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VEGETABLE SEED PRODUCTION - A READY RECKONER

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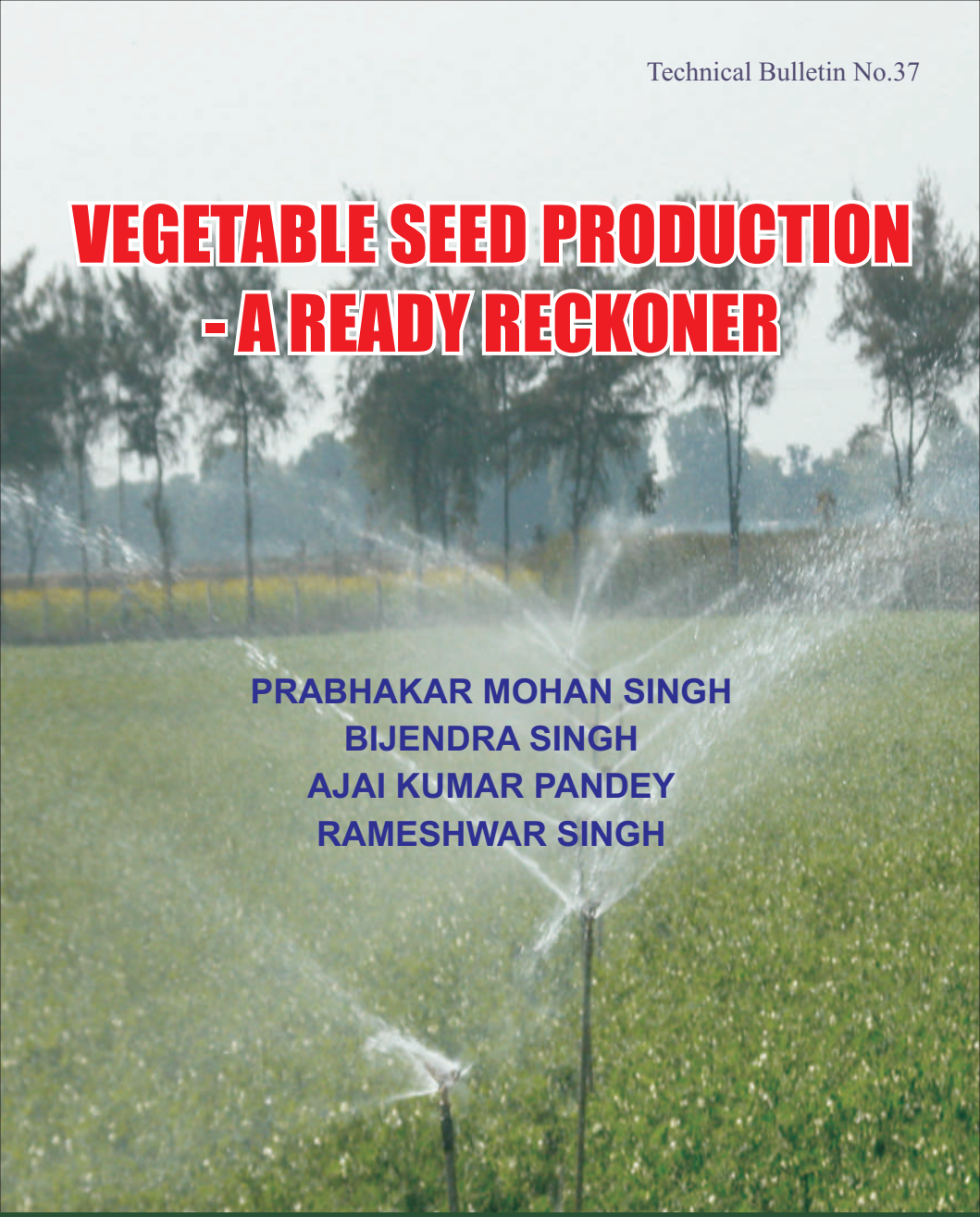

