

E-PRACTICAL MANUAL

Temperate Vegetable Crops

(Course No. HVS-211)

Credits: 2 (1+1)

[For B. Sc. (Hons) Horticulture IIIrd Semester Students]



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College of Horticulture

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Syllabus:

Identification and description of varieties/hybrids; propagation methods, nursery management; preparation of field, sowing/transplanting; identification of physiological and nutritional disorder and their management; post-harvest handling; cost of cultivation and field visits to commercial farms.

Name of Student:

ID. No:

Batch:

Session:

Semester:

Course Name:

Course No. :

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CERTIFICATE

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Has completed the practical of course.Course

No. As per the syllabus of B.Sc. (Hons.) Horticulture.....semester

In the year.In the respective lab/field of College.

Date:

Course Teacher

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Exercise- 1

Objective: To study the identification of Temperate Vegetable crops.

Sl. No.	Common Name	Scientific Name	Family	Edible part(s)	Description
1	Onion				
2	Garlic				
3	Cabbage				
4	Cauliflower				
5	Sprouting broccoli				
6	Brussels sprout				
7	Lettuce				
8	Chinese cabbage				
9	Leek				
10	Radish				
11	Globe artichoke				
12	Knol-khol				
13	Carrot				
14	Turnip				
15	Beet root				
16	Peas				
17	Broad beans				
18	Rhubarb				
19	Spinach				
20	Palak				
21	Asparagus				

[illegible][illegible]

Exercise- 2

Objective: To study the propagation methods of Cole crops:

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Spacing: row to row and plant to plant (cm) under Cole crops

Sl. No.	Name of the crop	Planting distance (row x plant) in cm
1	Cabbage	
2	Cauliflower	
3	Sprouting broccoli	
4	Brussels sprout	
5	Know-khol	
6	Chinese cabbage	

Importance of spacing of Cole crops:

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Exercise- 3

Objective: To study the nutritional and physiological disorder in cauliflower.

Boron Deficiency:

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Molybdenum Deficiency:

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Nitrogen Deficiency:

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Write the physiological disorder of cauliflower and its control:

[illegible]

Exercise: 4

Objective: To study the harvest indices and maturity standard of cool crops.

Harvest Index:

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Physiological Maturity;

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Horticultural Maturity;

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Maturity Sign;

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Lower Maturity;

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Higher Maturity;

Harvesting:

[illegible]

Differentiate between physiological and horticultural maturity:

[illegible]

Maturity symptom of cabbage:

[illegible]

Exercise: 5

Objective: To study the postharvest handling of Onion:

Postharvest Handling;

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Harvesting;

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Drying;

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Curing;

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Sorting and Grading;

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Benefits;

Practices for grading of onion;

Exercise: 6

Objective: To study the postharvest handling of onion – packaging:

Packaging;

[illegible]

Materials Used for Packaging;

[illegible]

Transportation;

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[illegible]

Intended Use	Temp (°C)	RH (per cent)
Seed purpose		
Table purpose		
Processing purpose		

[illegible]

Objective: To study the post-harvest handling of garlic.

Harvesting:

[illegible]

Harvesting method:

Manual Harvesting;

[illegible]

Mechanical Harvesting;

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Objective: To study the curing of onion

Curing Process:

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Storage:

Storage:



Exercise: 9

Objective: To study application of organic manure and bio-fertilizers.

Organic manure;

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A) Bulky organic manures;

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B. Concentrated organic manures:

i) Manures of plant origin:

Sl. No.	Manure	Nutrient content (%)		
		N	P ₂ O ₅	K ₂ O
1	Castor Cake			
2	Neem Cake			
3	Safflower cake			
4	Coconut			
5	Groundnut			
6	Niger			
7	Sesame cake			

ii) Manures of animal origin:

Sl. No.	Manure	Nutrient content (%)		
		N	P ₂ O ₅	K ₂ O
1	Fish mean, fish manuring and fish guano			
2	Bone meal (Raw)			
3	Bone meal (Steamed)			
4	Settled sludge (Dry)			
5	Night soil			
6	Human urine			
7	Cattle dung and urine mixed			
8	Horse dung and urine mixed			
9	Sheep dung and urine mixed			

Methods of application of manures:

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Bio-fertilizers:

[illegible]

Importance of manures and fertilizers;

Why leguminous plants are preferred for green manuring:

Exercise: 10

Objective: To study the inorganic fertilizer application in Temperate Vegetable crops.

Artificial fertilizers:

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Nitrogenous fertilizer:

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Phosphorus fertilizers:

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Potassium fertilizers:

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Methods of application of fertilizers:

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Recommended dose of fertilizers (per hectare) in tuber crops:

Sl. No.	Name of Crop	Recommended dose FYM & N:P:K	Time of application
1	Onion		
2	Garlic		
3	Cabbage		
4	Cauliflower		
5	Sprouting broccoli		
6	Brussels sprout		
7	Lettuce		
8	Chinese cabbage		
9	Leek		
10	Radish		
11	Globe artichoke		
12	Knol-khol		
13	Carrot		
14	Turnip		
15	Beet root		
16	Peas		
17	Broad beans		
18	Rhubarb		
19	Spinach		
20	Palak		
21	Asparagus		

Significance of inorganic fertilizers:

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Objective: To study the method of planting in Temperate Vegetable crops.

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Recommended spacing under Temperate Vegetable crops

Sl. No.	Name of Crop	Spacing (Row X Plant) cm
1	Onion	
2	Garlic	
3	Cabbage	
4	Cauliflower	
5	Sprouting broccoli	
6	Brussels sprout	
7	Lettuce	
8	Chinese cabbage	
9	Leek	
10	Radish	
11	Globe artichoke	
12	Knol-khol	
13	Carrot	
14	Turnip	
15	Beet root	
16	Peas	
17	Broad beans	
18	Rhubarb	

Exercise: 12

Objective: Estimation of cost of cultivation and B: C ratio of garlic.

Cost of production of various inputs

A. Variable Cost:

[illegible]

B. Fixed Costs:

Sl. No.	Particulars	Quantity	Rate (Rs.)	Value (Rs.)	% to TC
A.	Variable cost				
1	Seed (q)				
2	FYM (q)				
3	Fertilizers				
i.	IFFCO mixer (Kg)				
ii.	Urea (Kg)				
4	Plant protection				
5	Tractor hours/Bullock charges				
6	Human labours (man days)				
i.	Field preparation				
ii.	Sowing				
iii.	Manuring				
iv.	Interculture				
v.	Irrigation				
vi.	Spraying				
vii.	Harvesting (Dehauling, digging & filling in bags)				
7	Total human labour of which				
i.	Family labour				
ii.	Hired labour				
8	Sub total (1-7)				
9	Interest on working capital @8% p.a. (3 months)				
10	Total variable cost (A=8+9)				
B	Fixed cost				
i.	Rental value of land				
ii.	Interest on fixed capital @ 8% p.a. (3 months)				
iii.	Depreciation				
	Total fixed cost				
C	Total cost (A+B)				
D	Returns				
	Yield (q)				
E	Gross returns				
F	Net returns				
	Benefit cost ratio (B:C ratio)				

Exercise: 13

Objective: Estimation of cost of cultivation and B: C ratio of peas.

Sl. No.	Particulars	Quantity	Rate (Rs.)	Value (Rs.)	% to TC
A.	Variable cost				
1	Seed (no. of cuttings)				
2	FYM (q)				
3	Fertilizers				
i.	IFFCO mixer (Kg.)				
ii.	Urea (Kg)				
4	Plant protection				
5	Tractor hours/Bullock charges				
6	Human labours (man days)				
i.	Field preparation				
ii.	Sowing				
iii.	Manuring				
iv.	Interculture				
v.	Irrigation				
vi.	Spraying				
vii.	Harvesting (Dehaulming, digging & filling in bags)				
7	Total human labour of which				
i.	Family labour				
ii.	Hired labour				
8	Sub total (1-7)				
9	Interest on working capital @8% p.a. (3 months)				
10	Total variable cost (A=8+9)				
B	Fixed cost				
i.	Rental value of land				
ii.	Interest on fixed capital @8% p.a. (3 months)				
iii.	Depreciation				
	Total fixed cost				
C	Total cost (A+B)				
D	Returns				
	Yield (q)				
E	Gross returns				
F	Net returns				
	Benefit cost ratio (B:C ratio)				

Exercise: 14

Objective: Estimation of cost of cultivation and B: C ratio of onion.

