80850	161.200
Cucumber	40900	1.36	409.00	122700	99.500
Watermelon	80590	32.24	3223.60	322360	80.000
Muskmelon	41820	44.61	3345.60	250920	5.500
Radish	170300	42.58	8515.00	1703000	705.500
Carrot	64270	28.56	4284.67	642700	80.250

Exercise-12

Object- To introduce **s**eed extraction techniques in different vegetable.

Brinjal: The mature yellow colored fruits are allowed to sun dry.

Fig. Mature yellow coloured fruits of brinjal ready for seed extraction

After 3-4 days sun drying, the fruits are longitudinally cut open for easy drying of seeds. Once they dry properly the seeds can be scooped out in the vessel containing water

Fig. Longitudinally cut fruit of round brinjal ready for scooping out the seeds.

Tomato: Fruit picking should be done at red ripe stage and seeds are extracted from red ripe fruits after keeping them in wooden boxes or cement tank for fermentation.

Fig. Ripe tomato fruits being macerated for fermentation

Fig. Tomato fruits are being fermented in the wooden tank

The rate of fermentation depends on the ambient room temperature. After one to two day time, seeds are separated from the fruit pulp by washing with water and sieves. When the quantity of fruits is large the seeds are extracted by machine without fermentation

(a) (b)

Fig. Tomato seeds are being extracted by machine without fermentation (a) and dry seeds after extraction (b)

The seeds are dried in shade up-to seed moisture of 8% and stored in dry place in glass containers, cotton bags and aluminium foil packets.

Chilli: The red ripe fruits of chilli are plucked and then they are allowed to sundry in open threshing floor. The mature fruits of capsicum are cut open longitudinally for easy drying of seeds. Once they dry properly, the seeds can be scooped out in case of capsicum and chilli capsules need to break open to expose the seeds.

(a) (b)

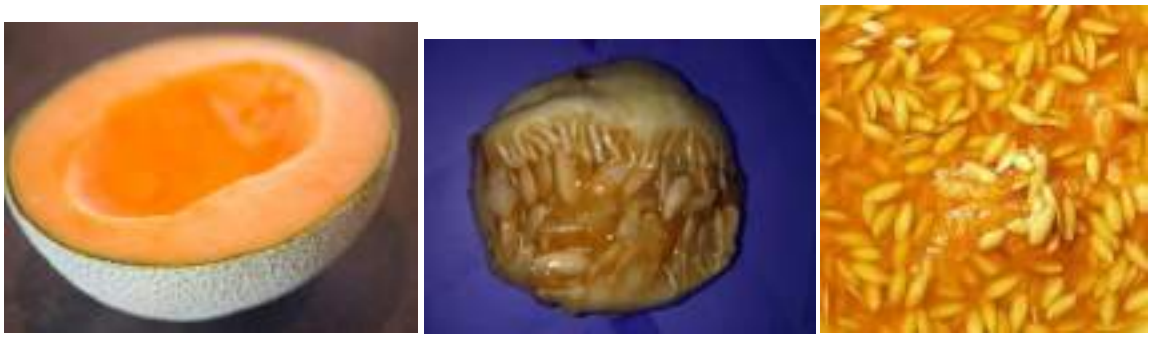
Fig.Ripe hot pepper fruits ready for plucking for seed extraction (a) extracted seeds after drying (b)

. **Cucumber:** The fruits of cucumber are cut longitudinally and the seed along with the placental material and fine pulp are separated through screening. Fermentation is usually avoided as it discolors the seeds and reduces the germination also. The seeds are spread on tarpaulin sheet under partial shade. The seeds are dried till the moisture reaches to 10% and then can be stored under ordinary room temperature. When seeds are to be stored in vapor proof containers, moisture content should be 6%.

(a) (b)

Fig. Ripe fruits (a) and longitudinally cut fruits (b) of cucumber showing scooping of seeds

Muskmelon: The extraction of the muskmelon seed is done by removing the seed from cavity and washing them thoroughly with plain water after fermentation. The seeds should be dried till the moisture content reaches 10% and can be stored under ordinary room temperature. When seeds are to be stored in vapour proof containers, the moisture content should be 6%.



(a) (b) (c)

Fig. Seed ball (b) removed from the cavity (a) cavity (a) and seed being fermented (c)

Pumpkin: The seed in pumpkin is extracted by cutting the ripe fruit and the seed ball from the cavity is extracted. Latter the seed is removed from the seed ball by maceration and the seed**.** The seed yield ranges from 75 to 125 kg/ha and in case of squash, it is 50-80 kg/ha.

a **b**

Fig. Mature fruit (a) and dry seeds (b) of pumpkin

Okra: The maturity of fruits in okra occurs in a sequential order on the plant, therefore, the repeated harvesting of the fruits is recommended. The angular fruited varieties of okra have a tendency of shattering and hence delayed harvesting leads to loss of the seed yield. At maturity the fruits turn grey to brown and that is the real stage of the harvesting of the fruits, otherwise the fruits may split. Mature fruits are harvested manually and it should be done preferably in the forenoon before 11 A.M. The seeds are extracted from hand harvested fruits when they are dry and brittle. The most efficient method of seed extraction by hand twists the fruits open or the fruits are threshed by hand or thresher.

(a) (b)

Fig. Okra fruits showing initiation of dehiscence (a) and completely dehisced fruits and seeds removed (b)

Coriander: To avoid shattering it is better to harvest the crop in morning hours when there is dew. It is recommended that the crop should be harvested when seeds are in light green stage so that unpleasant odor of the unripe fruits has disappeared. After harvesting, dry it in shade for 72 hours then put it for sun drying. The quality of the spice is highly dependent upon the stage of fruit maturity at harvest and on the methods used for its subsequent drying and handling. Sulphur dusting against powdery mildew also maintains the green color of the seeds. After drying, threshing is done by beating the crop residue with stick or by light thresher. He seeds are sieved, winnowed and dried in sun the before final packing.

(a) **(b)** **(c)** **(d)**

Fig. (a) Fully fruited plant (b), dry crop ready for harvesting (c), harvested bungles (c) and (d) threshed coriander seeds

Potato: Macerate the berries by hand or using reverse screw juice extractor into pulp. Treat the pulp with 10 % HCl and stir for 20 minutes to separate the seeds from the debris. Wash the seeds with plain water 3 to 4 times to remove the acid. Dry the clean seeds in shade on a stretched muslin cloth for 72 hrs. followed by half an hour drying under sun to reduce the moisture content

to 5-6 %. Pack the seeds in double polythene bags and store over $CaCl_2$ as desiccant in the refrigerator at the temperature of 6-10^{o}C.

Potato plant with berries (fruits) in clusters

Exercise-13

Object- Introduction of unexploited/underutilized vegetables.

Vegetables form an important ingredient of human diet and Indian food; in particular, as they are the cheap sources of minerals, vitamins, dietary fibers and health related phyto-chemicals like antioxidants. There are a large number of vegetables grown in India which have been classified into 10 major categories. Most of them are not acceptable to all categories of consumers on account of their seasonability, high price and non acceptability, particularly to those who are living in vegetable resource constraints ecologies.

1. **Reasons of non availability of cultivated vegetables**-
   Even there cultivated vegetables are not available to general mass during lockdown period due to epidemic of Corona virus disease because of the following reasons.
   (a) Whole sale and retailer mandies of vegetables have been closed during lockdown period, so that gathering of purchasers and consumers could be checked in order to prevent further spread of the virus.
   (b) The consumer families, mostly, do not procure/purchase vegetables from vendors due to fear of contamination.
   (c) Long distance transportation of vegetables through trains/trucks has been banned during epidemics of Corona disease.
   (d) Mandies and retail shops have been opened only during this unlock period/region suspected.
   (e) Risk in purchasing vegetables from vendors roaming from door to door due to contaminations of virus as each item touched by the customers several times.
   (f) Also, due to shortage of vegetables, the rates are high.
   (g) The transported vegetables are already old hence cannot be stored for long period.
2. **Relief from unexploited and underutilized vegetables**-
   In order to relieving the crises of short supply of traditional cultivated vegetables the locally available unexploited vegetables should be used which has served benefits such as:
   (a) The local habitants are acquaint to taste and preparation.
   (b) These vegetables are least costly as only searching, picking removal are required.
   (c) The vegetables are rich in vitamins like vitamin ‘C’ (Curry leaf, Karonda, Kareel, Tamarind) which imparts immunity).
   (d) They are full of dietary fibers (Bread fruit, Drumstick, Opuntia and Pulcherima) which are laxative.
   (e) They are very rich in calcium (water chestnut, wild spinach).