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Preface

Vegetables occupy an important place in diversification of agriculture and have played a pivotal role in nutritional security. With the changing paradigms of food and nutritional securities, the consumption of vegetables have attained tremendous importance. To meet the ever increasing demand of burgeoning Indian population, production and productivity of vegetables has to be increased manifolds. Due to increasing pressure on land through urbanization and industrialization, it is not feasible to increase the area under vegetables commensurate to our requirements hence the preciousness of high quality vegetable seeds becomes much more significant than it has ever been to increase the yield per unit area. Although use of quality seeds of improved varieties of different vegetable crops has witnessed tremendous growth in vegetable production and productivity, however, the availability of quality seeds in time and at affordable price is still a matter of great concern. Hence, it is imperative to enhance our vegetable seed production. For the pursuit, involvement for seed production at all the levels should be encouraged and for it a 'Ready Reckoner' for vegetable seed production is the need of the hour. Since there is a need for compiled information at one place for seed production of different vegetables, this bulletin has been developed and an attempt has been made to provide the information in a concise manner. Photographs have been included at places to make the text more comprehensive.

The authors are grateful to ICAR for providing necessary support to bring out this publication and to Director, IIVR for constant inspiration and encouragement for compilation of information on vegetable seed production. The valuable suggestions and inputs given by different colleagues are highly appreciated.

It is hoped that the publication will be useful for vegetable seed growers, research workers, teachers, students, planners, NGOs and extension personnel.

March 2010 Authors

Varanasi

Contents

1. INTRODUCTION

The availability of quality seed is of utmost importance for increasing the vegetable production. Vegetable growers recognize quality seed of improved varieties as the most strategic resource for higher and better vegetable yields. Although India ranks second in vegetable production, the quality vegetable seed production in the country has been insufficient.

The growth of plant and the quality of seed production are strongly influenced not only by genetic factors but also by the environmental condition, in which production is undertaken. Emphasis should always be laid on those factors which contribute to and affect seed quality like selection of crop and variety, seed source, roguing, harvesting and post harvest operations etc.

The package of seed production technology vary from location to location and from crop to crop. But a broad general recommendation can be adopted which could be suitably modified on the basis of individual vegetables and the growing area.

2. IMPORTANT VARIETIES

1. Tomato (*Lycopersicon esculentum* Mill.)

a. **Determinate types** – Kashi Vishesh, Kashi Anupam, Kashi Amrit, Pusa Early Dwarf, Pusa Gaurav, Azad T-6, Azad T-2, Punjab Kesri, Punjab Chhuhara, S-12, Hisar Arun, Hisar Lalit, HS-101, HS-102, Mani Leima, Narendra Tomato-2, CO-2, CO-3, Utkal Pallavi.

b. **Indeterminate types** - Pusa Ruby, Sel-120, Narendra Tomato-4, Narendra Tomato-5, Pant T-3, Pant Bahar, Marglobe, Arka Meghali, Arka Saurabh, Arka Vikas, Solan Vajr, Utkal Kumari.

2. Brinjal (*Solanum melongena* L.)

a. **Long type –** Kashi Taru, Pusa Purple Long, Pusa Purple Cluster, Pant Samrat, Azad Kranti, Pusa Anupam, Punjab Sadabahar, Punjab Barsati, Arka Nidhi, Arka Sheel, Arka Keshav, Utkal Keshari, Swetha

b. **Round type** - Pusa Purple Round, Pusa Kranti, Pusa Uttam, Pusa Upkar, Pant Rituraj, Kalyanpur T-3, Azad B-1, Azad B-2, Hisar Shyamal, Jamuni Gola, Punjab Bahar, Aruna, MDU-1, Swarna Mani, Utkal Tarini

c. **Green brinjal** - Green Brinjal Long-1, CO-1, Phule Harit, Arka Kusumakar, Arka Shirish, Utkal Madhuri

3. Chilli (*Capsicum annuum*)

Kashi, Anmol, Pusa Jwala, Azad Mirch-1, Pant C-1, Punjab Lal, Punjab Guchhedar, JM-218, MDU-1, CO-2, PKM-1, CA-960, LCA-235, LCA-334, K-1, K-2, Andhra Jyoti, Bhagya Lakshmi, Musalbadi, Jayanti, Arka Suphal, Arka Lohit, Anugraha, Kashmir Long-1, Utkal Ava.

4. Capsicum (*Capsicum annum* var. *grossum* L.)

California wonder, Arka Mohini, Arka Gaurav, Arka Basant, Nishat-1, Pusa Deepti.