Sl. No.	Particulars	Quantity	Rate (Rs.)	Value (Rs.)	% to TC
A.	Variable cost				
1	Seed (q)				
2	FYM (q)				
3	Fertilizers				
i.	IFFCO mixer (Kg.)				
ii.	Urea (Kg)				
4	Plant protection				
5	Tractor hours/Bullock charges				
6	Human labours (man days)				
i.	Field preparation				
ii.	Sowing				
iii.	Manuring				
iv.	Interculture				
v.	Irrigation				
vi.	Spraying				
vii.	Harvesting (Dehaulming, digging & filling in bags)				
7	Total human labour of which				
i.	Family labour				
ii.	Hired labour				
8	Sub total (1-7)				
9	Interest on working capital @8% p.a. (3 months)				
10	Total variable cost (A=8+9)				
B	Fixed cost				
i.	Rental value of land				
ii.	Interest on fixed capital @8% p.a. (3 months)				
iii.	Depreciation				
	Total fixed cost				
C	Total cost (A+B)				
D	Returns				
	Yield (q)				
E	Gross returns				
F	Net returns				
	Benefit cost ratio (B:C ratio)				

Exercise: 15

Objective: To study the sowing and transplanting time of cool season vegetable.

S. No	Crops	Sowing Time	Transplanting Time
1.	Onion		
2.	Garlic		
3.	Cabbage		
4.	Cauliflower		
5.	Sprouting broccoli		
6.	Brussels sprout		
7.	Lettuce		
8.	Chinese cabbage		
9.	Leek		
10.	Radish		
11.	Globe artichoke		
12.	Knol-khol		
13.	Carrot		
14.	Turnip		
15.	Beet root		
16.	Peas		
17.	Broad beans		
18.	Rhubarb		
19.	Spinach		
20.	Palak		
21.	Asparagus		

Exercise: 16

Objective: To study the varietal description of Cole crops.

[illegible]

[illegible]

Exercise: 17

Objective: To study the varietal description of onion and garlic.

[illegible]

[illegible]

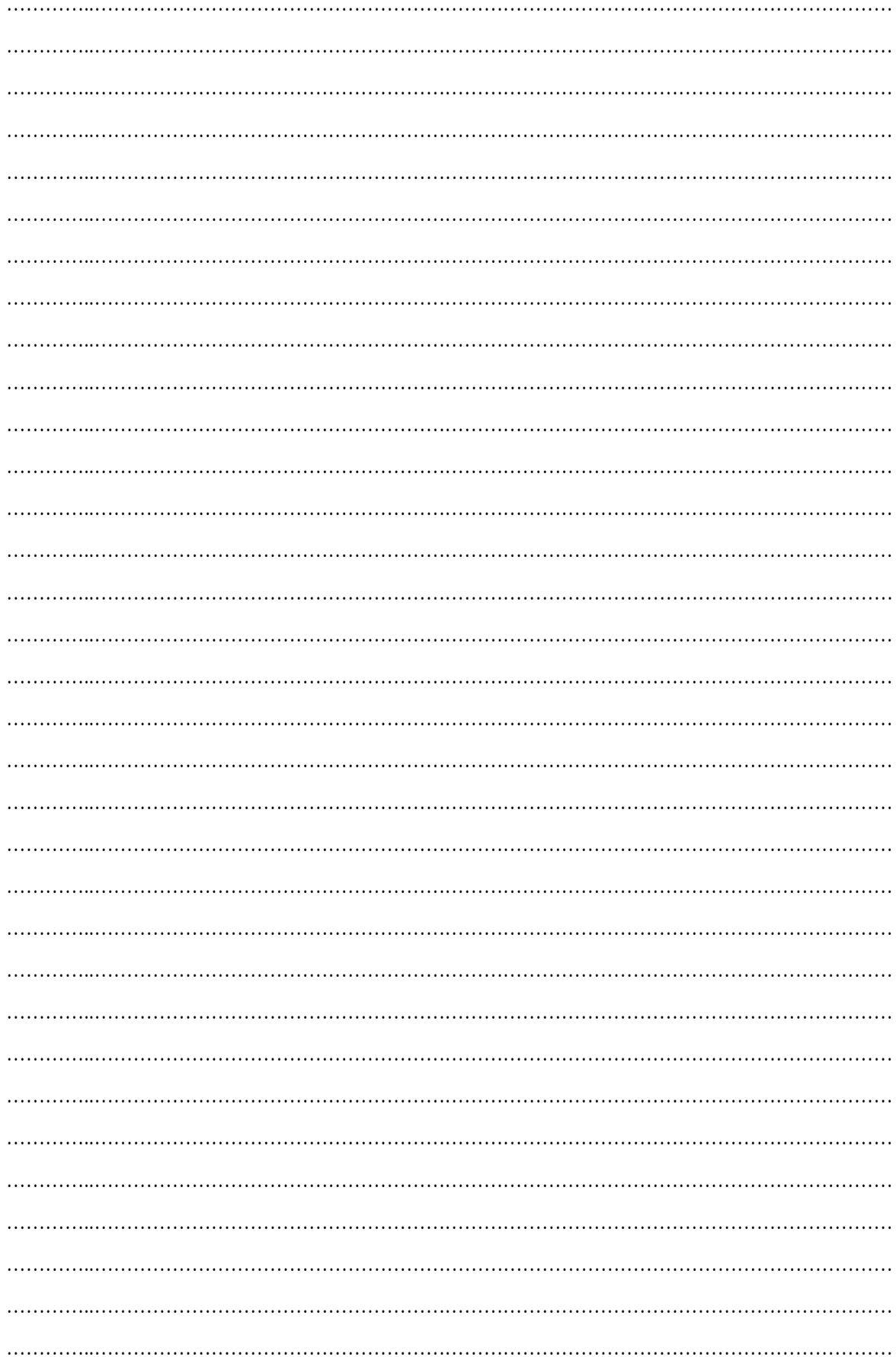
Objective: Collection of Temperate Vegetable crops sample and their description.

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Objective: Project preparation of commercial cultivation of Temperate Vegetable crops:

[illegible]



Objective: To study the nursery management of onion

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Exercise: 21

Objective: To study the nursery management of Cole crops

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Appendix

Identification of temperate vegetable crops

S. No	Common name	Scientific name	Family	Origin	2n=	Inflorescence type	Fruit type
1.	Cabbage	<i>Brassica oleracea</i> var. <i>capitata</i> L.	Cruciferae	Mediterranean region	18	Raceme	Silique
2.	Cauliflower	<i>Brassica oleracea</i> var. <i>botrytis</i> L.	Cruciferae	Mediterranean region	18	Raceme	Silique
3.	Chinese Cabbage	<i>Brassica rapa</i>	Cruciferae	China	20	Raceme	Silique
4.	Knol-khol	<i>Brassica oleracea</i> var. <i>gongylodes</i> L.	Cruciferae	Northern Europe	18	Raceme	Silique
5.	Brussels sprouts	<i>Brassica oleracea</i> var. <i>gemmifera</i> L.	Cruciferae	Mediterranean region	18	Raceme	Silique
6.	Sprouting broccoli	<i>Brassica oleracea</i> var. <i>indica</i> L.	Cruciferae	Mediterranean region	18	Cyme	Silique
7.	Radish	<i>Raphanus sativus</i> L.	Cruciferae	Mediterranean region	18	Raceme	Silique
8.	Turnip	<i>Brassica rapa</i> L.	Cruciferae	Mediterranean region	20	Raceme	Silique
9.	Lettuce	<i>Lactuca sativa</i> L.	Compositae	Middle East	18	Capitulum	Achenes
10.	Globe Artichoke	<i>Cynara scolymus</i> L.	Compositae	Mediterranean region	34	Capitulum	Achenes
11.	Asparagus	<i>Asparagus officinalis</i> L.	Asparagaceae	Temperate Europe and Asia	20		
12.	Onion	<i>Allium cepa</i> L.	Liliaceae	Central Asia	16	Umbel	
13.	Garden Leek	<i>Allium porrum</i>	Amaryllidaceae	Central Asia	16		
14.	Spinach	<i>Spinacia oleracea</i> L.	Amaranthaceae	Persia(Iran)	12		
15.	Beetroot	<i>Beta vulgaris</i> L.	Amaranthaceae	Mediterranean region	18	Spike	Aggregate
16.	Broad bean	<i>Vicia faba</i> L.	Fabaceae	India	12		Legume
17.	Garden pea	<i>Pisum sativum</i> L.	Leguminosae	Ethiopia and Western Asia	14	Raceme	Legume
18.	Rhubarb	<i>Rhnum rhabarbarum</i> L.	Polygonaceae	Temperate Asia	44		
19.	Palak	<i>Beta vulgaris</i> var. <i>bengalensis</i>	Amaranthaceae	Indo-China	18		
20.	Carrot	<i>Daucus carota</i> L.	Apiaceae	South Western Asia	18	Compound umbel	Schizocarp
21.	Garlic	<i>Allium sativum</i>	Alliaceae	Central Asia	16		Cloves

Sowing time and transplanting time of cool season vegetable.