These vegetables should be consumed during lockdown period of epidemics of Corona virus which not only tied down the crisis of vegetables, but will also impart immunity against notorious disease (Covid-19).

I. Introduction

India has witnessed appreciable progress in vegetable production during post green revolution era. India Being second largest producer of vegetables in the world, next to China, India accounts for 15 per cent of the global production. Vegetable form an important ingredient of human diet and Indian food, in particular, as they are the cheap sources of minerals, vitamins, dietary fibers and health related phyto-chemicals like antioxidants.

II. Importance

Having shorter life cycle, vegetables help in increasing cropping intensity. There are large numbers of vegetables grown in India which have been classified into 10 major categories. Most of them are not acceptable to all categories of consumers on account of their seasonability, high price and non accessibility, particularly to those who are living in vegetable resource constraint ecology.

Alternatively, there are some vegetables/plant parts which are of special taste, local importance and affordable to all sections of consumers. Some vegetables and/or plant parts which are used as vegetable are excluded from major categories which have not been attended for generation of production technology on account of several grounds. Such vegetables or plant parts are mostly non descript, least attended by researchers and extension workers. In this article, the efforts have been made to describe plant species where some parts are used as vegetables. This list is not exclusive or complete. There may be many more plant species about which the authors could not collect information. The collected species were described in respect of Hindi/local name, English name, botanical name, family and plant parts which are used as vegetable, other uses/special qualities, growing season/habit and areas where grown/used in the following 6 tables (1 to 6).

Category wise importance of unexploited vegetables is being given below:









1. Bamboo 2. Spathe of banana 3. Kachnar 4. Drumstick 5. Opuntia 6. Goolar 7. Karonda 8. Lotus 9. Lasoda 10. Asparagus 11. Cactus 12. Ficus

1. **Importance of tree/bush vegetables:** The details of 12 trees/bushes where either fruits and/or some other parts are used as vegetable and have some other special qualities have been given in **Table-1.**

Table-1: Details of 12 trees/bushes where some parts and/or fruits are used as vegetable

S. No.	Hindi/Local name	English name	Botanical name	Family	Plant parts used as vegetable	Other uses/special quality	Growing season/habit
1	Badhal, Dahya, Monkey jack and Lahooch bean	Bread fruit	*Artocarpus altilis*	*Moraceae*	Fruits	1.Wood is used as timber 2.Bark is source of tannin 3.Seed are purgative	February-June

						4.Bark produces bark cloth	
2	Kathal, Kanthal, Panas	Jack fruit, Jack tree	*Artocarpus hetrophyllus A.integrifolia*	*Moraceae*	Fruits and seeds	1.Heart wood is valuable timber 2. Wood yields yellow dye 3.Leaves are used as cattle fodder 4.Bark is used for tanning	February t June-July
3	Imli and Tamarind	Tamarind	*Taramindus indica*	*Caesalpiniaceae*	1.Fruit pulp is used for souring curries 2.Tender leaves	1.It is rich in vit 'C', tartaric acid, citric acid 2.Grown as avenue tree 3.Fruit pulp has medicinal values	Throughou the year
4	Sahjan and Soanjna	Drum stick tree and horse radish tree	*Moringa oleifera*	*Moringaceae*	Green fruits	1.Oil from seeds has medicinal value 2.Wood is used for shutters and picking sticks 3.Wood pulp is used in news print	1.Some varieties i South throughou the year 2.In North India January to April
5	Goolar/Domoor	Cluster fig	*Ficus glumerata*	*Moraceae*	Fruit	1.Grown along road side 2.Leaves are used as fodder 3.Bark is used as tannin 4.Host for lac insect	Throughou the year
6	Mahua, Moha	Mahua tree and Illipe butter	*Madhuca indica*	*Sapotaceae*	Flowers	1.Flowers are source of alcohol 2.Seed oil is used for cooking and soap making 3. Oilcakes make good manure	Summer months

						4. Flowers are useful in coughing and bronchitis 5.Tolerates alkanity	
7	Chokargond, Lasoora and Labherah	Sebesten, clammy cherry and Indian cherry	*Cordia dichofoma*	*Euphorbiaceae*	Fruits	1.Fruits are eaten raw or pickle 2.They have medicinal value 3.Bark is rich source of tannin 4.Trees are hardy	Summer months
8	Ker, Karar, Karira and Kareel	-	*Capparis aphylla, C. decidua*	*Capparidaceae*	Flower buds, green and mature fruits	1.Top shoots and young leaves are used as fodder 2.Bark is useful in Coughing and asthma 3.Wood is hard and heavy 4.It is termite resistant 5.Suitable for wind break and shelter belt	Summer months
9	Khejri, Chhokar, Jand, Sami Sangari	-	*Prosopis cineraria P. spicigera*	*Mimosaceae*	Young pods	1.Grown as hedge plant 2.Plant yields gum 3.Drought tolerant 4.Fruits are rich in protein and calcium	Summer months
10	Lal Kachnar, Kaliar	Camel's foot tree, Pink Bahauni a	*Bauhinia purpurea*	*Caesalpiniaceae*	Flower buds and fruits	1.Leaves are used as fodder 2.Tannin is extracted from bark 3.Wood is useful for agricultural implements	Summer months
11	Kurkurji wah	-	*Leea indica*	*Leeaceae*	Fresh shoots	Roots have medicinal quality in diarrhoea	-
12	Meethi neem	Curry leaf	*Murraya koenigii,*	*Rutaceae*	Leaves for	1.Rich in vitamin 'C', calcium and	Perennial shrub

			M.paniculata		flavouring the curries	phosphorus 2.High in medicinal values 3.Oil is used in perfumery	

Besides providing vegetables some trees/bushes are beneficial in respect of following traits and qualities.

1. All trees/bushes are perennial and thus their sowing/planting is required only once in several years (Until they decay/degenerate). Thus the seed

rate is negligible over the years as against the annual species where sowing is done every year/season.

2. They are very hardy and thus least care is required.

3. They provide timber wood which is used for various purposes.

4. They also provide fuel wood.

5. They are grown as avenue trees (Imli, Kachnar, Kathal).

6. The bark of trees provide tannin (Badhal, Goolar, Lasoda), dye (Kathal) and gum (Chhonkar).

7. Cluster fig acts as host for lac insect.

8. The leaves and twigs of these tree species provide valuable fodder for cattle.

9. The soft wood of trees viz., Sahjan is used in the production of news print.

10. They serve the purpose of wind breaks in the gardens and crop fields.

11. Besides the use as vegetable, the fruits are also used in pickling (Kathal, Sahjan and Karil).

12. Dried fruits are used as off-season vegetables (Karil and Sengri).

13. The fruits of Imli are very rich in vitamin ‘C’, tartaric acid and citric acid.

14. Mahua flowers are resource of alcohol.

15. Oil extracted from Mahua seeds is used in cooking and soap making and oil cake is useful as manure.

16. In Jack fruit, unripe fruits are used for vegetable and pickle. In ripe fruits the seeds are used as vegetable and the pulp makes delicious dish.

17. The fruit pulp of Imli is used for souring the curries and also have served medicinal qualities.

18. In Sahjan, the immature fruits are used for vegetable and pickeling and ripe ones are used in the preparation of special dish (Sabhar).