5. Vegetable Pea (*Pisum sativum* L.)

Early varieties - Kashi Nandini, Kashi Uday, Kashi Mukti, Ageta-6, Arkel, Azad P-3, Jawahar Matar-3, Jawahar Matar-4, PM-2, Pant Matar-2, Hisar Harit, VL-7, Swarna Mukti, NDVP-12, Lincoln,

Mid season varieties - Azad P-1, Azad P-5, Kashi Shakti, Bonneville, Jawahar Matar-1, JM-2, JP-83, JP-71, VL-3, VL-6, VL-8, P-88, Pant Uphar, NDVP-8, Arka Ajit

Edible podded varieties - Mithi Phali [Oregon Sugar Pod]

6. French Bean (*Phaseolus vulgaris* L.)

Pole types - Kentucky Wonder, Pusa Himalata, SVM-1, VL-12, VL-17

Bush types - Arka Komal, Arka Suvidha, Contender, Kashi Param, Azad Rajmah-1, Premier, VL Boni-1, VLRajmah-63, Pant Anupama

7. Cowpea (*Vigna unguiculata* L.)

Kashi Kanchan, Kashi Unnati, Arka Samrudhi, Pusa Komal, Pusa Phalguni, Pusa Barsati, Pusa Rituraj, S-263

8. Dolichos Bean (*Dolichos lablab* L.)

Pusa Early Prolific, Rajani, Kalyanpur Type-2, Jawahar Sem-53, Jawahar Sem-85, Konkan Bhushan, CO-1, CO-2, Swarna Utkrisht, Phule Gauri

9. Cluster Bean (*Cyamopsis tetragonoloba* L.)

Pusa Nav Bahar, Pusa Mausami, Pusa Sadabahar.

10. Okra (*Abelmoschus esculentus* L. Moench.)

Kashi Pragati, Kashi Vibhuti, Kashi Satdhari, Parbhani Kranti, Pusa Sawani, Punjab Padmini, P-7, Azad Bhindi-1, Phule Utkarsh, CO-2, MDU-1, Varsha Uphar, Arka Anamika , Arka Abhay, Varsha Uphar, Hisar Unnat, Susthira

11. Cauliflower (*Brassica oleracea* var. *botrytis* L.)

Early varieties - Early Kunwari, Kashi Kunwari, Pusa Katki, Pusa Deepali, Pusa Early Synthetic, Improved Japanese, Pant Gobhi-3

Mid season varieties - Pant Shubhra, Pusa Synthetic, Pusa Shubhra, Gobhi-4, Hisar-1

Late Varieties - Pusa Snowball-1, Snowball-16, Pusa Snowball K-1, Pusa Himjyoti

12. Cabbage (*Brassica oleracea* var. *capitata*)

Golden Acre, Pride of India, Copenhagen Market, Pusa Mukta, Pusa Drum Head

13. Knol-Kohl (*Brassica oleracea* var. *gongylodes*)

White Vienna, Purple Vienna, King of North, Large Green

14. Radish (*Raphanus sativus* L.)

Asiatic/Tropical types - Kashi Shweta, Kashi Hans, Pusa Chetki, Pusa Reshmi, Japanese White, Kalyanpur No.1, CO-1, Chinese Pink, Arka Nishant

European/Temperate types - White Icicle, Pusa Himani, Rapid Red White Tipped, Scarlet Globe.

15. Carrot (*Daucus carota* L.)

Asiatic/Tropical types - Pusa Kesar, Pusa Meghali, Selection-223

European/Temperate types - Early Nantes, Chantaney, Zeno, Pusa Yamdagni

16. Turnip (*Brassica rapa* L.)

Asiatic/Tropical types - Pusa Kanchan, Pusa Sweti, Punjab Safed

European/Temperate types - Pusa Swarnima, Pusa Chandrima, Goldenball, Snowball

17. Beet or Garden beet (*Beta vulgaris* L.)

Beet has only european type of varieties. These are Detroit Dark Red, Crimson Globe, Crosby Egyptian, Early Wonders

18. Bottle gourd (*Lagenaria siceraria* Mol. Standl.)

Pusa Summer Prolific Long (PSPL), Pusa Summer Prolific Round (PSPR), Pusa Naveen, Punjab Round, Punjab Komal, Arka Bahar.