S. No.	Crops	Sowing time	Transplanting time
1	Onion	May-June (Kharif)	July- Aug.
		Oct-Nov (Rabi)	End Dec-Jan.
2	Garlic	Sep.-Nov	-
3	Cauliflower	Mid May (Early)	July beginning
		July end (mid early)	September beginning
		August end (Mid late)	September end
		Sep. end to Mid Oct.	Oct.end to mid Nov.
4	Cabbage	Aug-Sep. (Northern plains)	End Oct.
		Mid Sep.(Eastern plains)	Nov.
5	Brussels sprout	Aug .to Sep.	Oct.
6	Broccoli	Mid Aug to Mid Sep.	Mid Sep. to Oct.
7	Knol khol	Mid Aug. to Sep.	Oct.
8	Lettuce	Sep to Nov	Mid Nov. to Dec.
9	Chinese Cabbage	Aug to Nov.(North)	4 to 5 weeks after sowing.
		March – July (Hills)	-
10	Radish	Sep to Jan.(Plains)	-
		March to Aug.	-
11	Carrot	Aug to Jan.	-
12	Beet root	Aug to Jan.	-
13	Turnip	Aug to Sep.	-
14	Globe Artichoke	Nov.	-
15	Pea	Beginning of Oct to Mid Nov.	-
16	Palak	Last week of Aug.	-
17	Spinach	Sep to Oct.	-
18	Leek	Spring and early summer	-
19	Broad Beans	Nov-Dec.	-
20	Rhubarb	Spring and Autumn.	-
21	Asparagus	July-Nov.(Plains)	-
		March-May (Hills)	-

Nursery management of onion

“An onion nursery is a place or an establishment for raising or handling of young onion seedlings until they are ready for more permanent planting.”

Soil

Red loam to black soils with good drainage facilities is highly suited for onion cultivation. It performs well at a soil pH range of 6-7 and a mild season without extremes of heat and cold.

Season

Sow the medium sized bulbs during April – May and October – November. It requires sufficient soil moisture during its growing period but heavy rains during bulb germination and bulb formation affects the crop growth.

Raising seedlings and transplanting

This is the most common method practiced for irrigated crop as it results in high yield and large size bulbs. In plains, seeds are sown during October-November for a rabi crop. In hills, seeds are sown from March to June. Seeds are first sown in well prepared nursery beds of 90-120 cm width, 7.5-10.0 cm height and convenient length. Ratio between nursery area and main field is about 1:20. Seed rate varies from 8 to 10 kg/ha. Seedlings of 15 cm height and 0.8 cm neck diameter are ideal for transplanting and this is achieved in 8 weeks. However, it varies from 6-10 weeks depending on soil, climate and receipt of rain. There is a practice of topping seedlings at the time of transplanting if seedlings are over-grown.

Preparation of field

Plough the land to a fine tilth and form ridges and furrows at 45 cm spacing. Sown the bulbs on both the sides of the ridges at 10 cm apart.

Irrigation

Irrigate at the time of planting of seedlings and third day and later at weekly intervals. Withhold irrigation 10 days before harvest.

Application of fertilizers;

Apply FYM 25 t/ha, *Azospirillum* 2 kg and *Phosphobacteria* 2 kg/ha, N 30 kg, P 60 kg and K 30 kg/ha as basal and 30 kg N/ha on 30th day of sowing.

Fertigation

Apply a dose of 75% of the total recommended dose of superphosphate *i.e.* 285 kg/ha as basal dose. *Azospirillum* and *Phosphobacteria* each @ 2 Kg/ha along with FYM 50 Kg and Neem cake @ 100 kg are applied before last ploughing. Raised beds of 120 cm are formed at an interval of 30 cm and the laterals are placed at the centre of each bed.

Pest and disease management

- Growing two rows of maize as barrier crops around field border.
- Selection of healthy onion seed bulbs.

- Bulb treatment –*Pseudomonas fluorescens* (5 g/kg) + *Trichoderma viride* (5 g/kg)
- Soil application of *P.fluorescens* (1.25 Kg/ha) + *T.viride* (1.25 kg/ha) + AM Fungi (VAM) (12.5 kg/ha) + Azophos (4kg/ha) + Neem cake 250 kg/ha.
- Installation of Yellow sticky traps 12/ha for thrips and leaf miner trapping.
- Installation of Pheromone traps 12/ha for cut worm (*S.litura*).
- Spray application of *P.fluorescens* (5 g/l) + *Beauveria bassiana* (10 g/l) on 30 DAP.
- Spray application of Azadairachtin 1% (2 ml/l) on 40 DAP.
- Need based application of *Profenophos* (2 ml/l) or Dimethoate (2 ml/l) or Triazophos (2 ml/l) for thrips/leaf miner/cut worm management.
- Need based application of Tebuconazole (1.5) ml/l) or Mancozeb (2 g/l)/Zineb (2g/l) for purple blotch disease management.

Nursery management of Cole crops.

Cauliflower –

Soil and Climate- Cauliflower can be grown in a wide variety of soils, but sandy and clay loam soils are most suited. It prefers well-drained upland soil for proper growth. The optimum pH range is 6.0 -7.0 It is a cool season crop and is sensitive to very low and high temperatures.

Field preparation –For preparation of field, soil is ploughed 2-3 times with power tiller or with spade. Planking is done during the last ploughing to make friable soil bed for transplanting. Raised beds of 1 m width, 4-5 m length and 30 cm above the soil are prepared.

Seed rate- Early season: 600 g/ha Mid and Late season: 400-500 g/ha

Sowing time – Early season: June-July, Mid season: August-September, Late season: October-November.

Nursery Raising- The nursery bed should be thoroughly prepared by adding well rotten FYM or compost @ 4kg/m². Before sowing, the seeds should be treated with Captan or Thiram @ 2.5g/kg seeds to get rid of fungal diseases. The seeds are sown at a spacing of 2-3 cm between seeds and 8-10 cm between lines. The depth of sowing is 1 - 1.5cm. After sowing, the seeds are covered with a mixture of fine soil and sieved FYM. After this, a light irrigation is provided with a water can. The nursery bed should be kept weed free.

Transplanting and spacing- Four to six weeks old healthy seedlings having 4-6 leaves should be transplanted. Before transplanting, hardening of seedlings should be done by withholding irrigation for 4-6 days prior to transplanting. Seedlings should be watered a day prior to uprooting and transplanting to avoid damage to the root system.

Spacing- Early season: 45 x 30 cm, Mid season: 60 x 45 cm, Late season: 60 x 60 cm

Manures and fertilizers- About 20 t/h FYM should be added in the soil one month before transplanting in the soil. Besides FYM, 120 kg nitrogen, 60 kg phosphorous, 60 kg potash should be applied for one hectare. Half dose of nitrogen and full dose of phosphorous and potash should be given at the time of transplanting and remaining amount of nitrogen should be given in two split doses i.e. 30 and 45 days after transplanting as top dressing.

Irrigation- First light irrigation should be given just after transplanting; further irrigations are to be given depending on weather and soil type. However, regular maintenance of soil moisture is essential during growth and curd development.

Cabbage –

Raising Seedlings- Use certified seed with special attributes, such as tolerance/resistance to pest and diseases and high yielding The seed rate is about 100-120 g/acre (depending on variety)

Nursery Site Selection: -Avoid setting up the nursery in fields previously having a Cabbage crop

Nursery Establishment: -Prepare a seedbed of 1 m width and of a convenient length. Make drills on the seedbed at a spacing of 10 – 20 cm apart. Thinly sow the seeds in the drills and cover lightly with soil.

Transplanting:-

Appropriate Time- Seedlings are transplanted 30 days after seed germination. It is recommended that transplanting should be done either early in the morning or late in the evening.

Recommended Spacing – The recommended spacing is 60 cm between rows and 45 – 60 cm between plants depending on the variety. Plant population: 11,000 – 14,800 plants/acre.

Fertilizer Application – Apply 2 – 3 handfuls of manure per planting hole (8 tons/acre) and 2 half-litre water bottle tops (10 g) of DAP per planting hole (80 kg/acre).

Management of Nursery: -

- ✓ Water thoroughly after transplanting and regularly.
- ✓ However, avoid over-watering which can lead to “Damping-off” disease.
- ✓ Start hardening the seedlings 1 – 2 weeks before transplanting by reducing the frequency of watering and the shade over the nursery.
- ✓ Mulching is important to provide a favourable environment for seedlings.

