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PRACTICAL MANUAL OF PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS



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Production Technology of Under-exploited Vegetable Crops**

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PREFACE

We have made our best effort to collect the various current updates of horticulture from expert teachers and successful students. It is our sincere hope that this Practical Manual can serve the purpose of students to succeed in various ICAR Competitive examinations.

I lay claim to originality; some of the subjects have been attempted in various different ways, before. I take the responsibility for any lapses in content, format and approach of the content and also for any other errors, either scientific or linguistic and will look forward to receiving reader's corrections or suggestions for improvement of Manual. The research information, research report and concept are collected from top ranked journals with good impact factor and authorized article printouts.

I hope that this Manual will be useful for undergraduate, Post graduate students, teachers and horticulture people across the country.

First of all, my humble and devoted prostration to almighty God with soulful respect. I bow down my head to him who enlightens and leads me in right way, with whose blessings I reached at this stage. We gratefully acknowledge the encouragement and enthusiastic cooperation extended by all our Colleagues in the faculty of horticulture more particularly by Dr. R. S. Verma, Assistant professor Department of Horticulture, BBAU, Lucknow (U.P.) I owe my gratitude to Dr. S.K. Verma, Senior & Head. KVK, Balrampur, (U.P.) for his co-operation, valuable suggestions and healthy criticism toward completion of manual work.

Publishing a Practical Manual requires diligence, patience and understanding on the part of the publishers. We are very grateful to Bhumi Publishing, Nigave Khalasa, Kolhapur, Maharashtra, India for having all these good qualities and bringing the excellent format of this Practical Manual.

**- Samiksha
Lalit Kumar Verma
Vivek Kr. Patel**

ACKNOWLEDGEMENT

Every effort is motivated by ambition and all ambitions have an inspiration behind. We owe this putting all things aside, first and above all, we would like to praise and thank the "Lord Hanuman" the Almighty the merciful compassionate, juncture. He bestowed us by giving strength, courage and confidence to write this book. His love, care and blessings made us achieve success in each and every step of our life.

Though only our name appears on the cover of this Practical Manual, many great minds have contributed to the successful completion of this Manual. The cooperation, timely help, perpetual support from galaxy of teachers, seniors, colleagues, friends and juniors had been a perennial source of inspiration for the attainment of our success.

Special thanks to Dr. S. K. Sahu (Khairagarh C.G.), Dr. Anita Kerketta Assistant professor Department of Horticulture, SHUATS, Naini, Prayagraj, Dr. S.K. Verma, Senior & Head KVK, Balrampur, (U.P.), Mr. B. P. Purame, late Mrs. Rekha Bai, N. Gupta and Shweta Verma.

We are very grateful to Bhumi Publishing, Maharashtra India Publication to bring the excellent format of the Practical Manual.

**- Samiksha
Lalit Kumar Verma
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PRACTICAL 1

Objective: To study the identification of important underexploited vegetable crops and their seeds