19. The mature seeds of Sahjan on germination produce radish like roots which are used in the preparation of pickle.

20. Kareel and Mahua can be grown in acute alkaline soils.

21. The Kareel wood is very heavy and hard which is commonly used in fabrication of agricultural implements.

2. Importance of unexploited leafy vegetables: Besides major leafy vegetables like spinach, fenugreek, sarson and kulfa, there are 22 more species which provide leaves, petioles and twigs as green vegetable, the details of which have been given in **Table-2.**

Table-2: Details of 22 plant species which are used as source of vegetable

S. No.	Hindi/Local name	English name	Botanical name	Family	Leaves and twigs as vegetable	Other uses/qualities
1	Basna Bak and Agastoya	Agati Sesbania	*Sesbania grandiflora* L.	*Papilionaceae*	Flowers, fruits and tender leaves	1.Plant is used as suppo and betel vine 2.Used as shade and wi 3.Leaves are used as foo
2	Makhana, Kakwagi and Thargigiojdi	Gorgan nut	*Euyale ferix*	*Euyalaceae*	Young leaves, petioles, fruits and seeds	1.Seeds are roasted and eaten 2.Used in religious cere
3	Patsan and Ambari	Bimlipat an jute, Kenaf and Mesta	*Hibiscus cannabinus* L.	*Malvaceae*	Tender leaves, shoots and fruits	1.Source of fiber 2.Used as paper pulp 3.Seed oil is used for bu 4.Seed cake is used as cattle feed a making
4	Dudhia kalmi	Moon flower	*Ipomea alba*	*Convolvulaceae*	Leaves and fleshy calyces	Fragrant night blooming
5	Ghiabato Boota	-	*Ipomea criocarpa* L.	*Convolvulaceae*	Leaves and stem	-
6	Nari	-	*Ipomea*	*Convolvulace*	Young terminal	-

			aquatica	*ae*	shoots and leaves	
7	Kalmi sag, Sarmali, Gandhian	Swamp cabbage, water spinach	*Ipomea replance* L.	*Convolvulaceae*	Young leaves and shoots	Vines are used as cattle
8	Ban kalmi	-	*Ipomea sepiaria* L.	*Convolvulaceae*	Whole plant	-
9	Michai	-	*Ipomea turbinate* L.	*Convolvulaceae*	Flower, pedicel	-
10	Khesari	Grass-pea, chickling pea, Jarosse	*Lathyrus sativus* L.	*Paplionaceae*	Foliage twigs	1.Foliage is used as catt 2.Grains are used as pul
11	Kasari	Grass pea	*Lathyrus nudicandis*	*Compositae*	Leaves are used in curries	1.Plant is used for fodde 2.It is used for making s
12	Poi	Indian spinach	*Basela alba*	*Basellaceae*	Leaves	It is rich in calcium, pho oxalate
13	Khersa culfa	Purslane	*Porchulaca eleracea*	*Porchulaceae*	Leaves and twigs	1.Rich in protein, vitam 2.Used for treatment of liver diseases 3.Blood purifier
14	Bathua	Chenopod, pig weed, limbs quarters	*Chinopodium album*	*Chinopodiaceae*	Leaves and tender twigs	1.Used as fodder 2.Rich in iron and prote
15	Sabji jute pat and tilapat nercha	Vegetable jute, white jute	*Corchorus capsularis* L.	*Tiliaceae*	Leaves	1.Rich in protein (18-22 carotene 2.It is rich source of fibe
16	Har farauri	Star gooseberry	*Phyllanthus acidua* L.	*Euphorbiaceae*	Leaves and fruits	1.Bark is used as tan 2.Used as fodder 3.It has medicinal value
17	Kusum	Safflower	*Carthamus tinctorious* L.	*Compositae*	Tender leaves and twigs	1.Flowers are used as dy 2.Seeds yield edible oil 3.Oil is used in soap, pa 4.Oil cake is used as cat

18	Kuttu	Buch wheat	*Fagopyrum esculentum*	*Polygonaceae*	Tender leaves and shoots	1.Grains are mixed with millets. The product is fasting 2.The husks are used for pillows
19	Jangali palak, Lal bibi, Khatti palak, amrule and ambarch	-	*Rumex dentatus*	*Polygonaceae*	Tender leaves	1.Roots are source of re 2.Rich in calcium, carot vitamin C
20	Amloo, lemon hoo	Mountai n sorrel	*Oxyriya dygina*	*Polygonaceae*	Leaves	It is good source of calc vitamin C
21	Chakwat	Orach	*Atriplex hortensis*	*Chinopodiace ae*	Leaves and branches	1.Leaves are rich in prot minerals 2.It has medicinal qualit
22	Makoy	Black night shade	*Solanum nigrum* L.	*Solanaceae*	Tender twigs and leaves	1.It cures dropsy disease 2.Ripe fruits are edible

In this category the major source of vegetables belong to families *Convolvulaceae* and *Paplionaceae*. The importance of this source of vegetable is given below:

1. In general, paplionaceous source is comprised of floral buds, flowers, leaves, tender twigs, fruits and green seeds.

2. The Leguminaceous source enriches the soil with nitrogen through atmospheric fixation.

3. The *Agethi sesbania*, besides providing grains for vegetable, is also used as support for pepper and betel vine, shade and wind break for orchards,

etc.

4. Makhana is a typical source of vegetable where young leaves, petioles, fruits and seeds are used as greens. The seeds are popped and are used in religious ceremonies.

5. Patsan and jute are useful source of fiber, besides leaves and fruits being used as vegetable.

6. Buck wheat which is a source of vegetable also provides grains, the substitute for cereal flour.

7. Jungli palak and mountain sorrel are rich in vitamin C.

8. Bathua is rich in iron, mineral and protein provides nutritious fodder also for cattle.

9. Safflower provides dye and also has medicinal quality for curing diabetes.

10. Most of the leafy vegetables are rich source of vitamins and minerals.

3. Importance of legume vegetables: There are 6 legume vegetables which belong to *Paplionaceae*family, the details of them have been given in **Table-3.**

Table-3: Details of legumes which are used as vegetable

S. No.	Hindi/Local name	English name	Botanical name	Plants as vegetable	Other uses/qualities
1	Chaudhari phalli, Charkori sem	Goa bean	*Psopocarpus tetragonolubus* L.	Tender pods and tuberous roots, flowers, sprouts	Grown as green manure, cover and fodder crops
2	Sanai, Jhunjhuna, Sum	Sunnhemp	*Crotalaria juncea*	Flowers	1.Stem fiber is used for various purpose 2.Stem fiber is used for cigarette and tissue paper 3.Green stem and leaves make green manure 4.Seed contain about 15% gum 5.It fixes nitrogen in the soil
3	Bakla	Broad bean, Windsor bean	*Vicia fava* L.	Fruits and seeds	1.Grown for fodder and hey 2.It fixes nitrogen in the soil
4	Kiwach Alkusi	Welvet bean and Horse eye bean	*Mucuna prusiana* L.	Fruits	1.Pods, seeds and roots have medicinal value 2.Rich in vitamin A and protein 3.It contains aldopa which is used in curring Perkinson disease 4. It fixes nitrogen in the soil
5	Bara sem, Makkhan sem	Sword bean	*Canavalia fadiata* L.	Pods (fruits), green seeds, flower, leaves	1.Used as green manure and cover crop 2.Fixes nitrogen in the soil
6	Bara sem	Horse	*Canavalia*	Pods and	1.Used as forage purpose

		bean, Jack bean, gotani bean and over look bean	*ensifermes* L.	immature seeds	2.Acts as cover crop 3.Flowers and young leaves are used as condiment 4.Used as green manure crop 5.Roasted seeds are used as substitute of coffee

1. All the legume vegetables belong to legume family which is characterized by fixing the atmospheric nitrogen in the soil.