Brussels Sprouts;

Brussels Sprouts are propagated by seed sown in nursery beds.

Season of Sowing:

Early : August to September

Late : November to January

Spacing : 5X5 cm Seed Rate : gram. (1 gram = 100 seeds)

Nursery seedlings are grown similar to other Cole crops. Brussels Sprouts

Knol-khol-

Knol-khol is propagated by seed on nursery beds. 5-6 weeks old seedling is transplanted to main field. Nursery management is similar to other Cole crops.

Season of Sowing-

Early-March-April in Northern Hills

Late- September - October in North India

Seed Rate-2.20 to 2.80 kg/ha. K

Varietal description of Cole crops.

1. Cauliflower

Early Kunwari:

A very early variety for growing in Punjab, Haryana, Himachal Pradesh and Delhi. Ready for harvest from mid-September to mid-October. Curds are semi-spherical with even surface.

Pusa Early Synthetic:

Plants erect with bluish green leaves, curd small to medium in size, flat, creamy white and compact. Average yield 11.7 tonnes/ha.

Pant Gobbi3:

A synthetic variety combining inbred lines. Plants with long stem, semi-erect-leaves and hemispherical creamy white, medium compact, nonnacey curds. Yield 12 tonnes/ha. Curds are ready for harvest in September.

Pusa Deepali:

Recommended for cultivation in entire north Indian plains. Plants medium tall, erect, bluish green and waxy leaves, curds compact, retentive white and medium in size.

Pant Gobhi 2:

Recommended for cultivation in the northern plains of the country. Curds are medium compact and yellowish. Yield potential is 10 tonnes/ha available in October in the plains. Mid-early varieties Improved Japanese: An introduction from Israel. Plants erect, leaves bluish green; curds compact and white. Yield potential is 20 tonnes/ha.

Pusa Hybrid 2:

First h\ hybrid released by a public sector organization. Plants semi-erect with bluish green upright leaves, resistant to downy mildew. Curds are creamy white, very compact, yielding 23 tonnes/ha.

Pusa Sharad:

A variety released by IARI Variety Release Committee. Foliage bluish-green, leaf with narrow apex and prominent mid-rib. Semi-dome-shaped white and very compact curd. Average yield 24 tonnes/ha.

Pant Gobhi 4:

A variety released for November maturity. It has medium long stem, semi-erect leaves; hemispherical creamy white, medium compact, non-nacey curds. Average yield 14 tonnes/ha. Mid-fate varieties

Pusa Synthetic:

A synthetic variety, plants erect, frame narrow to medium, curds creamy-white to white and compact. The yield potential is 27 tonnes/ha.

Pant Shubhra: Released for cultivation in Bengal Assam basin and Sutlej Ganga

Mid-early varieties

Improved Japanese:

An introduction from Israel. Plants erect, leaves bluish green; curds compact and white. Yield potential is 20 tonnes/ha.

Pusa Hybrid 2:

First hybrid released by a public sector organization. Plants semi-erect with bluish green upright leaves, resistant to downy mildew. Curds are creamy white, very compact, yielding 23 tonnes/ha.

Pusa Shared:

A variety released by IARI Variety Release Committee. Foliage bluish-green, leaf with narrow apex and prominent mid-rib. Semi-dome-shaped white and very compact curd. Average yield 24 tonnes/ha.

Pant Gobhi 4:

A variety released for November maturity. It has medium long stem, semi-erect leaves; hemispherical creamy white, medium compact, non-ncey curds. Average yield 14 tonnes/ha.

1. Cabbage.

Golden Acre –

Early growing variety with small round heads, colour of the leaves is light green from outside and dark green from inside. Individual head weighing 1-1.5 kg, harvested within 60-65 days after transplanting. Late harvesting leads to heads cracking. Average yield is 20-24 t/ha.

Pride of India –

Early growing variety medium-large head weighing 1-1.5 kg, harvested within 70-80 days after transplanting, Average yield is 20-28 t/ha.

Copenhagen Market –

Late maturing variety, popular variety in West Bengal. Head is large in size weighing 2.5-3 kg each. harvested within 75- 80 days after transplanting,

Pusa Mukta –

Heads flattish round, medium sized with light green outer leaves, weighing 1.5-2 kg each. Tolerant to black rot disease. Average yield is 25-30 t/ha.

Pusa Synthetic-

Heads are medium in size, high yielding variety, Average yield is 35-46 t/ha.

September Early –

Mid season variety popular in the Nilgiris, head is compact, flat-oblong with bluish green foliage, weighing 4-6 kg. Harvested within 105-110 days after transplanting. It is susceptible to black rot disease. Average yield is 40-50 t/ha.

Pusa Drumhead -

Late season variety. The heads are large, flat, somewhat loose and drum shaped. Each head weighs 3-5 kg. Outer leaves are light green with prominent mid-rib. Requires long winter for a good crop, tolerant to black leg disease. Average yield is 50-54 t/ha.

Early Drum Head –

Early maturing variety with heads flat, medium-large, weighing 2-3 kg, Average yield is 20-30 t/ha.

Late Large Drum Head –

Late maturing variety with heads compact, flat and equal in size. Harvested within 100-120 days after transplanting. Average yield is 20-30 t/ha.

Pusa Ageti:

Tropical type variety produces seed under subtropical conditions. Produces marketable heads at temperature range of 15-30 °C but the day temperature should not be above 35 °C. Head weight is 600-1200 g, ready for harvest in 75-90 days after transplanting.

2. Broccoli

Punjab broccoli:

Its leaves are smooth, wavy and dark green. The leaves as well as sprouts have slightly bluish tinge. The sprouts are compact, attractive and succulent. The main sprouts are ready for harvest in about 65 days after transplanting. Its average yield is 175 q/ha

Fiesta:

It is a mid season broccoli variety. It produces dense, well-domed heads with thick stems on stout plants. Has limited heat tolerance at maturity, but is ideal for late summer sowing for a fall/winter broccoli crop. Plant on tighter spacing for single harvest—has limited side shoot production

Palam Vichitra:

It is a heading broccoli which is medium-sized and bears dark green leaves with purple tinge stem. Heads are purple and compact, rich in vitamins and minerals. This variety is suitable for cultivation under low hill conditions.

Pusa KTS 1 –

Medium-tall variety (65-70 cm), dark green waxy foliage with slightly wavy margins, heads are solid, main head size and weight about 6.0-15.4 cm and 350-450 gm respectively, matures in 90-105 days after transplanting.

Palam Samridhi-

A high yielding variety with large terminal head weighing about 300-400 gm each

Gypsy-

It is an early broccoli variety with a strong root system for good productivity in poor soil. It produces nicely-domed green heads with medium to small bead size. This variety is tolerant to heat.

3. Brussels sprout

Jade Cross –

It is a widely adapted hybrid variety developed for shipping , processing and home garden. Its plants are vigorous uniform in size and appearance with dark –green leaves.

Oliver –

It is an early producer 85 days F1 hybrid and is easy to pick . are compact and 2-3 cm in diameter.

Royal Marvel –

This is an early 85 days and productive F1 hybrid, which has resistance to bottom rot and tip burn.

Hilds Ideal –

Its plants are medium tall (55-60 cm) and bear 45-50 sprouts per plant. Sprouts are green compact and are with good flavour.

Rubine –

Its late maturing (85-95 days) variety with 3-4 cm sprouts. Its plants are red and yield is lower than green variety but good flavoured sprouts.

4. Knol – Khol

Large Green-

The knobs are green, round and large-sized with small tops. These are usually tender and delicately flavored with white flesh. It is ready to harvest in about 75 days after transplanting. The average yield potential is 225–250 q/ ha.

White Vienna-

It is an early maturing variety takes about 55–65 days to mature after transplanting. The plants are dwarf with medium green leaves and stem. The knobs are globular, light green, smooth and tender with delicate flavour. Its yielding potential is 175q ha

Purple Vienna-

The knobs are purplish-blue with greenish-white flesh. It takes about 70 days to mature and more yield potential as compared to White Vienna.

King of North-

It is an early maturing variety. The plants are dark green with about 25 cm height and bear flattish-round knob. It matures in 60–65 days after transplanting

RADISH

Asiatic varieties

Pusa Desi:

It is a selection from a local material developed at IARI, New Delhi. Roots are 30-35cm long tapering pure white with green tops and pungent taste. Tops have green cut leaves. This variety is suitable for sowing from mid-August to early October.

Pusa Reshmi:

Suitable for main season (mid-September to early October). Roots mildly pungent, 30-35cm long, white with green shoulder tolerant to slightly higher temperature. It takes 55—60 days for root production.