1. Asparagus



2. Artichoke Seed



3. Leek Seed



4. Brussels Sprout



5. Chinese Cabbage



6. Broccoli



7. Kale



8. Jerusalem Artichoke



9. Amaranths



10. Celery



11. Parsley



12. Parsnip



13. Lettuce



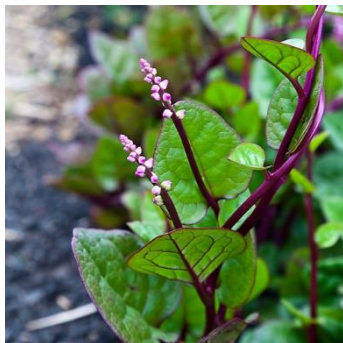
14. Rhubarb



15. Spinach



16. Basella



17. Bathu (Chenopods)



18. Chekurmanis



19. Elephant Foot Yam



20. Lima Bean



21. Winged Bean



22. Vegetable Pigeon Pea



23. Jack Bean



24. Sword Bean



25. Sweet Gourd



26. Spine Gourd



27. Oriental Pickling Melon



28. Little Gourd (Kundru)



PRACTICAL 2

Objective: To study the botanical description of plants

Sr. No.	Common Name	Botanical Name	Family	Chromosome No.
1.	Asparagus	<i>Asparagus officinalis L.</i>	Liliaceae	2n=20
2.	Globe Artichoke	<i>Cynara scolymus</i>	Compositae/ Asteraceae	2n=34
3.	Jerusalem Artichoke	<i>Heliathus tuberosus</i>	Asteraceae	2n=102
4.	Leek	<i>Allium porrum</i>	Alliaceae	2n=4x=32
5.	Brussels Sprouts	<i>Brassica oleraceae Var. gemmifera</i>	Cruciferae	2n=18
6.	Chinese Cabbage	<i>Brassica compestris</i>	Brassicaceae	2n=20
7.	Broccoli	<i>Brassica oleraceae Var. italic</i>	Cruciferae	2n=18
8.	Kale	<i>Brassica oleraceae Var. acephala</i>	Cruciferae	2n= 18
9.	Amaranthus	<i>Amaranthus spp.</i>	Amaranthaceae	2n=32
10.	Celery	<i>Apium graveolens</i>	Apiaceae	2n=22
11.	Parsley	<i>Petroselinum crispum</i>	Apiaceae	2n=22
12.	Parsnip	<i>Pastinaca sativa</i>	Apiaceae	2n=22
13.	Lettuce	<i>Lactuca sativa</i>	Compositae	2n=18
14.	Rhubarb	<i>Rheum rhaponticum</i>	Polygonaceae	2n=44
15.	Spinach	<i>Spinacia oleracea</i>	Chenopodiaceae	2n=12
16.	Basella	<i>Basella alba</i>	Basellaceae	2n=48
17.	Bathua (Chenopods)	<i>Chenopodium album L.</i>	Chenopodiaceae	2n=36.
18.	Chekkurmanis	<i>Sauropus androgynus</i>	Euphorbiaceae	
19.	Elephant Foot Yam	<i>Amorphophallus paeoniifolius</i>	Araceae	2n= 26,28
20.	Lima Bean	<i>Phaseolus lunatus</i>	Leguminoacaeae	2n=22
21.	Winged Bean	<i>Psohocarpus tetragonolobus</i>	Leguminoacaeae	2n=22

22.	Vegetable Pigeon Pea	<i>Cajanus cajan var. bicolor</i>	Leguminoaceae	2n=22
23.	Jack Bean	<i>Canavalia ensiformis</i>	Leguminoaceae	2n=22
24.	Sword Bean	<i>Canavalia gladiata</i>	Leguminoaceae	2n=22
25.	Sweet Gourd	<i>Momordica cochinchinensis</i>	Cucurbitaceae	2n=28
26.	Spine Gourd	<i>Momordica dioica</i>	Cucurbitaceae	2n=28
27.	Pointed Gourd	<i>Trichosanthes dioica</i>	Cucurbitaceae	2n=24
28.	Oriental Picking Melon	<i>Cucumis melo var. conomon</i>	Cucurbitaceae	2n=24
29.	Little Gourd	<i>Coccinia indica</i>	Cucurbitaceae	2n=24

PRACTICAL 3

Objective: To study about nursery layout and planting of underexploited vegetable crops

Site of the Nursery:

- Nursery should be situated near the main field so that it's easy for the time of transplanting.
- Nursery area should get proper sunlight from morning to evening so, for this south-west aspect is most suitable as it very sunny.
- The area should be provided with proper drainage. There should not be any water stagnation.
- Stray animals and strong winds should be prohibited in the nursery area.
- Water source should be available near the nursery area for proper irrigation.

Nature of Soil:

- It should contain good organic matter.
- The texture of the soil should neither be too coarse nor too fine.
- The soil should be porous and properly aerated.
- The water holding capacity of the soil should be high.
- 6 to 7 pH range should be of the soil.
- Soil should be neutral as acidic and alkaline soils are not suitable for raising nursery.
- Soil should have adequate amount of all essential nutrient elements. Soil testing of nursery area should be done from time to time so that additional nutrients can be mixed for improving the fertility of soil.

Steps for Nursery bed preparation:

- The field should be ploughed and proper levelling should be done. The soil should be fine textured. It should be free from clods and debris.
- The bed should be raised bed so that proper drainage of excess water is possible. On both side of the bed surface there should be little slanting.
- 3 to 5 m should be the length of the nursery bed it can be changed according to the land and requirement of the plant but the breadth of the bed should not be more than 1.00 to 1.2m and the height should be 15 to 20cm.
- 3m×1m×15cm is the standard size of the nursery bed.

- Spacing should be 32-40 cm. This space can be used for inter cultural operation such as reading disease and pest management. Access rainwater can also be drained out from this space.
- There should be addition of 20-25kg of well rotten FYM with 200g of single super phosphate and 15-20g of fungicides and insecticides such as mancozeb and dusts like methyl parathion.
- Type of crop, season and growing area of crop for transplanting decide the number of nursery beds to be prepared.
- In East and West direction beds should be prepared and line of sowing of sheets should be from north to south direction on the beds.

Procedure of Seed sowing in Nursery bed:

- Seed should be treated with fungicides like Bavistin or thiram or captan @3g/kg of seed to prevent soil borne diseases.
- Rows should be made at a spacing of 5 cm.
- At 1 cm depth of height seeds are sown.
- For uniform distribution in the rows a little bit of sand is mixed in the seed and it is covered with soil or farmyard manure.
- Broadcasting of seeds should be avoided in nursery bed thick sowing or sowing with broadcasting oil leads to damping of disease increment.