2. Most of legume vegetables serve as green manure crops.

3. They also provide nutritious feed and fodder for cattle.

4. Some of them serve as cover crop, thus check soil erosion.

5. Sunhemp, besides being used as source of vegetable, provides stem fiber.

6. Kiwach is very rich source of minerals, vitamins and protein. It also contains aldopa which cures Perkinson disease.

7. In jack bean, the seeds are used as substitute of coffee.

4. Importance of cucurbitaceous vegetables: This is a very big source of vegetables (11) which belongs to the family *Cucurbitaceae.* All these

vegetables grow in dry part of the country during rainy season, the details of which have been given in **Table-4.**

Table-4: Details of cucurbitaceous vegetable source

S. No.	**Hindi/Local name**	**English name**	**Botanical name**	**Plant part used as vegetable**	**Other uses/qualities**	**G se**
1	Ban karela, kakrol, kakora	Spine gourd	*Momordica cochinachinesis* (Roxb.)	Fruit	Cures diabetes	R (S O di pl
2	Kundru, kanduri	Kovai fruit and Ivy gourd	*Coccinia indica,C.grandish, C.cordifolia*	Fruit, tender leaves and twigs	1.Juice from leaves and roots is used in diabetes 2.Rich in iron, phosphorus, minerals and carotene	A sp sh co
3	Amantmul, kundri,Bam	Melothria	*Melothria hetrophylla*,	Leaves, twigs and	1.Itis rich in calcium and other minerals	Pr cl

	kurteen		*Solena hetrophylla*	tuberous roots	2.Cures diabetes 3.Juice is used in injuries and wounds	
4	Launku	Chayote, chocho and christophine	*Sachium edule*	Fruits, tender leaves, twigs and tuberous roots	1.Leaves are rich in vit A,B,C, calcium, iron 2.Leaves are used as fodder 3.Stem fiber is used in basket making	T cl pe m vi
5	Thumba	Colocynth	*Citrullus colocynthis*	Bitter fruits are used as salad and pickle	1.Dry seeds are made in to floor 2.Seed contains 16% oil	P m pl
6	Phoot and kachra	Snap melon	*Cucumis melo var. momordica*	Immature fruit	1.Ripe fruits as dessert 2.Seeds are useful in confectionary	A R tr
7	Kacharia, petha, sendha	Kachra	*Cucumis cellosus*	Fruits	1.Used in chatni, salad, pickle 2.Fruits are cut in pieces and dried which are used during off season	A R m pl
8	Meetha karela	Achocch a	*Cyclathera pedata* L.	Fruits, tender twigs and leaves	Used as salad and ripe fruits are useful in pudding	A cl cu
9	Lupha jugali karela	Balsom apple	*Momordica balsami*	Fruits, leaves, and tuberous roots	1.Fruits are used for petha 2.Leaves are good source of vit.C	A he vi
10	Kumra, villaiti kaddu	Pumpkin and marron	*Cucubita pepo*	Fruits, flowers, growing tender twigs	-	A
11	Ghia torai	Vegetable sponge	*Luffa aegyptiaea*	Immature fruits and unopened flower buds	1.Dried fruits yield fibrous structure which is widely used in fabrication of articles 2.Fibrous sponge is used in scrubbing the utensils	A tr

1. All the minor vegetables belong to the family *Cucurbitaceae.*

2. Most of the plant species are monoecious (male and female flowers appear on the same plant).

3. One of these cucurbits (kakora) is dioiceous (where male and female plants are separate).

4. In both of the plant species the cross pollination is effected by the insects.

5. Mostly green and unripe fruits are used as vegetable.

6. In sponge gourd the flower buds are used as vegetable.

7. In pumpkin group of cucurbits the tender growing twigs and flowers are used as vegetable.

8. The sponge of fruits of sponge gourd is used in making mat, hand fan and sponge for cleaning the utensils.

9. In snap melon the mature fruits are used as vegetable and ripe ones form delicious dish.

10. Kakora and kundru are useful for curing diabetes.

11. The seed of snap melon are used in confectionary.

12. The unripe fruits of kachri are cut in to pices and dried and stored for off-season use.

13. Most of these cucurbits are rich some of vitamin C.

5. Importance of tuber and corm/rhizome vegetables: This group includes kamal rhizomes and arvi (Ghuinya). Both are starchy

vegetables. The details of which have been given in **Table-5.**

Table-5: Details of rhizome and corm vegetables

S. No.	Hindi/Local name	English name	Botanical name	Family	Plant part used as vegetable	Other uses/qualities
1	Kamal, Kanwal	East Indian lotus, Sacred lotus	*Nelumbo nucifera, Nymphoea nelumbo*	*Nelumbonaceae*	Rhizomes, seed and young leaves	Fragrant flowers are mu garlands and used in e
2	Arvi	Arum lily common balla	*Zantedeschia aethiopica*	*Araeceae*	Young leaves and petioles	Poultice of leaves is use wounds and sores

1. In Kamal (lotus) rhizomes, seeds and young leaves are used as vegetable.

2. In lotus the flowers are scented and thus are used for decoration and worship.

3. The juice of lotus leaves are used for curing desyntry and diarrhoea.

4. In arvi, young leaves, petioles and corms are used as vegetable.

5. Poultice of arvi leaves is used in burns, sores and wounds.

6. Miscellaneous vegetables: This group of vegetables belong 15 different families and is grown in different ecologies, the details of which have

been given in **Table-6.**

Table-6: Details of different plant species used as vegetables

S. No.	Hindi/Local name	English name	Botanical name	Family	Plant part used as vegetable	Other uses/qualities
1	Singhara	Water chest nut	*Trapa bispinosa T. quadrispinosa*	*Trapaceae*	Immature kernels are used as vegetable.	1.Mature and dried kerne used as cereal meals 2.Kernels are rich in calc starch
2	Bans	Thorny bamboo, Spiny bamboo	*Bambusa arundinacea* (Retz.) *B.spinosa*(Rox b.)	*Bambusaceae*	Young buds, tender suckers/stem	1.Culms are used for mak paper, thatching. 2.Young stems are used f pickling. 3.Grains are consumed as 4.Kernels are rich in calc
3	Vrakshiya tamatar	Tree tomato	*Cyphonandra betacea*	*Solanaceae*	Fruits	Jam and jelly is prepared juice
4	Teet baingan	Tit baigan	*Solanum torvum*	*Solanaceae*	Fruits	1.It cures cough 2.It dissolves the blood c snake bits

1. Water chestnut is aquatic herb which grows in ponds, lakes, tanks and other water bodies through ripe fruits or vines. These immature fruits are used as vegetable. The dried kernels of mature fruits are ground and the resulting flour is used as substitute of cereal flour. It is very rich in calcium and starch.

2. Thorny bamboo is perennial tall woody grass. The young buds, tender suckers are used as vegetable. The tender stem is also pickled. The stems are used for making paper, grains are consumed as cereal. The culms are also used as thatching material.

3. Tree tomato is a perennial tree of *Solanaceae* family. The fruits are used as vegetable and juice is used in the preparation of jelly and jam.

4. Tit baigan is a spiny shrub/herb, the fruits of which are used as vegetable. It has immense medium uses. It cures cough. The juice dissolves blood clots in snake bite.

Exercise-14

Object- Inlist of different plant species used as vegetable.

Details of plant species used as vegetable

S.No.	English name	Hindi/vernacular name	Botanical name	Family	Plant part used as vegetable/other uses
1	Okra, Lady's finger	Bhindi	*Abelmoschus esculentus* L.	*Malvaceae*	1.Tender fruits as vegetable 2.Seeds contain 20% edible oil 3.Mucilage from stem is used for cleaning of juggery
2	Leek	Vilayti lahsun	*Allium porrum* L.	*Alliaceae*	Stout stem is used as vegetable
3	Onion	Pyaj	*Allium cepa* L.	*Alliaceae*	Immature and mature bulbs are used as vegetable
4	Giant Taro	Munkanda	*Alocasia cucullafa*	*Araceae*	Stem rhizomes are used as vegetable
5	Large Taro	Banda	*Alocasia indica*	*Araceae*	Stem rhizomes are used as vegetable
6	Taro	Banda	*Alocasia macrorrhiza*	*Araceae*	Corms are edible
7	Amaranth	Chaulai	*Amaranthus blitum*	*Amaranthaceae*	Leaves are used as vegetable
8	African Spinach	Ramdana	*Amaranthus cruentus*	*Amaranthaceae*	Whole plant is used as vegetable
9	Prickly amaranth	Kateli chaulai	*Amaranthus spinosus*	*Amaranthaceae*	Used as vegetable
10	Elephant foot yam	Suran, Zimikand	*Amorphophallus companulatus* Roxb.	*Dioscoriaceae*	Corms are used as vegetable
11	White yam, Greater yam	Khamalu	*Dioscoria alata* L.	*Dioscoriaceae*	Tubers are used as vegetable
12	Potato yam	Ratalu, gainthi	*Dioscoria bulbifera*	*Dioscoriaceae*	Aerial bulbs are eaten as vegetable
13	Lesser yam	Suthni	*Dioscoria esculenta* Roxb.	*Dioscoriaceae*	Tubers are used as vegetable
14	White mustard	Safed rai	*Brassica alba*	*Cruciferae*	Tender shoots and leaves are used as vegetable
15	Kale	Karam saag	*Brassica oleraceae var. acephala*	*Cruciferae*	Young shoots and leaves are used as