Pusa chetki:

Developed by selection from a Denmark introduction; suitable for growing in hotter months, i.e. middle of March to middle of August when no other variety can be grown successfully; roots medium, long stumpy, pure white and mildly pungent with soft texture. Leaves are dark-green entire with slight lobing and upright

Japanese White:

An introduction from Japan and recommended by IARI Regional Station Katrain; suitable for sowing from October-December. Roots are 25-30cm long, 5cm in dia, cylindrical blunt at the tip. Skin pure white, flesh snow white crisp, mildly pungent, leaves deeply cut.

Punjab Safed:

A derivative of the cross White 5 x Japanese White. Roots 33- 40 cm long smooth and white, foliage light green. It takes 50-60 days for root formation

CO 1.

A selection RS 44-1 developed at Tamil Nadu Agricultural University. Coimbatore. Roots milky white, less pungent, 23cm long and cylindrical. Suitable for growing in plains in all seasons. It also sets seeds in plains. It has a potential; yield of 9-10 tonnes/ha in 45 days crop duration.

Arka Nishant:

An improvement over a collection IHR72 from Singapore developed at IIHR, Bangalore after 10 cycles of mass selection. Roots are long marble-white crisp in texture with mild pungency. Resistant to pithiness, pre-mature bolting, root branching and forking. It sets seeds freely in plains.

Chinese Pink:

An introduction identified by Dr Y S Parmar University of Horticulture and Forestry, Naum (Solan). Roots are 12-15cm long pink with white towards tip, semi-stumpy to stumpy. It takes 50-55 days for root formation.

Temperate varieties**White Icicle:**

A table variety, roots 12-15cm long 2-3cm in dia, icicle-shaped, mildly pungent, flesh cnsp-icy-white sweet. It takes 30 days for harvest.

Pusa Himani:

Developed at IARI Regional Station, Katrain through hybridization between Black and Japanese White; suitable for December-February sowing when no other variety can form such good roots. In hills it is the only variety which can be grown throughout the year barring 3 winter months, viz. November-January. Roots 30-35cm long, semi-stumpy, pure white with whitishgreen shoulder, mildly pungent, crisp with sweet flavour. Tops with green cut semi-erect leaves.

Rapid Red White Tipped:

It is a table type. Roots small globular, bright-red with white tip. Flesh pure white crisp with mild pungency. It is ready for harvest in 21 days. Suitable for November-December sowing in plains.

Scarlet Globe:

Root round small with 2cm dia, bright-red; flesh crisp and white; takes 25-30 days from sowing to root formation. Delayed harvest will result in pithiness.

Scarlet Long:

Roots long tapering to a point with red skin. Flesh-white and crisp.

Carrot**Tropical or Asiatic varieties****Pusa Kesar:**

This is a selection from a cross of Local Red and Nantes Half Long developed at IARI, New Delhi. The roots are scarlet in color with sufficiently red coloured core unlike the local tropical cultivars where in the core will be yellow or white. It is also richer in carotene, viz. 38mg/100g of edible portion. The most desirable feature of this variety is that roots stay for about a month longer in the fields than Local Red without bolting. It sets seeds freely in the plains. Suitable for sowing from early September to early November, takes about 80-90 days from sowing to root formation.

Pusa Megbali:

This is a selection from a cross between Pusa Kesar and Nantes developed at IARI, New Delhi. It has long orange coloured tapering roots with self-coloured cores. The roots are rich in carotene content (11571 lu/100g). This variety is capable of seed setting in plains.

Sel. No. 29:

A selection made from a local material by Punjab Agricultural University. Roots are long, tapering, thin and light-red in colour.

Sel. No. 233:

It is a derivative of a cross Nantes x No. 29 and released by Punjab Agricultural University. Roots are long smooth, semi-cylindrical orange with light orange coloured core. Takes 90-100 days for root formation.

Hisar Gairic (CCS HAU, Hisar)

It has been developed by selection from a local material. Plant top is medium heavy with light green leaves. The roots are attractive, long, tapering, light brick red with thin and self colour core. It takes 120 days from sowing to harvesting. Average root yield is 285 quintals per hectare.

PC 34 (PAU, Ludhiana)

It has been developed by selection from a local material and takes ninety days from sowing to harvesting maturity. The roots are deep red and tapering with self colour core; 62 cm long with 3.15 cm diameter. Average TSS content is 8.8 per cent and yield is 510 quintals per hectare.

Temperate or European types**Nantes Half Long:**

It is an introduction recommended by IARI Regional Station, Katrain. Suitable for sowing during winter months. Roots are cylindrical stumpy, well shaped with abrupt tail, orange scarlet in color with self-coloured core. Flesh is sweet with good flavour. It takes about 110-120 days for the production of roots.

Early Nantes:

Roots are almost cylindrical terminating abruptly in small thin tail, 12-15cm long, orange flesh with self-coloured core. It takes 90-100 days for root formation.

Cbantenay:

It is an excellent cultivar for canning and storage. Roots are 11- 15cm long, 3-5cm broad with tapering to blunt end. The cortex is deep-orange with self-coloured core.

Danvers:

A mid-season cultivar suitable for fresh market and processing. The roots have deep-orange-cortex and yellow core.

Zeno:

It was introduced from Germany in the Nilgiris hills of Tamil Nadu by the State Department of Horticulture. The roots are deep-orange with self-coloured core. It takes 110-120 days for root formation.

Ooty 1:

Developed at Horticultural Research Station, Ooty of Tamil Nadu Agricultural University. Roots are deep-orange with self-coloured core.

Pusa Yamadagni:

Developed at IARI Regional Station, Katrain by hybridization between EC 9981 and Nantes. Roots are 15-16cm long orange with self-coloured core slightly tapering with stumpy to semi-stumpy ending. It is earlier by a week or 10 days than Nantes.

Pea**Early group**

Asauji: It is smooth seeded cultivar suitable for early sowing.

Arkel:

It was developed by selection from the genetic material introduced from England. The plants are dwarf (30-45 cm); pods are attractive, dark green, well filled and 8-10 cm long. Dry seeds are light green and wrinkled. It is an early maturing and takes 50-55 days from sowing to marketable green pod stage. Average yield is 50 quintals per hectare and shelling outturn is 40 percent. It is tolerant to high temperature and is suitable for dehydration. It is a most popular exotic pea introduced from England and occupies a large area in India, it yields 5 tonnes/ha and plants are susceptible to collar rot.

Jawahdr matar 3 and 4: These varieties have bold wrinkled seeds and yield 4—6 tonnes/ha.

Matar Ageta-7 (PAU, Ludhiana)

It is early maturing variety and first picking is possible 65-70 days after sowing. Each plant bears 15-18 well filled pods with 7-9 grains per pod. Pods are medium long (9.5 cm), slightly curved at tip and are borne singly or in doubles. Shelling out turn is 48 percent and average green pod yield is 75 quintals per hectare.

Jawahar Pea 54, (JNKV, Jabalpur)

It was developed by selection from the double cross (Arkel \times JM 5) \times (4BC \times JP 501). Its plants are 40-50 cm tall, pods are big, sickle shaped each containing 8-10 grains that taste sweet. The seeds are wrinkled, greenish-yellow and large sized. Average pod yield is 70 quintals per hectare. It is resistant to powdery mildew.

Hisar Harit (HAU, Hisar)

It was developed by selection from the cross Bonneville \times P 23. It takes relatively longer period for marketable maturity than typical early types. The plants are semi-dwarf and first

picking is possible 60 days after sowing. The pods are well-filled, sickle shaped, large and green. The seeds are green at maturity and show dimples on surface. Average yield is 90 quintals per hectare.

Mid-season group

Bonneville:

It is a popular variety in India introduced from USA and yield 10 tonnes/ha. Plants are susceptible to powdery mildew.

Arka Ajit:

It was developed by IIHR, Bangalore as a variety resistant to powdery mildew and rust and yield 10 tonnes/ha in 90 days.

Jawahar matar 1 and 2:

These varieties have bigger pods and yield 10-12 tonnes/ha. The plants are susceptible to powdery mildew.

UN 53 (6):

It is a snap pea (whole pod edible) line developed by IIHR, Bangalore, and yields 8-9 tonnes/ha in a crop duration of 90 days.

Ooty1:

It is a pure line selection from the accession PS 33 among the germplasm maintained at TNAU, horticultural Research Station, Ooty with a crop duration of 90 days. It is dwarf type with a yield potential of 11.9 tonnes/ha. It is resistant to white fly.