Shading nets or polysheets use:

- If there is very high temperature (>30°C), after seed germination or during the Seedling growth then cover the practical manual Olericulture-I 20 and the nursery bed with 50% or 60% shading nets (green or green + black coloured) about 60 to 90 cm above the ground by providing suitable support.
- Covered the nursery bed in night with polishing sheet of about 60 to 90 cm above ground in winter season. In morning before the temperature rises remove the as
- sheet. This technique is used to protect Young seedlings from severe Frost or low temperature injury.
- Nursery bed can be covered by policy during rainy season also.

Irrigation:

- With the help of Rose can light irrigation is provided to the nursery bed till the seeds germinate.
- Irrigate the bed twice during morning and evening in summer season.

- In winter season irrigation is sufficient once a day.
- Nursery bed should be moist not wet otherwise jumping-off of seedling may appear.
- Irrigation depends on the weather condition. Irrigation is done when temperature is high and is not needed during rainy season.

Thinning:

- Thinning is done to remove weak unhealthy, diseased, insect-pest damaged and densely growing plants from the nursery beds, it is done by keeping distance of about 0.5 to 1 cm from plant to plant.
- Balance light and air is facilitated to each and every plant by thinning. Also helps to check the disease and insects pest infestation.

Steps for inter culture and weed control:

- Weeding is necessary at proper interval of time for getting healthy seedlings. Weeds can be removed manually either by hand or by hand hoe (thin forked khurpi).
- After the seeds showing pre emergence herbicides can be sprayed to control the weeds. After seeds sowing stomp @3ml/litre of water should be sprayed on the Nursery bed and it is covered with mixture of farmyard manure, soil and sand.
- Spray urea@ 0.3% for good quality seedlings when the plants are 8 to 10cm tall.

Plant protection:

- Plant protection is important measure in the nursery against incidence of insect pest and diseases to get healthy seedlings.
- Damping off is a serious pest disease.
- Seed should be treated with Bavistin or thiram or captan @2.5g/kg of seed.
- Drench the nursery beds with 0.1 % solution of brassicol or 0.7% of captan or thiram after germination when disease appears after seed emergence.
- To avoid further spread of pest and diseases affected seedlings is removed or disposed off.

Hardening of plants:

- Stop irrigation in the nursery bed before 4 to 5 days of transplanting but on the day of transplanting first water is applied in the nursery bed and then plant is taken for transplanting.
- To prevent or check the growth hardening should be gradual.
- Crops like tomato brinjal and chillies of warm season cannot withstand severe hardening.

- Hardened plants can survive in weather conditions like hot days wind or low temperature more efficiently than non-hardened seedlings.

Transplanting:

- When plants become 10 to 15 CM tall after 4 to 6 weeks of sowing, they are ready for transplanting.
- Transplanting should be done always in afternoon and healthy plants are selected for transplanting.
- Seedling should be dipped in a solution of 0.25% of mancozeb and 0.05% of carbendazim before transplanting.
- The plants should be fixed well and irrigate them daily to establish them well.

5 primary advantages of transplanting:

- It enhances earlier harvest.
- It reduces the impact of adverse environmental conditions during the early Seedling growth.
- It reduces the quantity of seed needed for crop establishment.
- It enhances plant stands and faster maturity.
- It eliminates the need of thinning

PRACTICAL 4

Objective: To study about culture practice operation of underexploited vegetable crops.

1. Cultural practices followed in Amaranthus

- Amaranthus can be cultivated throughout the year.
- The field is prepared to field filth and the size of the bed prepared for growing crops is 2.0m × 1.5 m.
- For summer crop amaranthus should be shown during mid March and for kharif crop mid July.
- For 1 hectare 1.5 to 2 kg seed is enough for sowing. Seeds are very small so it should be mixed well with the sand and sown at the depth of 1cm and spacing of 30cm.
- For good germination a little irrigation is required. Seedlings of 2 to 3 cm long are thinned out to a spacing of 3 to 4 cm.

2. Cultural practices followed in Basella

- Basella is propagated through seeds for commercial purpose but stem or root cuttings are also practiced.
- Seeds are sown from March to May in norther and eastern part of India and grown twice once in july and again in October to November in southern parts.
- In hills late spring or early summer is the best time for sowing.
- Spacing is 45cm × 45cm.
- Plants are allowed to sprawl over the ground.
- The crop is grown on bamboo stakes or trained on trellis. Seeds are sown 20 to 25cm apart in rows at the base of bamboo stakes or trellis.
- Seed rate is 12 to 15 kg/ha.

3. Cultural practices followed in Broccoli

Preparation of land:

- Ploughing should be done thoroughly 3 to 4 times and make it friable.
- Land should be properly levelled before making small beds for planting crops.
- The size of the bed prepared should be 3×3 or 4×4m.
- About one-month prior land should be prepared before sowing and 15 to 20 tons of well rotten FYM per ha should be mixed in the soil.