					vegetable
16	Cauliflower	Phool gobhi	*Brassica oleraceae var. botrytis*	*Cruciferae*	Immature inflorescence is used as vegetable
17	Cabbage	Band/patta gobhi	*Brassica oleraceae var. capitata*	*Cruciferae*	Head is eaten as vegetable
18	Yellow sarson	Sarson	*Brassica campestris var. sarson*	*Cruciferae*	Tender shoots and leaves are used as vegetable
19	Rape	Kali sarson	*Brassica nigra*	*Cruciferae*	Leaves are used as vegetable
20	Brussels' sprouts	Buttan gobhi	*Brassica oleraceae var. gemmifera*	*Cruciferae*	Young shoots, buds and leaves are used as vegetable
21	Knol khol	Ganth gobhi	*Brassica oleraceae var. caulirapa*	*Cruciferae*	Swollen stem is used as vegetable
22	Turnip	Shaljam	*Brassica rapa* L.	*Cruciferae*	Swollen roots are eaten as vegetable
23	Taro	Arvi	*Colocasia esculenta* L.	*Araceae*	Tubrous rhizomes and young leaves are used as vegetable
24	Red pumpkin	Sitaphal	*Cucubita maxima*	*Cucurbitaceae*	Fruits are used as vegetable
25	Squash	Meetha kaddu	*Cucurbita moschata*	*Cucurbitaceae*	Fruits are used as vegetable
26	Pumpkin	Vilayti kaddu	*Cucurbita pepo* L.	*Cucurbitaceae*	Fruits are used as vegetable
27	Cluster bean	Guar	*Cyamopsis tetragonoloba* L.	*Paplionaceae*	Green pods are eaten as vegetable
28	Sweet gourd	Meetha karela	*Cyclanthera pedata*	*Cucurbitaceae*	Fruits are used as vegetable
29	Carrot	Gajar	*Daucus carota*	*Umbelliferae*	Roots are used as vegetable and fodder
30	Lettuce	Salad	*Lectuca sativa* L.	*Compositae*	Tender leaves are used as salad
31	Bottle gourd	Lauki	*Lagenaria siceraria* L.	*Cucurbitaceae*	Tender fruits are used as vegetable
32	Ridge gourd	Kali torai	*Luffa acutangula* Roxb.	*Cucurbitaceae*	Tender fruits are used as vegetable
33	Sponge gourd	Ghia torai	*Luffa aegyptiaca* L.	*Cucurbitaceae*	Tender fruits are used as vegetable
34	Tomato	Tamatar	*Lycopersicon esculentum*	*Solanaceae*	Ripe fruits are used as vegetable

					and several preparation
35	Bitter gourd	Karela	*Momordica charantia* L.	*Cucurbitaceae*	Fruits are eaten as vegetable
36	Spine gourd	Ban karela	*Momordica dioca*	*Cucurbitaceae*	Fruits are eaten as vegetable
37	Small bitter gourd	Jangli karela	*Momordica dioca*	*Cucurbitaceae*	Fruits are eaten as vegetable
38	Velvet bean	Kiwanch	*Mucuna cochinchinensis*	*Paplionaceae*	Fruits are eaten as vegetable
39	Parsley	Parsley	*Petroselinum sativum* L.	*Umbelliferae*	Leaves are used as vegetable/salad
40	Goa bean	Chardhari phalli, pankhiya sem	*Psophocarpus tetragonolobus*	*Paplionaceae*	Pods are eaten as vegetable
41	Red tail radish	Sengari	*Raphanus candatus* L.	*Cruciferae*	Fruits are used as vegetable
42	Radish	Mooli	*Raphanus sativus* L.	*Cruciferae*	Entire green plant is used as vegetable

Exercise-15

Object-Inlist of national/state seeds corporations in India.

S.No.	Name of S.S.C.	Address	Mob./Tel. no.
1	National Seeds Corporation Ltd.	Beej Bhawan, Pusa Complex, New Delhi-110012	011-25842672
2	West Bengal State Seeds Corporation Ltd.	Gangadhar Babu Lane, Bow Bajar Calcutta-700012	033-223275591
3	Rajasthan State Seeds Corporation Ltd.	Pant Krishi Bhawan, Janpath, Jaipur-302005	0141-2227514
4	Orissa State Seeds Corporation	Sawantarapura, Old Town, Bhubaneshwar-751002	086-37299872
5	Karnataka State Seed Corporation Ltd.	Beej Bhawan, Bellary Road, Hebbal, Bangaluru-560024	080-23415652
6	Punjab State Seed Corporation Ltd,	SUO-835-36, Udyog Path, 17G-228, Sector-22, Chandigarh-160022	0172-2701582
7	National Seeds Corporation	1711, Tuka Ram Gate, Lalaguda, Secundrabad-500017	040-27731152
8	Gujarat State Seeds Corporation Ltd.	140/107, Raj Viraj Complex, Besides, Gujarat Furniture, Dharbar Road, Bhakti Nagar, Rajkot-360002	281-2222688
9	Maharashtra State Seeds Corporation Ltd.	55, Trusrobkeshur Road, MIDC Area, Cotpur Colony, Nasik-422007	0253-2350749
10	Uttaranchal Seed and Tarai Vikas Nigam	Haldi, Udham Singh Nagar	
11	Haryana Beej Vikas Nigam	Chandigarh	
12	A.P. State Seeds Corporation Ltd.	Hyderabad	
13	Bihar State Seeds Corporation Ltd.	Patna	
14	Assam state Seeds	Guwahati	

	Corporation Ltd.		
15	M.P. State Seeds Corporation Ltd.	Bhopal	
16	U.P. State Seeds Corporation	Lucknow	
17	State Farms Corp. of India	14-15, Nehru place, New Delhi	
18	National Horticulture Research and Development Foundation.	Nasik, Maharashtra	

Exercise-16

Object-Inlist of seed certification agencies.

S.No.	Name of S.S.C.A.	State	Address	Mob./Tel.no.
1	A.P. State Seed Certification Agency	A.P.	House no.5-10-193, Ist Floor, HACA Bhawan, Opp. Public Garden, Hyderabad-500004	040-23237016/23235939
2	Assam State Seed Certification Agency	Assam	Dr.B.K. Koskoti Road, Ulubari, Guwahati-81007	
3	Bihar State Seed Certification Agency	Bihar	Tranquality riding Road, Sheikhupura, Patna-800014	
4	Chhattisgarh State Seed Certification Agency	Chhattisgarh	Indira Gandhi Agricultural University Campus, Krishi Nagar, Raipur-492006	
5	Seed Certification unit, Delhi Administration	Delhi	Room No. 526, Old Civil Supply Building, New Courts, Tis Stazuri, Delhi-110004	
6	Gujarat Seed Certification Agency	Gujarat	Outside Shalipur Gate, Opposite Krishi Chambers, Narian Kings, Ahmedabad-380001	
7	Haryana Seed Certification AGency	Haryana	SCO1038-39, Seed.22B, Chandigarh-160020	
8	H.P. State Seed Certification AGency	H.P.	Nalagarh House, Shimla-171005	

9	Seed Certification Wing, Deptt. of Agriculture, Jammu Division	Jammu	Talab tilloo, Jammu	
10	Seed Certification Wing, Deptt. of Agri., Kashmir Divison	Kashmir	Lal Mandi Post Office, Jawahar Nagar, Srinagar	
11	Karnataka State Seed Certification Agency	Karnataka	K A I C Premises, Opposite Baptist House, Bellary Road, Hebbal, Banglore-560024	08023419481 2345505
12	Deptt. of Seed Certification, D. of Agriculture.	Kerala	Directorate of Agriculture, Vikas Bhawan, Trivantpuram 647041	
13	M.P. State Sed Certification Agency	M.P.	HIG/A-7, BDA Colony, Near 1250 Hospital, Tulsi Nagar, Bhopal - 462003	
14	Maharashtra State Seed Certification Agency	Maharashtra	Import of Nilkanth Cotton Mill NH6, Muzaffarpur Road, Shivani, Akbla-444005	
15	Brissa State Sed Certification Agency	Orissa	Cold Storage Campus, Samomtrapur Bhubaneshwar-751002	
16	Punduchery State Seed Certification Agency	Punducherry	New Light House Road, Vamba Keqrapur, Punduchary-605001	
17	Punjab State Seed Certification Authority.	Punjab	SCO-837, Sector -224 Chandigarh-160022	
18	Rajasthan Stte Seed	Rajasthan	3rd Floor, Pant Krishi	

	Certification Agency		Bhawan, Janpath Jaipur-302004	
19	Seed Certification Wing	Sikkim	Deptt. of Agircultgure, Govt. of Sikkim, Gangtok-237101	
20	Deptt. of Seed Certification	Tamilnadu	1424-A, Thadagam road, GCT Post Office, Coimbatore 641013	
21	U.,P. STate Seed Certification Agency	U.P.	A-284, Sect.5, Indira Nagar, Lucknow.	
22	SW.B. State Seed Certification Agency.	W.B.	238, Netaji Subhashchandra Road, Kolkatta	

Exercise-17

Object- Inlist of top vegetable seed industries in India.