Late Maturing/ Main Season Varieties

Punjab 87 (PAU, Ludhiana)

It was developed by selection from the cross Pusa 2 × Morassis 55. Its plants are medium tall and dark green. First picking is possible 100 days after sowing. Pods are dark green, 9-10 cm long and slightly curved at the end. The grains are bold, sweet and suitable for dehydration. Average yield is 135 quintals per hectare and shelling out turn is 50 percent.

Punjab 89 (Introduction, New Zealand)

The pods are attractive dark green, long, borne in doubles and having 9-10 grains per pod. First picking is possible 85-90 days after sowing. The seeds are sweet and shelling out turn is above 55 per cent. Average pod yield is 150 quintals per hectare.

Bonneville (Introduction, USA)

Its plants are medium tall, attaining a height of 60-70 cm. The pods are large, dark green, straight and well filled having 6-7 seeds. The seeds are bold, sweet and wrinkled at maturity. Average yield is 150 quintals per hectare.

Azad P-2 (VRS, Kalyanpur)

It was developed by selection from the cross Bonneville × 6587. Its plants are 130-150 cm tall and erect with light green foliage. Pods are medium sized, light green, straight and

borne in clusters of two with 6-7 grains which are wrinkled and taste sweet. Average yield is 120 quintals per hectare. It is resistant to powdery mildew.

Jawahar Pea 83 (JNKV, Jabalpur)

It was developed by selection from the double cross (JMI \times JP 829) \times (46 C \times JP 501). Its plants are dwarf (50 cm); pods are large and curved, each containing about 8 sweet tasting grains. Average yield is 120-130 quintals per hectare. It is resistant to powdery mildew.

Jawahar Pea 15 (JNKV, Jabalpur)

It was developed by selection from a three way cross (JMI \times R 98 B) \times JP 501 A/2. Its plants are dwarf (50 cm), pods are large each containing about 8 grains. Average yield is 130 quintals per hectare. It is resistant to Fusarium wilt and powdery mildew.

Arka Ajit (IIHR, Bangalore)

It has been developed by selection from the multiple cross involving Bonneville, IIHR 209 and Freezer 656. Pods are 8-9 cm long. Seeds are bold, sweet and shelling is 55 percent. It takes about 90 days from sowing to first picking. Average yield is 100 quintals per hectare. It is resistant to rust and powdery mildew.

Arka Karthik (IIHR, Bangalore)

It has been developed by selection from the cross Arka Ajit \times IIHR 554. Plants are bushy and erect. Pods are 11-12 cm long with 8-10 sweet grains. It takes about 90 days from sowing to first picking. Average yield is 80 quintals per hectare. It is resistant to rust and powdery mildew.

Arka Sampoorna (IIHR, Bangalore)

It is a snow pea variety developed by selection from a multiple cross involving Bonneville, IIHR 209, Freeza 656 and Manao Sugar. Plants are bushy and erect. Pods are flat, sweet and crisp with the parchment layer. It attains marketable maturity 80 days after sowing. Average yield is 80 quintals per hectare.

Oregon Sugar Pod (Introduction, USA)

It is a snow pea variety. The plants are tall (140 cm); pods are light green, broad, flat and 12-13 cm long. First picking is possible 90 days after sowing. Average yield is 120 quintals per hectare.

Oregon Sugar Pod II (Introduction, USA)

It is also a snow pea variety. The plants are bushy and about 75-90 cm tall. The pods are 10-12 cm long, tender, crisp and suitable for stir-frying. It takes about 60 days from sowing to first picking.

Sugar Snap (Introduction, USA)

It is a snap pea variety. The plants are about 120 cm tall and require staking. At maturity, the pods are 7-8 cm long, round, crisp and delicious. It takes about 70-75 days from sowing to first picking.

Broad bean

Varieties

There is no improved variety available in India, but several exotic varieties introduced from abroad are given below.

Long pod type:

Aquadule Claudin, Imperial White long pod, Masterpiece green long pod, Imperial green long pod, Red Epicure

Windsor type:

Imperial White Windsor, Gaint Four seeded Green Windsor, Imperial Green Windsor.

TURNIP

Improved Varieties

As in radish, turnip varieties are also grouped into European or temperate types and Asiatic or tropical types. The temperate varieties are sweet, tender and palatable whereas Asiatic types are pungent with tough texture and are suitable for pickle making. The Asiatic types set seed freely in plains whereas temperate types set seed only in hills. The tropical types are tolerant to high temperature and are, therefore, sown early in the season. Following are the improved varieties of turnip.

Tropical Types

L-1 (PAU, Ludhiana)

This variety has been developed from the cross PTWG × 4-White. Plant top is medium; leaves are complete with serrated margins and dark green in colour. Roots are round, pure white, smooth, rat-tailed and crisp with mild flavour. It takes 45-60 days to reach marketable maturity. Average yield is 260 quintals per hectare.

Early Milan Red Top (Introduction, Italy)

Plant top is small with 4-6 sessile leaves. Roots are flat with purplish red top and white underneath. Flesh is pure white, crisp and mildly pungent. It is an extra early variety and roots are ready for harvesting 45 days after sowing.

Pusa Kanchan (IARI, New Delhi)

It has been developed by selection from the cross Local Red Round (Asiatic type) × Golden Ball (Temperate type). Plant top is small. Roots are round with red skin and are ready for harvesting 50-55 days after sowing. Flesh is creamy-yellow with excellent flavour and taste. Root yield varies from 250-400 quintals per hectare

Temperate Types

Golden Ball (Introduction, England)

It is suitable for sowing late in north Indian plains. Plant top is small; leaves are erect, deeply serrated and light green in colour. Roots are round, medium sized with yellow skin and

yellow flesh. It reaches marketable maturity 70 days after sowing. Average yield is 175 quintals per hectare.

Purple Top White Globe (Introduction, USA)

This is suitable for sowing late in north Indian plains. Plant top is medium heavy; leaves are erect, deeply serrated and dark green. Roots are large, round, smooth with bright purple top and white base. Roots attain marketable size 60 days after sowing. Average yield is 200 quintals per hectare.

Pusa Chandrima (IARI, Katrain)

It is a temperate variety and is suitable for sowing from October to December in plains. It has been developed by selection from the cross Snow Ball × Japanese White. Plant top is medium heavy and leaves have moderately deep cuts. Roots are medium to large, globular, smooth and pure white. Flesh is sweet and tender. Roots are ready for harvesting 50-60 days after sowing. Average yield is 400 quintals per hectare.

Pusa Swarnima (IARI, Katrain)

It is an early maturing variety and has been developed by selection from the cross Japanese White × Golden Ball. Roots are flatish-round, 7-8 cm in diameter with creamy – yellow skin, amber flesh and mild taste. Tops are medium heavy with moderately cut leaf lamina. Harvesting is possible 65-75 days after sowing. Average yield is 280 quintals per hectare.

BEETROOT

Improved Varieties

Based on the shape of roots, beetroot varieties are classified into five groups viz. flat, short top, round or globular, half long and long. Most of the varieties cultivated in India are the exotic ones. The following varieties are recommended for commercial cultivation in India

Detroit Dark Red (Introduction, USA)

The roots are round with smooth, uniform and deep red skin. Flesh is dark blood red, tender and fine textured with light red zoning. The tops are small; and leaves are dark green with maroon tinge. It takes 80 – 100 days to reach maturity.

Crimson Globe (Introduction, USA)

Roots are globular to flat, medium red with small shoulders; flesh is dark crimson-red with indistinct zoning. Tops are medium to tall, large, bright green with maroon shades.

Crosby's Egyptian (Introduction, USA)

Roots are flat to globular with smooth skin. The flesh colour is dark purple-red with some zoning. The top is medium tall, green with red veins. It takes 55-60 days to reach marketable maturity.

Early Wonder (Introduction, USA)

The roots are flattened globe with rounded shoulders and smooth, dark red skin. The flesh is dark red with light red zoning. The leaves are large with red veins. The roots attain marketable maturity after 55 to 60 days of sowing.

Ooty 1 (Udhagamandalam)

Its skin is thin and flesh colour is blood-red. It takes 120-130 days to reach marketable maturity. Average yield is 310-450 quintals per hectare.

SPINACH

Improved Varieties

Virginia Savoy (Introduction, USA)

It is a prickly seeded cultivar having blistered, large and dark green leaves with round tip. Plants are upright and vigorous in growth. Average yield is 100-125 quintals per hectare. It is resistant to spinach mosaic.

Long Standing (Introduction, USA)

Leaves are dark green, large, thick and conical in shape. First cutting is possible 48-days after sowing. Average yield is 100-125 quintals per hectare.