Sowing:

- In northern India sowing time is September to mid November.
- Direct sowing and transplanting methods both are used.
- Seed rate for direct sowing is 2 to 2.5kg seed/ha and for transplanting seed required is 500 to 600g/ha.

Transplanting:

- For transplanting 3 to 4 weeks old seedlings are used.
- Spacing is 60×45cm.
- Thinning is essential in direct sowing method after 15 to 20 days of sowing.

4. Cultural practices followed in Lettuce

Preparation of land:

- Plough the soil to fine filth for two to three times.
- Conduct the soil test to check the nutritional status of soil.
- For the early harvest warm sandy soil are preferred and loam to clay loam or peat for late production. In hot weather Lettuce can be produced on peat soil.
- On the basis of soil testing micro nutrients are added if they are deficient in the soil.
- Lettuce generally prefers to grow in fertile soil and the pH of the soil should be 6 to 6.8.
- Soil should be constantly moist for good yields.

Time of sowing:

- Nursery should be prepared in the month of mid September to mid November.
- Coastal areas would be preferred for July, August, September and October months production.
- Distance should be 15 to 20cm for seed sowing.
- 3 to 4 days is required for germination of seeds.
- 3 to 4 hours of sunlight in morning is required by lettuce after germination.
- After 4 to 6 weeks seedlings are ready to transplant in the main field.

Seed rate:

- For 1-hectare 275g of seeds of lettuce is required.
- 1 to 2 kg for direct seeding is required.
- At the depth of 0.6cm or less lettuce seeds should be sown.

Beds:

- Raised beds should be prepared for transplanting and seeding.
- It's seeds are small in size and require a depth of $\frac{1}{4}$ inch or 0.6cm.

Spacing:

- Row to row spacing should be of 45cm and plant to plant distance should be of 30cm.

Plant population:

- No. of plants per hectare should be 50,000 to 60,000 plants.

Preparation and transplanting:

- Lettuce requires nutrient rich and well drained soil for its cultivation. So it necessary to perform a proper field preparation before sowing of seeds and transplanting of young seedlings.
- The most essential operation is Mulching in the cultivation of lettuce.
- Lettuce should be transplanted after last frost.
- Well drained soil free from soil stones and roots is required for lettuce cultivation.
- Lettuce seeds are also sown directly by some cultivators but this method is not recommended for high soil temperatures.

Irrigation:

- There should be proper drainage and organic content matter should be high.
- Regular supply of water is essential however high moisture level and excess water close to the time of harvesting can be destructive to the yield and quality of the crop.

5. Cultural practices followed in Celery

Propagation:

- Celery is grown from seeds, by raising seedlings in Nursery beds. The seed is sown directly in the month of October in rows at the depth of 2cm at the temperature of 15 to 20°C.
- Seedlings emerge within 2 weeks and rate of germination is 80%.

Seed Rate:

- Seed Rate = 1kg/ha.
- 60 days old seedlings of 12 to 15cm tall with 7 to 8 cm root growth ensure a good crop stand; this enables to escape from early season frost and low temperature.

Spacing:

- 30×30 or 40×25 cm

Nursery raising and transplanting:

- Seeds are sown in small beds at 8×1.25 m in Nursery between 15th September to 15th October at seed rate of 50gm per bed.
- Transplanting is done in early December late transplanting can reduce the yield significantly.

6. Cultural practices followed in little gourd

Preparation of land:

- Plough the soil to fine filth.
- Apply any well rotten manure along with micronutrients.

Method of propagation and planting in Ivy Gourd-

- Ivy gourd is generally propagated vegetative through stem cuttings.
- Stem cuttings is semi hardwood and length is 20cm and thickness is about 2cm.
- Stem cuttings have at least 4 to 6 leaves.
- 2 or 3 cuttings is planted at the depth of 6cm with basin diameter of about 2 meters.
- Distance between the basins is about 2m.

Season:

- The planting is done before rainy season starts I.e in June to July or in spring season from February to March.
- Female to Male plant population ratio is 10:1.
- Replanting is recommended after every 4 years as ivy gourd plants are perennial in nature.
- 2m bamboo sticks should be used to support the plant vines.

7. Cultural practices followed in Sprouting Broccoli

Nature of soil:

- Soil should be fertile and rich in organic matter.
- pH of the soil should be 5.5-6.5.

Seed rate:

- Seed rate = 300-500g/ha

Spacing:

- 45×45 or 60×45.

Time of sowing:

- In plain areas sowing is done in the month of October and in hilly regions sowing is done in the month of September.
- In high hills, sowing is done in May to June.
- Harvesting is done in late spring or early summer by over watering them.

Intercultural operations:

- Herbicides are used in initial stages and in later stages hand weeding is done along with fertiliser top dressings.
- Application of Alachor @2kga.i/ha or Trifluralin @0.5kg/ha or Pendimethalin @1.2kg a.i./ha. Or Fluchloralin @0.5kg a.i./ha for transplanting is beneficial for controlling annual land broad leaved weeds.