S.No.	Name of company	Address
1.	Adventa India Ltd.	309 3rd Floor, Rheja Chambers, Mauseum Road. Banglore 560001 Tel.: (080) 5594524 Fax: (080) 5594525
2.	Ankur Seeds Pvt. Ltd.	27, New Cotton Market Layout, Opp. Bus Station, Nagpur- 440018 Tel.: (0712) 726148 Fax: 723455
3.	Bejo Sheetal Seeds Pvt. Ltd.	A-3, Old MIDC Jalna, Maharashtra – 431203
4	Century Seeds Pvt. Ltd.	B-A 22-24, Phase II Mangolpuri, Industrial Area, Delhi-110034 Tel.: (011) 7019890, 7017061 Fax: 7017568
5.	Ganga Kaveri Seeds Pvt. Ltd.	Suit- 1406-1407, Babu Khan Estate, Bashir Bagh, Hyderabad- 500001 Te.: (040) 242450, 242451 FAX: 233418
6.	Heritage Seeds Pvt. Ltd.	201, Luse Towe,r Azadpur, Delhi- 110033 Tel.: 7433355, 7228935
7.	Indo- Americon Hybrid Seeds (India) Pvt. Ltd.	Po. Box No. 7099, 17th Cross 2nd A Main, K.R. Road, B SK 2Nd Stage, Bangalore- 560070 Te.: (080) 6650111 Fax: 6650479
8.	Kaveri Seed company	206/6 Nagama gowda Bldg. old Hospital Road, Davengere, Bangalore

9.	Krishidhan Seeds Pvt. Ltd.	Royal House, 11/3 Usha Ganj, Indore India- 452001, MP
10.	Namdhari Seeds (P) Ltd.	119, Arasappa Complex 9th Main Road, Ideal House, Raj Rajeshwari Nagar , Bangalore- 560039 Tel.: (080) 2210987 Fax: 8602168
11.	Nath Seeds	Nath House, Nath Road PB No. 318, Aurangabad – 431005 Tel.: (0240) 333313/14 Fax: 33118
12.	Nuziveedu Seed Pvt. Ltd.	NSL ICON, 4th Floor ,Road No 12, Banjara Hills Hyderabad – 500037
13.	Rassi Seeds	Door No. 8-3-105/5, Bawanpally, Hyderabad-500011 Tel.: 40158, 40458 Fax: 41558
14.	Shri Ram Bio Seeds Genetics (1) Ltd.	510, 5th Floor Raghav B Block, Raghav Ratan,, Hyderabad- 560001 Te.: (040) 5717442 Fax: (040) 5781182
15.	Pro- Agro Seed Complex Ltd.	A-311, Ansal Chamber No. 1,3 Bhikaji Cama Place, New Delhi- 110066 Tel.: (011) 6191163 Fax: 6192084
16.	Sungu Seeds Pvt. Ltd.	207, Aradhana Bhawan, Azadpur, Delhi- 110033 Tel.: (011) 7133045
17.	J.K. Agri-Genetics	20, Paigah Colony, behind Anand Theater , S.P. Road

		RVP (HS), Secundrabad, Hyderabad -3 Tel.: (040) 843329 Fax: 840995
18.	Golden Seeds Pvt. Ltd.	B-22A, Block-B, Brigade NM, Building , KR Cross Yediyur, Bangalore- 560082 Tel.: (080) 6646764 Fax: (080) 6656742
19.	VNR Seeds	Block No. 1, Auto Nagar, Hyderabad- 500070
20.	Syngenta India Ltd.	1st Block 9th Floor, Suzvey No. 64/P & 79P, My Home Hub, Modhapur, Hyderabad- 500081
21.	Vibha Agro-Tech Ltd.	Plot No. 22, Huda Techno Enclove, Hitech city road, Madhapur, Hyderabad-500081
22.	Uniccorn Agro Tech Ltd.	1-7-139/3/ Paradise Secundrabad, Hyderabad
23.	Mahyco Seeds (Maharashtra Hybrid Seeds Co. Pvt. Ltd.)	Dowalwadi PB-76 Jalna-431203, Maharashtra Tel.: (02482) 236830
24.	Nunhems India Ltd.	No. 16, Sri Raman Janeya Complex, 1st A Main Canara Bank Road, New Town Yelanka Bangalore – 560064 Tel.: (080) 50797979
25.	Novartis India Seeds Division	Seed Division-Seed Hose, 1170/27 Revenue Colony, Shivaji Nagar, Pune-335803 Tel. (020) 5539311-13 FaxL5537571

Exersice-18

Object- Identification of popular hybrids of private sector.

S.N.	Crop	Hybrids
1.	Tomato	Lyco, US-304, Lakshmi, Dilver, 9802, Pusa Hybrid 1 & 2, Karnataka Hybrid, Lerica, Vaishali, JKTH-3055,NUN-7730, Madhuri, Naveen
2.	Brinjal	Nav Kiran, Jambo, Suphal, HOE-404, ARBH-786
3.	Chilli	CH-1, Sholdeir, Blaze, VNR-305, Agni, NS-1101, HOE-808
4.	Capsicum	Lario, Indira, Bombay, Picadore, Bharat, Early Bonty, Hira
5.	Cabbage	Shatabdi, Golden, Green Globe, BC-64, 73, Small Wonder, Saurabh, Gaurav, Ascent, Cabbage NO.-8, Hari Rani Gol, Ganga, Yamuna, Kaveri, Meenakshi, Geetanjali, Keertiman, Bahar, Sumit, Bharti, Bajrang, BSS-32, Nath-401, 501, Kalyani, Sri Ganesh Gol
6.	Cauliflower	Snow Crown, BSS-18, NS-60& 90, Summer King, SYCFH-202
7.	Okra	Avantika, Syngenta-152, Namdhari-180, M-64, Slender, Varsha, Snehal, Vijay, Vishal
8.	Bottle gourd	Reena, Nutra, Varadh, Sarita, Kaveri, Savita, Sarda.
9.	Pumpkin	Sumo, Thunder Ball MPH-1, 2 & 4.
10.	Sponge gourd	Namdhari-4414,442, Nutan
11.	Bittergourd	NBGH-167
12.	Cucumber	Malini, Raisy & Harmoney, Hybrid No.-1

Exercise-19

Object- Introduction of some great contributors of Indian agriculture.

Dr. B.P. Pal, the Director on Imperial Agricultural Research Institute, now Indian Agricultural Research Institute (IARI) and the first Director General of Indian Council of Agricultural Research (ICAR), was pioneer in rose breeding and the father of development of N.P. (New Pusa) series of wheat made significant contribution in the development of rust resistant, tall wheat varieties.