Early Smooth Leaf:

This is a smooth seeded cultivar and produces small lightgreen leaves with a pointed apex

Spinach beet/Palak

Varieties

Punjab Green:

This cultivar was developed by Punjab Agricultural University, Ludhiana, through selection. Its plants are semi-erect, foliage is shining dark-green, thick, long and broad. The leaves are succulent and free from sourness. There is mild purple pigment on the stem. It is ready for first cutting 30 days after sowing. Its average yield is 3 tonnes/ha. It is slow bolter.

Pusa Jyoti:

This cultivar was developed by the Indian Agricultural Research Institute, New Delhi by polyploidization of the culture as a result of induced mutagenesis using All Green as a source material. It has very big leaves with darkgreen colour. Leaves are thick, tender, succulent and crisp. The plants are very vigorous, quick growing and regenerate quickly after each cutting. It yields about 50 tonnes/ha in 6-8 cuttings.

HS 23:

This cultivar was developed by Haryana Agricultural University, Hissar, Haryana through selection. It produces dark-green, large, thick, tender and juicy leaves. It is a quick growing cultivar and is ready for first cutting 30 days after sowing. A total of 6-8 cuttings at two weeks interval can be obtained.

Ooty 1:

It was developed at Horticultural Research Station, Ooty of Tamil Nadu Agricultural University through selection from an introduction from Himachal Pradesh. Leaves are green with a length of 40-50cm and breadth of 8-10cm. The crop comes to first harvest 45 days after sowing. Subsequent harvests can be done once in 15 days for 4 times. The yield is 1.5 tonnes/ha/cutting.

All Green:

It was developed at the Indian Agricultural Research Institute, New Delhi. It produces green tender leaves and gives about 6-7 cuttings at 15-20 days interval. It yields about 12 tonnes/ha.

Pusa Harit:

This cultivar was developed by hybridization between sugar beet and local palak at IARI Regional Station, Katrain, HP. It produces thick, green, very large and slightly crinkled leaves. It is a heavy yielder and has very late bolting habit as it has low chilling requirement.

Jobner Green:

This was developed at Jobner campus of University of Udaipur by selection from a spontaneous mutation detected from a local collection, SI. No. 5. It produces green, large, thick and tender leaves with strong flavour having entire margin. It is a high yielder and gives an average yield of 30 tonnes/ha.

Pusa Bharati:

It is the latest variety at the Indian Agricultural Research Institute, New Delhi. It produces green, tender leaves. It has higher vitamin C content and (3-carotene than Pusa Jyoti. It is very high yielder and gives an average yield of 50 tonnes/ha.

Varietal description of Onion and Garlic

1. Onion

- ✓ Open pollinated varieties.

Arka Beem-

It is a tri-parental synthetic variety with Red to pinkish red elongated globe shaped bulbs. Average bulb weight is 120 g.

Arka Sona –

Yellow onion developed for export market for Asian countries. Bulb yield: 45t/ha in 120 days.

Bhima Super –

Bulbs round with tapering neck; maturity 110-115 DAT; average yield 26-28 tonnes / ha. Recommended for kharif and late kharif season.

Bhima Light Red –

This onion variety is recommended for cultivation in *rabi* season in Karnataka and Tamil Nadu. It is a medium maturing (115 days after transplanting) variety having light red globe bulbs Its average yield in 385 q/ha.

Arka Pragati-

Globe shaped bulbs with thin neck. Medium size bulbs with deep pink coloured outer scales and high pungency. Average bulbs weight: 100-160 g. Yield 35 t/ha .

Pusa Madhavi –

Bulbs medium to large in size, light red in colour and flattish round in shape. Keeping quality is good, plant mature in 130-145 days after transplanting. The average yield potential is 30 t/ha. Recommended for rabi season. Suitable for export purpose.

Arka Niketan –

Bulbs globular with thin neck, attractive colour, 46 cm in size. TSS is 12.14%, pungency and dry matter also high. Good keeping quality. Plant mature in 145 days after transplanting. The average yield is 34 t/ha. Though, it is recommended for rabi season mainly, it can be grown in late kharif also in Maharashtra.

Arka Lalima –

CMS based F1 Hybrid Medium to big sized bulbs with globe shape and firm texture. Field tolerance to diseases and pests. Suitable for kharif and rabi. Bulb yield: 47t/ha.

Arka Kirthiman –

CMS based F1 Hybrid Medium to big sized bulbs with globe shape. Field tolerance to diseases and pests. Suitable for kharif and rabi. Bulb yield: 45 t/ha.

Arka Pitamber –

Bulbs uniform yellow. Medium size with globe shape and thin neck. Less pungent with TSS 11% and total sugar 9.81%. Tolerant to purple blotch, basal rot diseases and trips with long shelf life (3-4 months). Suitable for export market .

2. Garlic**Bhima Purple –**

This variety with attractive purple skinned bulbs has been recommended for cultivation in the states of Andhra Pradesh, Bihar, Delhi, Haryana, Karnataka, Maharashtra, Punjab and Uttar Pradesh. It matures in 120-135 days and the average yield is 6-7 t/ha.

Bhima Omkar –

This variety has been recommended for cultivation in the states of Delhi, Gujarat, Haryana and Rajasthan. It matures in 120-135 days and average yield is 8-14 t/ha. It produces medium size compact white bulbs.

Agrifound White (G-41):

Bulbs are compact, silvery and white with creamy flesh, bigger elongated clove with 20-25 in number and diameter of bulb is 3.5 to 4.5 cm, total soluble solids (41%), Matures in 140-150 days, average yield 130 q/ha.

Yamuna Safed (G-1):

Bulb are compact, silvery white skin with creamy flesh, diameter 4.0-4.5 cm. Sickle shaped cloves with 25-30 in number, total soluble solids (38%), dry matter (40%) and pyruvic acid (29 micro mole/g). matures in 140-150 days, average yield 150-175 q/ha.

Yamuna Safed-2 (G-50):

Attractive with white creamy flesh. Diameter of bulb is 3.5- 4.0 cm. The number of cloves is 35-40 per bulb. The crop matures in 140-160 days. It gives an average yield of 150-200 q/ha.

Yamuna Safed-3 (G-282):

Bulbs are creamy white, bigger in sized and 4.5-5.5 cm in diameter. The number of cloves is 15-16 per bulb. They contain 38-42 total soluble solids, 42% dry matter. The crop matures in 120-140 days. It gives an average yield of 175-200 q/ha. earliest maturing variety suitable for export.

Agrifound Parvati (G-313):

Bulbs are bigger, creamy white in colour with pinkish tinge. Diameter of bulb varies from 5.0 to 6.5 cm, 10-16 bigger cloves per bulb. Crop matures in 230-250 days after sowing. The average yield of variety ranges between 200 to 225 q/ha., long day type and tolerant to purple blotch.

Agrifound Parvati-2 (G-408):

Bulbs are bigger, creamy white in colour. Diameter of bulb varies from 5.0 to 6.0 cm, cloves bigger 12-14 in number per bulb. Crop matures in 240-260 days after sowing. The average yield of variety ranges between 200 to 225 q/ha.

Yamuna Purple-10 (G-404):

Bulbs are compact, attractive light purple in colour with creamy flesh. Diameter of bulb varies from 4.8 to 5.5 cm and bigger elongated cloves 25-30 in number per bulb. The average yield of variety ranges between 200 and 225 q/ha.

Yamuna Safed-6 (G-324):

Bulbs are white in colour with creamy white flash and better keeping quality. Crop matures in 155-165 days after sowing. The average yield ranges between 145 and 150 q/ha. The variety has been recommended for growing in kharif season.

Nutritional Disorder

Cauliflower

Browning

It is also called red rot or brown rot and is caused by boron deficiency. The symptoms first appear as water soaked lesions on internal tissues of stem and on surface of the curd. Later they change into a rusty brown colour. Browning is associated with hollow stem and internal discoloration. Other symptoms include thickening, brittleness and downward curling of older leaves. The affected curds develop a bitter taste.

CONTROL

Apply Borax @ 10.0-15.0 kg per hectare to control browning. The doze of the chemical depends upon the soil type, soil reaction and extent of deficiency. On neutral and alkaline soils, a higher quantity of Borax is used. However, excessive use of Borax leads to toxicity.

Whiptail

This results from the deficiency of molybdenum and is more frequent in acidic soils. In addition, there are genotypes those are more prone to occurrence of this disorder. The peculiar symptom of the disorder is that the leaf blades do not develop properly and in extreme cases only midrib develops

CONTROL

Improve soil pH to 6.5 by liming. Apply sodium or ammonium molybdate @ 1.0 kg per hectare

Physiological Disorders

Buttoning

The term buttoning is applied to the development of small curds called buttons. The plants do not develop normally and the leaves remain small. Deficiency of nitrogen is the chief cause of buttoning besides the selection of improper varieties. Temperature stress (too low or too high temperature), water stress, poor quality seedlings, crowding in nursery and transplanting over-aged seedling are also responsible for buttoning.