19. Bitter gourd (*Momordica charantia* L.)

Pusa Do Mausami, Pusa Vishesh, Kalyanpur Baramasi, MDU-1, Priya, Arka Harit, Punjab-14.

20. Sponge gourd (*Luffa cylindrica*)

Pusa Chikni, Pusa Supriya, Kalyanpur Chikni

21. Ridge gourd (*Luffa acutangula* (Roxb.) L.)

Pusa Nasdar, Kalyanpur Dharidar, PKM-1, CO-1, Arka Sujat

22. Ash gourd (*Benincasa hispida*)

Kashi Dhawal, Kashi Ujjwal, Pusa Ujjwal, CO-2

23. Pumpkin (*Cucurbita moschata*)

Pusa Vishwas, Pusa Vikas, Kashi Harit, CM-14, CO-1, CO-2 Arka Chandan.

24. Cucumber (*Cucumis sativus* L.)

Swarna Ageti, Poinsette, Sheetal, Khira-90, Poona Khira, Kalyanpur Green

25. Muskmelon (*Cucumis melo* L.)

Hara Madhu, Pusa Rasraj, Pusa Madhuras, Pusa Sharbati, Kashi Madhu, Punjab Rasila, Punjab Sunehri, Durgapura Madhu, Hisar Madhur, Arka Rajhans.

26. Watermelon (*Citrullus lanatus* Thunb.)

Sugar Baby, Asahi Yamato, Durgapura Meetha, Durgapura Kesar, Arka Manik.

27. Round melon (*Praecitrullus fistulosus*)

S-48, Arka Tinda

28. Long melon (*Cucumis melo* var. *utilissimus*)

Arka Sheetal, Lucknow Early

29. Onion (*Allium cepa* L.)

Pusa Red, Pusa Ratnar, Baswant-780, N-2-4-1, N-53, Agri Found Dark Red, Agri Found Light Red, Arka Niketan and Arka Kalyan

3. ISOLATION DISTANCE

Maintaining proper isolation distance is a must for obtaining pure seeds of any particular variety. The isolation distance is decided based on the nature of pollination in a particular crop and the class of seed being raised. The recommended isolation distances for different vegetables are provided in the following table :

Table 1 : Recommended isolation distance for foundation & certified seed production of different vegetables

Vegetable Crops		Minimum isolation distance (metres)	
		Foundation seed	Certified seed
1.	Cowpea	10	5
2.	Garden pea	10	5
3.	Chilli & Capsicum	400	200
4.	Cauliflower, Cabbage & Knol khol	1600	1000
5.	Lettuce	50	25
6.	Carrot	1000	800
7.	Onion	1000	500
8.	Radish and Turnip	1600	1000
9.	Okra	400	200
10.	Tomato	50	25
11.	Brinjal	200	100
12.	Cucurbits	1000	500
13.	Spinach beet (Palak)	1600	1000

4. CULTIVATION PRACTICES

4.1 Solanaceous Crops

The method of cultivation for seed production is nearly the same as that of cultivation for vegetable production. However, the care must be taken to maintain the specified isolation distance. The details about sowing and transplanting time are given in Table-2 and seed rate, planting distance & fertilizers in Table-4. Roguing of seed crop throughout the crop period is must to maintain true to the type plants. The most important roguing stages have been given in Table-5.

4.2 Cole Crops

Individual plants with good curd (cauliflower), head (cabbage) or knob (knol-khol) are marked and allowed for bolting and seed production. Roguing of seed crop throughout the crop period is essential to maintain the true to the type plants (Table-5).

In case of cauliflower, the seeds of early and mid varieties are produced in plains while seed of late variety (snow ball types) are produced in mid hills due to low temperature requirement (below 10 °C for 6–8 weeks after full vegetative growth, but before curd formation). The seeds of cabbage and knol khol are produced in high hills as they require chilling temperature of 4–7 °C for 6-8 weeks after head and knob formation to produce flower stalk.

The methods of seed production in cole crops are as follows:

I. Seed to seed method - In this method, the plants with good curd (cauliflower) head (cabbage) and knob (knol-khol) are left in the field where they flower and produce seeds. But this method occupies lot of area because selected plants for seed production are left scattered in the field. However, in early cauliflower this method yields relatively better quality and quality of seeds. The seeds ripen from March to May.