8. Cultural practices followed in Brussel Sprouts

Climate Requirements:

- It requires a cool climate for its growth.
- It is sensitive to high temperature.
- In hot weather bud clusters become loose quickly.
- It is tolerant to frost.
- However, the best quality sprouts are produced in sunny weather and light frost during night.
- Seed germination requires a temperature of 12-16°C and for optimum growth temperature required is 16-20°C.

Nature of soil:

- Brussels sprouts require sandy and silt loam for its growth.
- Drained upland soil is most suitable for its growth.
- Capability of retention of good moisture must be present in the soil.
- pH of soil should be 5.8 to 7.2.

Time of sowing:

- Sowing is done from June to July and transplanting is done from July to September for early crops and from October to mid- November for late crop in northern part of India.
- Sowing is started from mid to late September in eastern part of India
- In southern hills sowing is delayed except in western and southern peninsular regions where it can be grown all round the year.
- Seeds are sown in April to June for summer or autumn crop in high hills areas.
- In hilly areas which receive heavy rain , the summer or autumn crops are rather limited and sowing is done in autumn to harvest them in late spring or in early summer by over watering them.

Seed rate:

- Seed rate = 200-500g seed/ha.

9. Cultural practices followed in Chinese Cabbage

Climate Requirements:

- It requires temperature of 15 to 22°C during early growth of crop.
- 0°C temperature is tolerated for short period of time but too low temperature can induce premature bolting of Chinese cabbage.
- Winter season is best for growth of crops and there should be proper irrigation for good yields.

Soil:

- Sandy loam to texture loam soil is preferred.
- pH should be 5.5-7.0.

Preparation of land:

- Land should be ploughed to fine tilth.
- Chisel plough or disc plough is used to prepare the land. The land is prepared two months earlier. Weeds and unwanted plants residues should be removed.
- In case of sandy soils, rotary hoed cultivation is preferred to prepare a good seedbed.

Seed rate:

- 500-600g/ha with single grain technique and first Norma traditional seed technique about 1kg seed/ha is recommended.

Spacing:

- In row spacing is 15 to 20 cm.
- Distance should be 1-2 cm within the rows.
- Seeds should be sprinkled into furrows and covered with 1 to 1.5 cm of soil.

Transplanting:

- Seedlings can be transplanted when it is about 15 to 16cm tall or 2 to 3 weeks old.
- 75,000 to 80,000 seedling/ha is required.

Propagation:

- Propagation can be done from seeds.
- It can be directly sown in the Nursery bed.

10. Cultural practices followed in Kale

Soil:

- The soil should be fertile and rich in organic matter.
- pH of soil should be 5.5-6.5 as Kale is slightly tolerant to acidic soil

Land preparation:

- Ploughing should be done 4 to 5 times to fine tilth.
- At the time of field preparation manure should be applied. Drainage should be checked as it is main problem for early and sometimes for mid season crops when rain occurs during cropping period.
- Therefore, early crops should be transplanted on ridges or raised beds and mid and late crops should be planted on flat beds.

Seed rate:

- Seed rate = 400-500g/ha.

Planting:

- In northern India August to October is best time for planting. For H.P, Kashmir and nilgiri region August September is best time for planting.

Spacing:

- Spacing- 45cm×30cm.
- 5 to 6 weeks old seedlings are transplanted in the main field.

Weed control:

- Herbicides are used in early stages and then hand weeding is done in later stages of plant growth with fertiliser top dressings.
- Before transplanting application of Alachor @2kg a.i./ha or Trifluralin @0.5kg/ha or Fluchloralin @0.5kg a.i./ha is beneficial for controlling annual and broad leafed weeds.

11. Cultural practices followed in Elephant foot yam

Soil:

- Rich red loamy soil is preferred.
- pH range should be 5.5-7.0.

Climate Requirement:

- Requires well distributed rainfall with warm and humid weather during vegetative phase and dry and cool weather during corn development period.

Preparation of land:

- The land is ploughed to fine tilth.

Season and planting:

- For 45 to 60 days sit undergoes a dormancy period. Traditionally farmers take advantage of this period by planting the crop in the month of February to March so that sets would sprout with the pre monsoon showers.
- Planting season is April- May. The tuber is cut into 750-1000 g small bits so that each bit has at least a small portion of the ring around each bud. Whole corn of 500 g size can be also used for planting.
- Cormels and minisett transplants of 100g size are used planting material at a spacing of 45×30 cm.
- "Arumbu" projections with tender buds are removed before planting as they do not give vigorous growth.
- 6 to 8 bits is given by an ordinary sized yam for planting. The cut pieces are dipped in cow dung solution to prevent evaporation from cut surfaces.

Spacing and Planting:

- Spacing is 45×90 cm for cut pieces planting or pit of 60×60×45 cm size is dug and planted.
- The pit is filled with top soil and FYM 2kg/pit prior to planting. The ring, the sprouting region is kept above the soil while planting the pieces.
- For 1 hectare land about 3500kh of corms are required.
- Sprouting takes place within a month.