Blindness

Blind cauliflower plants are those, which lack terminal bud. The leaves, which develop are large, dark green and leathery. Sometimes, the axillary buds develop but the plant fails to produce a marketable head. It is associated with prevalence of low temperature reaching subzero °C when the plants are still small or due to damage to terminal bud by mis-handling or injury caused by insect-pests.

Leafyness

This is a condition in which the bracts grow out of the curd. The disorder occurs due to excessive nitrogen application and if temperature is higher than the optimum at the time of curd

development.

Riceyness and Fuzzyness

In this disorder, the pedicles and/or peduncles grow out giving full velvety or partially velvety appearance to the curd. This condition develops due to poor seed stock and growing of varieties at temperatures considered unfavourable.

Cabbage

Splitting of heads

Splitting of heads may occur due to heavy rains after prolonged drought, excessive fertilizer application and delayed harvesting. Early maturing varieties are more prone to head splitting than the late maturing ones

Carrot

Splitting or forking

Splitting or forking in carrot is caused by both genetic as well as environmental factors. Wider plant spacing resulting in large sized roots is associated with splitting. Excess of nitrogen application and irregular irrigation are also responsible for the disorder. Further, the crop that received nitrogen from ammonia-based fertilizers is more prone to splitting than the one received nitrogen from other sources.

Radish

Forking

Splitting of roots is called forking and is a common problem in radish. Forking is caused due to hard soil pan, delayed harvesting and water stress followed by excessive water application. Avoiding these conditions will help minimize forking in radish.

Brown heart

It is a commonly occurring disorder in radish and turnip caused by boron deficiency. Dark spots that first appear on roots characterize it. The plants remain stunted due to retarded growth rate. Leaves show variegated appearance with yellow and purplish red blotches. Roots remain small showing distorted and greyish appearance.

CONTROL

Brown heart can be controlled by soil application of borax @ 15-20 kg per hectare or foliar application of 0.1 per cent boron.

DISEASES AND THEIR CONTROL

Damping off (*Pythium* spp., *Rhizocotinia* spp, *Fusarium* species, *Botrytis* spp., *Sclerotinia* spp., *Phoma* spp., *Phytophthora* spp., *Colletotrichum* spp.)

Damping-off is caused by many soil borne pathogens that attack under conditions unfavourable for rapid seed germination and growth. The symptoms include both preemergence and post-emergence death of seedlings. In pre-emergence phase, the seedlings fail to emerge from the soil. In post-emergence phase, seedlings are attacked at the soil level. Tissues of young seedlings become water-soaked and soft near the soil level. In advanced stage it results in girdling of stem and death of the seedlings.

CONTROL

Avoid sowing nursery in sick and poorly drained soils. Sterilize the seedbeds with formalin @ 1.0-1.5 per cent solution. Treat the seed before sowing with Captaf or Thiram @ 3 g per kg seed and avoid crowding in nursery. Drench nursery beds with Captaf @ 200 g per 100 litres of water after 7-and 15-days of sowing.

Black rot (*Xanthomonas campestris* pv *campestris*)

The disease is caused by seed borne bacteria and affects cauliflower, cabbage, knobhol, broccoli etc. It also affects root crops like radish and turnip. Symptoms of disease appear as V-shaped chlorotic to yellow lesions on margins of leaves with base towards the mid-rib. The veins of affected leaves turn black and leaves fall off pre-maturely. The infection spreads through the xylem to the stalk. Vascular tissues show browning.

CONTROL

Use disease free seed. Soak the seed in hot water at 50°C for 25-30 minutes which kills internally seed borne bacteria. Treating the seed with Aureomycin @ 1000 ppm for 25 minutes is also effective against seed borne inoculum. Follow clean cultivation and remove and destroy the diseased plant debris. Remove and destroy alternative wild hosts from vicinity of the crop fields. Follow crop rotations with non-crucifer crops. Spray the crop twice or thrice with a mixture of 40 g of Streptocycline + 200 g of Copper Oxychloride in 200 liters of water at an interval of 7-10 days. Growing resistant varieties is durable and economical method of managing the disease.

Soft rot (*Erwinia carotovora*)

It is a serious problem of cauliflower, cabbage and broccoli during transit but may also occur in the field. The disease appears after occurrence of black rot or due to mechanical injury. The symptoms appear as water-soaked or greasy spot on leaves at the base of the curd. The affected curds emit foul smell.

CONTROL

Avoid mechanical injury to mature heads and control black rot. Grow resistant varieties.

Club root (*Plasmoidophora brassicae*)

It is caused by a soil borne pathogen that remains active for 4-7 years even when crucifers are not cultivated in the field. The disease appears in cauliflower, cabbage, broccoli, Brussels sprouts, Chinese cabbage etc. The first signs of infection are turning of leaves into pale green to yellowish colour which may show flagging and wilting during hot sunny days. The infected plants may remain stunted and later dry. The characteristic symptoms are appearance of small or large spindle like spherical or club-shaped swellings on roots and rootlets which interfere in absorption of mineral nutrients and water resulting in wilting of plants.

CONTROL

Remove and destroy the diseased plants and alternative host plants from vicinity of the crop fields. Improve soil pH to neutral level by adding lime @ 2.5 tonnes per hectare. Follow long term crop rotations with non-cruciferous crops.

Stalk rot (*Sclerotinia sclerotiorum*)

It is a destructive disease of cabbage and cauliflower worldwide and the pathogen has wide host range. The disease occurs in field, transit and storage. It is more serious under cool and humid conditions. Leaves of the infected plants turn pale yellow. Older leaves touching the soil show dark brown to black soft rot showing fluffy growth of fungus. Stem and inflorescence twigs become straw coloured and dry. Pith of infected plant portion is filled with black, hard sclerotia of variable sizes.

CONTROL

Ensure good drainage conditions in the field. Follow crop rotation with non-crucifer crops like beets, cereals, groundnut etc. to reduce soil inoculums. Spray the crop with Benlate or Bevistin @ 0.1 percent.

Downy mildew (*Peronospora parasitica*)

The disease affects both seedlings and mature plants. The disease is more serious under high humidity conditions. The symptoms appear as white mildew growth generally on under- side of leaves. Yellowing may appear on upper surface of leaves. The infected areas enlarge in size and turn tan and necrotic. Affected leaves wither and die. Maturing heads or curds are also damaged and show browning. Severely infected curds rot and fail to produce seed.

CONTROL

Follow crop rotation with non-crucifer crops. Clean cultivation and wider spacing between plants help to reduce disease incidence. Grow resistant varieties and spray the crop

with Indofil M-45 @ 3.0 g per litre of water. If disease is severe, spray the crop with Ridomil MZ @ 0.25 g per litre of water.

Black leg (*Phoma lingam*)

The fungus is seed borne and attacks the crop at any growth stage. The disease appears as depressed light brown to dark brown cankerous spots near the base of stem which later enlarge and girdle the stem. Affected plants collapse and fall down.

CONTROL

Treat the seed with hot water at 50°C for 30 minutes and grow resistant varieties. Avoid planting in poorly drained soils and follow clean cultivation. Seed treatment with Benomyl (24 hour soaking in 0.2 percent solution) is also effective to kill the fungus in seed.

Alternaria leaf spot (*Alternaria brassicae* and *A. brassicicola*)

Small light brown to dark brown circular spots appear on leaves. Later on these spots develop concentric rings. Infected leaves turn yellow and drop. In seed crop, the symptoms may also appear on seed stalks and seed pods resulting in reduced seed yield. The disease is serious under hot and humid conditions.

CONTROL

Follow clean cultivation and crop rotation with non-crucifer crops. Hot water treatment of seeds at 50°C for 30 minutes is effective to check seed borne inoculum. Spray the crop twice or thrice with Indofil M-45 or Kavach @ 0.25 g per litre of water at 7-10 day intervals.

Cabbage yellows or Fusarium wilt (*Fusarium oxysporum* f.sp. *conglutinans*)

The fungus is both seed and soil borne. It affects cabbage and Brussels sprouts. First sign of the disease is yellowing and browning of lower leaves. The affected plants look pale and remain dwarfed. The older leaves defoliate. Pith of the infected stem shows yellowing or browning of vascular bundles

CONTROL

Field sanitation, disease free seed and crop rotation reduce incidence of the disease. Growing resistant varieties is the best method of the disease management. COLE CROPS 17