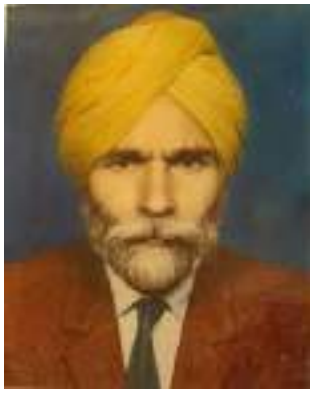
B.P. Pal (1906 – 1989)
Rose and wheat breeder

Dr. M.S. Swaminathan, who succeeded Dr. Pal as second Director General of ICAR, served several Internationl Agricultural Research Organizations, including International Rice Research Institute, Philippines. He strengthened ICAR by establishing several crop based research institutes and All India Coordinated Crop Improvement Projects. Dr. Swaminathan is the father of wheat revolution in India by introducing and developing dwarf varieties of wheat. He established Swaminathan Research Fondation in Chennai. At the age of 96 years he is still active in agricultural activities.

M.S. Swaminathan
Father of wheat revolution in India &
Chairman of Swaminathan Foundation

Padamsri Dr. Har Bhajan Singh was pioneer in introducing germplam of crops, more so of vegetables. For his interest in introduction, a separate division “Plant Introduction” was created at IARI, New Delhi which was later on upgraded to National Bureau of Plant Genetic Resources

(NBPGR). Dr. Singh is credited with large number of vegetable varieties like okra “Pusa Sawani”, brinjal “Pusa Purple Long” and “Pusa Purple Round”.



Dr. Har Bhajan Singh (1914 – 1974)
Father of Plant introduction

Indian Agricultural Research Institute: The chronology of development of Indian Agricultural Research Institute was that it was established as Agricultural Research Institute (ARI) at Pusa, Bihar in 1905 with five sections (Agriculture and cattle breeding, chemistry, economic botany, entomology and mycology). The institute was renamed as the Imperial Agricultural Research Institute in 1919. The main building at Pusa was damaged by a major earth quake erupted in 1934. Then the institute was shifted to New Delhi and formerly opened on November 1935. Later (1947) the institute was renamed as Indian Agricultural Research Institute (IARI) which covers an area of 500 hectares. This institute was conferred with the status of a “Deemed to be University” by the University Grant Commission in 1958. The institute has inherited a great tradition of agricultural research which goes back to the work of Leather in agricultural chemistry, of Butler on fungi, of Maxwell-Lather and Fletcher in cataloguing the insect pests and Howards in the breeding new and improved strains of crop plants, including the early Pusa wheats. The Institute has bigger library in India with 150000 books and receiving more than1000 scientific journals and periodicals.

An old building (Pusa) and new building (New Delhi) of IARI

Dr. T.S. Venkataraman: Imperial Sugarcane Institute, Coimbatore, established in 1912, now Sugarcane Breeding Institute, conducts research on the botanical, cytological, physiological, chemical, mycological and entomological aspects of sugarcane cultivation. Dr. T.S. Venkataraman was pioneer in developing thick sugarcane varieties, Paunda or ganna (noble cane) by using *Saccharum spontaneum* (Kans grass). He is an authority in developing sugar industry in the country. He is famous for noblization of sugarcane.

T.S. Venkataraman (1884 – 1963)
Father of noble cane

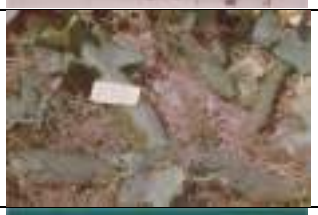
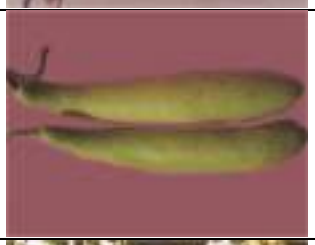
Exersice-20

Object- Identification of varieties developed from Department of vegetable science, C.S.A.Uni. of Ag. & Tech. Kanpur.

Kalyanpur Type-3 Plants are semi spreading, tall, green, leaf small, calyx green tight, fruits are light in weight, purple, round, less seedy and better self life. The yield potential is 250-300 q/ha.	
Azad B-1 Round fruited, plant dwarf, upright, compact, vigorous, 60-70 cm in height suitable for north region of Uttar Pradesh, tolerance to phomopsis blight and fruit rot. The yield potential is 300-350 q/ha.	
Azad B-2 Plants of round fruited brinjal are erect and long term bearing. Fruits are bright purple, light in weight, 15-20 fruits/plant and fruit weight 125-130 gm, resistant against phomopsis and fruit rot, yield 350-400 q/ha.	
Azad B-3 Plants are erect, early bearing, dark green foliage. Fruits are long cylindrical, shining purple, bottom end splash to white, fruit weight medium 60-70 gm, yield potential 400-450 q/ha.	
Azad B-4 Medium tall plant, erect and compact, first picking after 55-60 DAT, fruits round, light purple with green calyx, resistant to phomopsis blight, flesh firm, long self life, yield potential 300-400 q/ha.	
Azad Kranti Fruits long, smooth, dark purple, calyx green,and fruiting prolific, fruiting after 55-60 DAT, yield potential 300-350 q/ha.	

Azad Hybrid Plants medium, tall having purple bright colour, calyx green, and long terms fruit bearing, fruits round, bright deep purple, soft flesh, resistant against shoot borer and average fruit weight 190-200 gm, more number of fruits per plant, yield potential 500-600 q/ha.	
Angoorlata Indeterminate plants, height after staking 240-260 cm and 140-150 cm without staking, 4-8 bunches of fruits per plant, good keeping quality due to less juicy and tight epicarp. Fruit medium in size, oblong, red at maturity, moderately heat tolerant and resistant to root knot nematodes and leaf curl mosaic, cropping period 100-105 days, suitable for late sowing and kitchen garden, average yield450-550 q/ha.	
Kalyanpur Type-1 Plants are highly develop, branched, high fruiting, fruit round, red, beaked at the stigmatic end, medium, smooth, average fruit weght 50-60 gm and yield 250-300 q/ha.	
Azad T-2 Plants determinate, fruits red, round, small, more number of fruits/plant, average yield 300-350 q/ha.	
Azad T-3 Plants determinate, early fruiting, fruit compact, red round, bold, smooth, average fruit weight 90-100 gm and yield potential 400-500 q/ha.	
Azad T-5 Indeterminate plants, medium bearing, fruits red, round, bold, less seed, TSS 6-6.5, good shelf life, suitable for processing, average fruit weight 50-60 gm, fruit ripe after 55-60 DAT, yield potential 400-450 q/ha.	
Azad T-6 Early, long term fruiting on determinate, bushy plants profuse branching, fruits round, red, smooth, medium in size, suitable for rabi crop, average fruit weight 50-60 gm and yield 450-500 q/ha.	

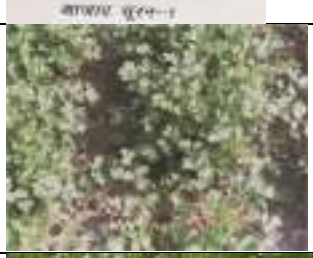
Azad T-8 Detreminate, plant compact, leaf curved in wards, 50-60 fruits/plant, 5-9 fruits /cluster, medium oval, red at maturity, maturity in 80-90 DAT, 500-600 q/ha.	
Kalyanpur Tomato Hybrid-1 Plant determinate, fruits oval in shape, red at maturity, 50-60 number of fruits per plant, yield potential 500-550 q/ha.	
Kalyanpur Tomato Hybrid-2 Plant indeterminate, having high production quality, fruits round in shape, red colour, average yield potential 500-550 q/ha.	
Azad Mirch-1 Plant dwarf, fruit erect, borne in cluster, 12-14 cluster per plant, 8-12 fruits per cluster, fruit length 5-6.5 cm, foliage dark green, fruits ripe after 75-80 DAT, average yield of red ripe fruits 50-70 q/ha.	
Azad Mirch-2 Attractive fruits, long,and smoothPlant dwarf, fruit erect, borne in cluster, 12-14 cluster per plant, 8-12 fruits per cluster, fruit length 5-6.5 cm, foliage dark green, fruits ripe after 75-80 DAT, average yield of red ripe fruits 50-70 q/ha.	
KCH-3 Plant height medium, bushy, branched, leaves light green, suitable for pickle, fruit length 7-9 cm, straight, distal end pointed, slightly pungent, more number of fruits per plant, average red ripe yield 100-125 q/ha.	
Kalyanpur Hari Chikni Early, fruit long, smooth, dark green, distal end pointed, suitable for rainy season, yield 175-200 q/ha.	