12. Cultural practices followed in Pointed Gourd

Land preparation:

- Land is ploughed 2 to 3 times to fine tilth. To enhance the fertility good manure should be applied.

Planting:

- It requires a warm and humid climate.
- It remains inactive in the winter season.
- It requires fertile soil.
- It requires well drained sandy loam soil because of its susceptibility to water logging.
- Female to Male plant ratio should be 9:1.

Distance:

- The row-to-row distance should be 1m and plant to plant should be 50cm.
- The distance between plants is between 1.5-2.0m × 1.5-2.0m.

Propagation:

- It is generally propagated through vine cuttings and root suckers.
- Seeds are not used for its propagation as crop establishment from seed may contain 50% no fruiting male plant.
- To propagate from root suckers, tuberous roots of pointed gourd are dug in the early spring, sub divided and replanted.
- For propagation both pre-rooted and fresh vine cuttings are used.
- Fresh vines used for planting should have 8 to 10 nodes per cutting and should be partially or fully defoliated to check transpiration.
- N:P ratio should be 90:60 kg/ha.
- Maximum early as well as total yield at N:P rates of 90:60kg/ha maximum number of fruits plants when both N and P are applied at the rate of 60kg/ha..
- To achieve maximum fruit production vines require training on some form of aerial support system.
- Vines trained on bower system have 14% higher yield than compared to those grown on the ground.

Yield:

- In tropical regions Pointed gourd produces maximum yield till 3-4 years and after that yield potential is gradually decreased.

13. Cultural practices followed in Spine Gourd

Climate and soil:

- It requires warm humid climate.
- This can be also grown in areas with temperature of 25-40°C and with annual rainfall of 150-200 cm.
- It requires sandy loam soil.
- Soil should be rich in organic matter and pH should range from 6.0 to 7.0.

Land preparation:

- The field is prepared by digging pit. The pit should be filled with 5kg FYM, 150g SSP and 50g MOP and 3g Furadon to protect from termites.
- To promote plant growth and development two time top dressings of Urea @80g near root zone is done.

Seed rate:

- Seed rate = 3000-5000 tubers/ha.

Time of sowing:

- February-March

Spacing:

- 2m×1m

Training:

- Different training system viz. Single stake system, bower and Kniffin system are followed as per availability of training materials.

14. Cultural practices followed in Asparagus

Soil, Climate and Rainfall:

- The soil should be light and medium loam or sandy loam soil well supplied with organic matter.
- It can be also grown in heavy clay soil with deep cultivation and well drainage.
- pH of soil should range from 6.0 to 6.7.
- Asparagus can also be grown in soil with high content of salt.

Sowing and transplanting:

- Seed rate = 8-10kg/ha.
- The seed is sown in early spring or during winter and requires 3 to 4 weeks to germinate and 8 to 10 weeks to produce 'Crowns'.
- Spacing- 1.5-2.0m and Distance is 45 to 60 cm.

Male and Female plants:

- Asparagus is a dioecious plant, i.e male and female flowers are produced on separate plants. In addition to dioecious plants, a small percentage of seedlings develop hermaphrodite plants.

Inter cropping:

- To compensate the expenses in the 1st and 2nd year low growing vegetables may be grown as inter crops between the rows of asparagus.
- Cole crops, Beans, green crops etc. Can be grown, provided enough nutrients are applied for both crops.

Cultural practices follow on different underexploited vegetable crops



Summer Ploughing



Final Field Preparation



Preparation on Nursery Beds



Final Nursery Bed Preparation



Sowing on Seeds in Nursery Bed



Sowing on Seeds in Pro- Tray



Germinated Plant on Pro-Trays (A)



Germinated Plant on Pro-Trays (B)



Transplanted on Plant in Main Field



Transplanted on Plant in Main Field

PRACTICAL 5

Objective: To study about short term experiments of underexploited vegetables

Introduction:

Huge number of underexploited vegetables is available; however, standardization of cultural practices is at to be done and standardized. Therefore, for pushing of production unexploited their efficiency a short-term experiment becomes essential. Therefore short term experiments are propose to be conduct under:

1. Asparagus:

Varieties

- Many new varieties of Asparagus are available now.
- There are two groups into which varieties are broadly divided, 1. With green-coloured spears: more popular and mainly used in fresh market.
- With white or light green coloured asparagus- mainly used for processing.
- All available male hybrids are more productive and they do not produce seed which sprout to become a weed.
- In North Carolina Jersey Gem, Jersey Giant and Greenwich produce superior yields.
- Jersey Gem is tolerant to Cercospora leaf spot disease.
- The extra seed cost is cut down by increased yields of hybrids

Perfection:

- Recommended by IARI, New Delhi.
- It is an early, uniform, productive variety and delicious with high food value.
- The appearance of spears is large green, succulent and light topped.
- Average yield = 80 to 100q/ha.

Selection-841:

- Bush type is medium, uniform and productive.
- The spears are 15 to 20 cm long, succulent, tender, green with better flavour and suitable for soup preparation.
- Average yield is 90 to 110q/ha.
- UC-72, UC-66 and Sel-831 are grown in Kashmir, India.

The recommended variety of IARI is Perfection.

Planting season:

- In hills: March-May
- In plains: July-November

Seed Rate:

- 3-4kg/ha

Nutrient management:

- Apply basal dose of chicken manure @75-125q/ha or FYM @150-260q/ha.
- Apply 80-120kg of nitrogen, 80-100kg of phosphorus and 60-80kg of potassium per hectare during succeeding years.
- Apply NPK once just before the appearance of spears in the spring in early March.
- At the conclusion of the harvest season in mid May apply the same amount of fertiliser.
- Apply the fertiliser at the top of soil or with very shallow incorporation.

a) Crown planting

b) Direct seeding methods

c) Seedling transplant method

Planting methods:

- Use disease free crowns only.
- The asparagus crowns should be planted in such a way that top of the crown is 15cm below the soil level.
- Plant crowns with distance of 30cm in the rows with buds upright, and 150 cm between rows to have 21,750 crowns per hectare.
- Crowns should be covered with 5-7.5 cm of soil after planting.
- Seeds should be placed at the distance of 5 cm in the rows and at the depth of 2-2.5 cm.
- Seed rate for single row seedlings is 2.5-3.4kg/ha and seed rate for double row seedlings is 4.5-6.8kg/ha.
- Peat pots, plastic pots, trays, peat pellets or seedlings type trays can be used to grow asparagus seedlings.
- 5×5 cm seedling cells are better for better seedlings growth and survival.

Irrigation:

- For good germination and early seedling growth adequate moisture should be maintained.
- During first two months the plant should not be dry while they are establishing a root system.

Weed management:

- Weed management is very important in asparagus production.
- Time cultivation is a critical part of any asparagus weed control program, especially during the first two years.
- The first year asparagus should be cultivated at least once in a month until September or 6 times.
- By using herbicides the number of cultivation may be reduced.
- After harvest remove all the weeds.

a. Asparagus Beetles

b. Asparagus Rust (*Pucciniaasparagi*)

c. Fusarium wilt

d. Violet Root Rot

Disease, insect pests and their control

- Adults and larvae damage the young shoots. Apply dust of 1% of rotenone on the spears to kill the beetles. Larvae are also effectively killed by the dust.
- It is the most serious disease. Reddish yellow spots appear on the trunk. This disease reduces the yield and sometimes also kill the plants.
- Fungus (*Fusarium* sp.) causes the disease in the soil. Brown discoloration is caused to the affected spears and it gradually shows wilting and stunt growth.
- This disease is caused by fungus *Helicoboridiumpurpureum*. Yellowing and dropping of leaves is caused. The diseased plants should be collected along with roots and destroyed.

Harvesting:

- During first year of planting Asparagus can be harvested within 2 to 4 weeks or 8 spears per plant.
- During the second-year harvesting should be limited as it results in slight reduction in spear size which is an indication of when to stop.
- Asparagus take long time to develop a large root system.

- Spears should not be taller than 22.5 cm.
- The decision on when to harvest is based on having an average of one harvestable size spear per foot of row.
- It may be necessary to harvest daily when temperature exceeds 27°C.

Yield:

- Male plants give higher the total yield while female plants give larger individual spears.
- Varieties, regions, climates and sex forms vary the varieties
- Average yield is 25-40q spears/ha.

Storage:

- Asparagus can be stored at 95% relative humidity and at 0-2°C for 2-3 weeks.
- After 13 or 16 days of storage spears stored in wet tissue paper looked fresh and firm.

2. Lettuce:

Some of the important varieties are

Punjab Lettuce No. 1:

- Recommended by Punjab Agricultural University, Ludhiana.
- Leaves are light green, shiny and crisp.
- It is non heading variety, it has loose leaves and takes about 45 days from sowing to first harvest.
- Average yield = 88q/ha.

Great lakes:

- Released by IARI, New Delhi, crisp head type having large firm heads with green leaves. Outer leaves are blistered, resistant to tip burn but susceptible to powdery mildew.

Alamo-1:

- Released by Dr Y S Parmar University of Horticulture and forestry, Solan head type variety.
- Leaves are crisp, cup shaped, bending and dark green in colour.
- Head is solid and weight is 500 to 800 gm.
- Ready for harvest in 80 to 90 days.
- Average yield is 235q/ha.

- Few other varieties are Slowbolt (Leaf type), Chinese Yellow (Leaf type), Imperial 859 (Crisp Head type), White Boston (Butter Head type), Dark Green (Cos type), Alamo 1 (Head type), Simpson Black Seeded (Leafy type), Eves Wonder (Heading type) and Ruby (Leafy & purple coloured).