Azad Torai Chikni-1 It is early group variety, plants long trailing climber and spreading in nature, flowering early (36-40 days), early growth vigorous, fruits long uniform, less thickness, green and smooth, resistant to powdery and downy mildew, suitable for rainy season, yield potential 150-200 q/ha.	
Azad Torai-2 Early group variety, plants long climber and spreading in nature, fruits medium in size, light green and smooth, profuse fruiting, suitable for rainy as well as summer season, yield potential 140-160 q/ha.	
Kalyanpur Long Green Spreading type vines, fruit long, smooth, green, tender, blossom end semi round, homogenous fruit size, suitable for rainy season, yield 250-300 q/ha.	
Azad Harit Spreading type vines, fruits long, light green, cylindrical, smooth, 15-20 fruits per plant, yield 300-350 q/ha.	
Azad Nutan Early maturing variety, less spreading plants, fruits green, medium in size (35-40 cm), smooth, cylindrical, average fruit weight 800-900 gm, marketable fruits ready at 55-60 DAS, moderately resistant to powdery mildew, suitable for rainy season, yield potential 350-450 q/ha.	
Azad Sankar-1 Fruit early, long, average one feet long, cylindrical green, plant vines 3-3.5 m long, tasty and sweet after cooking, more number of fruits, yield 500-600 q/ha.	
Kalyanpur Baramasi It is high creeper with dark green stem, fruits long (20-25 cm), green, thin tapering and whitish at distal end, tolerant to mosaic and fruit fly, yield potential 100-125 q/ha.	

Kalyan Sona Fruit plump, dark green, suitable for stuffing, preferred for summer season, yield 125-150 q/ha.	
Azad Pumpkin Plants are climbers and spreading, leaves green and hairy, fruits in cluster, yellowish orange, less seed, spherical and medium in size, fruits are depressed at the both poles, moderately resistant to CMV, suitable for both season, yield 500-550 q/ha.	
Kalyanpur Green Plant nature is spreading type, early fruiting, fruit long, medium, thick, green, while brown at maturity. Most popular variety due to its shape size, colour and taste, suitable for rainy season yield 80-100 q/ha.	
KAG-1 Fruits white cylindrical, more fleshy and spongy, fruit length 25-30 cm, maturity in 125-130 DAS, suitable for rainy season, moderately resistant to wilt, yield 300-350 q/ha.	
Azad P-1 It is medium maturity variety, plants medium tall, branched, vigorous dark green foliage. Pods are medium in size (7.5-9 cm long), slightly curved at distal end, dark green and well filled. Seeds are medium in size, wrinkled with green and brown colour, first picking after 80 DAS, 7-8 seeds per pod, yield 90-100 q/ha green pods.	
Azad P-2 It is medium duration variety, plants tall in plant height, Pods are medium in length, light green, thick, smooth, 7-8 grains per pod with less sweetness, yield 80-90 q/ha green pods.	
Azad P-3 It is early duration variety, plants dwarf and straight, pods long, curved, green and well filled, seeds wrinkled with green colour, sweet, first picking after 60-65 DAS, 8-9 seeds per pod, most popular variety due to sweetness and earliness, yield 75-80 q/ha.	

Azad P-4 Plants medium in height and bearing, pods straight, small, light green, suitable for late sowing, resistant to powdery mildew, 5-6 grains per pod, suitable for cultivation in northern plains, yield 80-90 q/ha.	
Azad P-5 Plants medium in height, pods medium long, thick, well filled, late maturing variety and provide green pod up to March, suitable for cultivation in northern plains, yield 80-90 q/ha.	
Kalyanpur Type-2 It is pole type, stem light green, angular leaves, flowers clustered, pod white, broad, fleshy, flat, succulent, seed colour black, smooth and bold, popular for pickle purpose, moderately susceptible to mosaic and aphid, pod yield potential 200-250 q/ha.	
Azad Sem-1 Flowers white, 10-14 pods per bunch, resistant to YVMV, pod yield 125-130 q/ha.	
Rajni Stem colour purple in early stage, flower purple, pod dark green, thin, crescent shape, yield 150-175 q/ha.	
5269 Green pod, long, smooth, yield 60-70 q/ha.	
Azad Rajmah-1 Plant bushy, dwarf and upright with green foliage, pods green attractive, smooth, light green, straight, thick, less fiber and average length, suitable for green pod, yield 75-80 q/ha.	

Azad Bhindi-1 (Azad Ganga) Early, high yielding variety, recommended for plains in both seasons, plant height 100-125 cm and flowering occurs in 40-42 DAS, yield 100-125 q/ha.	
Azad Bhindi-2 It is early, tall, fruit green, medium in size, thin with short tapering length, resistant to YVMV, recommended for both seasons, plant height 100-125 cm and flowering occurs in summer 38-40 and in rainy season 40-42 DAS, yield 110-140 q/ha.	
Azad Bhindi-3 (Azad Krishna) Crop early, plant tall 100-125 cm, fruit red, medium, thin with medium tapering length, moderately resistant to YVMV, flowering occurs in summer 38-40 and in rainy season 40-42 DAS, yield 125-150 q/ha.	
Azad Bhindi-4 (Azad Mohini) Early high yielding and YVMV resistant variety suitable for both season, plant tall, height 100-125 cm, fruits green, medium in size, thin with medium tapering length, leaf petiole pigmented, flowering 38-40 in rainy season and 36-38 DAS in summer season, yield 125-150 q/ha.	
Kalyanpur Red Round Rabi onion, plant height 65-70 cm, erect, leaves medium in length, bulb red in colour, round, medium in size, narrow neck pronounced better keeping quality, equatorial bulb size 4-6 cm, TSS 13-14%, average bulb weight 60-70 gm, mild pungent, yield 250-300 q/ha.	
Kalyanpur No.-1 White cylindrical, thick, tapering, shoulder green, yield 300-350 q/ha roots	
Azad Haldi-1 Plant height 73 cm, leaf length 37.5 cm, width 14 cm, number of tillers per plant, number of rhizomes per plant 18.5, crop mature in 255 DAP, average yield 350-400 q/ha.	

Azad Arvi-1 Early, plant height medium, broad leaves, number of leaves less, more corms per plant, corms round to oval, big in size, average yield 300-350 q/ha.	
Azad Suran-1 Tall type plant 95 cm, leaf length 45 cm, leaf width 35 cm, polar diameter of corm 20 cm, equatorial diameter of corm 18 cm, weight of corm 1.0-1.25 kg, acridity free, average yield 400-450 q/ha.	
Azad Dhania-1 Vigorous plant, foliage dark green, seed green at maturity, mature in 105-115 DAS, more number of umbels, number of primary branches per plant 12-15, seed yield potential 16-18 q/ha.	
Azad Dhania-2 Growth erect, foliage dark green, parrot green colour seed at maturity stage, fruit pericarp grove and brittle, plant height 125-130 cm, maturity 105-115 DAS, number of umbels/plant 90-100, average seed yie;ld 15-17 q/ha.	
Azad Saunf-1 Plant erect, high, dark green, maturity in 160-170 DAS, seed yellowish brown big in size, ridges on seed, sweetness with aroma in seed, seed yield potential 16-18 q/ha.	
Azad Methi-1 Plant vigorous with distinct red colour at the base of stem, plant height 90-100 cm, flowering in 45-55 DAS, crop maturity in 140-150 DAS, seed yield potential 15 q/ha.	
Azad Methi-2 (Azad Arunima) Plant vigorous with distinct red colour of leaf at the base of the stem, for dual purpose, plant height 80-90 cm, maturity in 120-130 DAS, number of pods/plant 65-90, average yield 28-29 q/ha leaf and 13-14 q/ha seed after two cuttings.	

Azad Ajwain-1 Plant growth erect, leaves dark green, medium spreading, suitable for sowing in rabi and zaid seasons, internodes short, seed yield 10-12 q/ha.	
Azad Kalaunji-1 Plant height medium, white and blue small flowers, flowering in 60-70 DAS, profusely branched, seedy, less affected by disease and pest, seed black and angular, seed yield 8-10 q/ha.	

Printed at University Printing Press, CSAU, Kanpur