Recently developed Lettuce cultivars:

- Cultivars 9547 and 9542, Salma, Svetlana (Nathasha), Impact, Magnum, Marksman, Diamond, Elisa and Florida Buttercrops.

Nutrient management:

- 100-150q of well rotten FYM should be incorporated during land preparation for getting higher yields.
- Along with this 50kg of N and K₂O and 90kg of P₂O₅ should be applied.
- At the time of field preparation entire quantity of FYM, P, K and half N is applied. The rest of the N is top dressed after one month of first application at the time of earthing up.

Irrigation:

- In directly sown crops a pre-sowing irrigation is done when there is no sufficient moisture in the soil.
- Lettuce crop should be irrigated after the transplanting.
- Irrigation is done at the interval of 8 to 12 days.

Intercultural operations:

- To maintain proper aeration and to be free from weeds shallow hoeing and weeding is done.
- 3 to 4 hand weeding at the interval of 15 to 21 days are sufficient.
- Fluchloralin @1.0-1.5kg/ha is applied before transplanting to control most of the weeds.
- Propyzamide @1.5kg/ha when applied as pre-planting prove to be effective herbicide for control of weeds.

Harvesting:

- It depends on the type and purpose for which it is grown.
- Solid head is developed by head lettuce for the market.
- The leafy variety is ready for harvest within 50 to 60 days and is harvested when leaves attain full size but remain tender.

- The head type variety is ready to harvest within 60 to 70 days. When head type attain a good size and become solid they are harvested.
- For consumption at home lettuce leaves can be harvested at any time but for market purpose it need to attain full size.

Yield:

- Yield is 100-140q/ha.

3. Sprouting Broccoli:

Cultivars:

Palampur Green:

- Leaves are green and tender, stem is creamy and late flowering type.
- After 23-30 days 5-6 cuttings are provided and after 15 days subsequently.

Pusa Sag:

- It is cross of Wongbok×Turnip
- It tastes like local sag.

Solan Band Sarson:

- It is a head variety head is long and solid and weighs about 700-1100 gm and have 6-9 outer leaves.
- It is ready within 120 days, leaves light and core light golden in colour.
- It is suitable for long distance transportation and it is used for salad and cooking.
- Avg yield is 400q/ha.

Solan Selection:

- Leaves are tender, well filled and light green petioles.
- Avg yield is 150-190q/ha.

Chinese Sarson No. 1:

- It is non-heading type leaves are light green and broad. It has semi-erect plant habit.
- Mid-rise is white, succulent and tender.
- First cutting after transplanting can be done within 30 days.
- It is quite rejuvenating, giving 6 to 8 cuttings.
- Average yield is 40q/ha.
- It is resistant to *Alternaria* leaf spot.

Other cultivars fall in the following groups:

- Chiffu Group
- Hotoren Group
- Kaha Group
- Aichi Group
- Kenshin Group

Sowing time:

- Mid September to end of November in plains while in mid hills April to July.

Seed rate:

- For Direct sown crops it is 2-2.5 kg/ha but when transplanted then it will 500-750g/ha.

Spacing:

- Early maturing varieties- 30-40 × 30-40 cm
- Late maturing varieties- 70 cm × 55 cm

Nutrient management:

- The requirement of manures and fertilizer depends upon the fertility of soil in Chinese cabbage.
- At the time of field preparation 200-250q/ha FYM is applied.
- The application of NPK depends on the soil type, varieties and place.
- N:P:K requirement is 250-300:150-200:250-300kg/ha. Half quantity of N and full quantity of P and K is applied at the time of transplanting.
- The remaining quantity of N is applied after 30 days of transplanting.

Irrigation:

- The first irrigation should be done just after transplanting.

Water management:

- Chinese cabbage is very sensitive to soil moisture.
- Sufficient quantity of water is required for maximum growth and yield.
- First irrigation is given immediately after transplanting.
- Irrigation may be done at the interval of 10-15 days according to the season and soil but soil moisture should be maintained regularly.
- Furrow method of irrigation is used for irrigation.
- At the time of maturity of heads heavy irrigation is avoided.

Binding:

- In winter for harvesting heads which are near to maturity are covered with outer leaves and bound with rice straw to protect them from cold damage.

Harvesting:

1. Heading Type:

- Harvesting is done when compact head becomes of 1 to 2 kg.
- Heads are cut off using kitchen knife.
- Before marketing fully developed heads are cut from the stalks and loose outer leaves are removed.

2. Non- Heading Type:

- Harvesting is done of fully developed leaves from base without injuring the central growing point.

Yield:

- 250-500q/ha.

4. Elephant Foot Yam:

Varieties:

- See Padma – It was developed at CTCRI, Triruvannthapuram; yield is 42 t/ha.
- Gajendra – It was developed at APAU, Hyderabad.

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