II. Head to seed method - In this method, the selected plants with head of cabbage/curd of cauliflower/ knob of knol khol are uprooted carefully and replanted in a compact block for seed production.

Table 2 : Time of nursery sowing and transplanting in transplanted seed crops

Northern Plains

S. No.	Name of the vegetable	Time of nursery sowing	Time of Transplanting
1.	Tomato	September	October
2.	Brinjal	July	August
3.	Chilli	July	August
4.	Cauliflower		
	Early	June –July	July-August
	Mid	August-September	September-October
5.	Onion		
	Kharif	June	August (Bulbs are harvested and planted in November)
	Rabi	November	January (Bulbs are harvested in April-May, stored for about 5-6 months and planted in November)

Temperate areas

Sl. No.	Name of the vegetable	Time of sowing		Time of Transplanting	
		1200 m and above	800-1200m	1200m and above	800-1200m
1.	Tomato	Mar-April	Feb-April	April-May	March-May
2.	Brinjal	Mar-April	Feb-April	April-May	March-May
3.	Cauliflower	Aug-Sept.	Aug-Sept.	Sept.	Aug-Sept.
4.	Cabbage	Mar-April	Feb-March	April-May	March-April

Sl. No.	Name of the vegetable	Time of sowing		Time of Transplanting	
		1200 m and above	800-1200m	1200m and above	800-1200m
1.	Knol khol	August.	August.	Sept.	Sept.
2.	Lettuce:				
	Loose leaf type*	Aug-Sept.	Aug-Sept.	Sept-Oct.	Sept-Oct.
	Heading type	Sept-Oct./ Dec-Jan**	Sept-Oct.	Oct-Nov./ Mar**	Oct-Nov.

Generally directly sown in Sept-Oct

**Late sowing (transplanting can be done in spring only)

4.3 Onion

Onion seeds are largely produced in Maharashtra, Gujarat, Madhya Pradesh and Rajasthan. In Northern India, generally in U.P., Haryana, Punjab, Bihar it is suffering with Purple Blotch thus the seed yield is very low and uneconomic. It is largely a cross-pollinated crop with upto 93% natural cross pollination (NCP), but some self pollination does occur. It is chiefly pollinated by honeybees. For seed production, an isolation distance of 1000m for foundation and 500m for certified seeds must be maintained. The details about sowing and transplanting time are given in Table-2 and seed rate, planting distance & fertilizers in Table-4. It is a biennial crop and takes two full seasons to produce seeds. In the first year bulbs are produced and in second year seed stalks are produced. It requires cool condition during early development of the bulb crop and again prior to and during early growth of seed stalk. Varieties bolt readily between 10-15^{0}C.

Mostly bulb to seed method is used for seed production. Seed to seed method is used in case the bulbs have lower keeping quality or in unavoidable circumstances. Well matured bulbs should he harvested and topped leaving an 1/2 inch mark. Before storage a thorough selection and curing of bulbs should be done. The length of time required for curing depends on weather conditions and

may take three to four weeks. The mature bulbs should be stored in well ventilated, cool stores (0-4.5^{0}C) until three to four weeks prior to planting. The roguing is started in the field when bulbs are not harvested. After harvesting the true to type bulbs are selected.

4.4 Vegetable Peas and Beans

The agronomic practices for the cultivation of seed crop are more or less the same as for green pods except that the sowing is adjusted such so that the seed maturity coincides with the drier part of the season. The other details are provided in Table-3 & Table-4. Although a self pollinated crop, pea is well known for producing off type plants. Hence, rigorous roguing must be undertaken at flowering and fruiting stage as mentioned in Table-5.

Table-3 : Time of sowing in direct sown seed crops

Plains

Sl. No.	Name of the vegetable	Time of sowing
1.	Okra	a) Feb-March for summer b) June-July for kharif
2.	Vegetable Peas	October last week to November1st fortnight
3.	French bean	October last week to November 1st week
4.	Cowpea	August 1st fortnight
5.	Radish [Asiatic type]	Sept. last to October IInd week
6.	Carrot [Asiatic type]	Sept. last to October Ist week
7.	Spinach beet	October- November
8.	Methi	October-November
9.	Cucurbits	a) Feb-March for summer b) June-July for kharif

Temperate areas

Sl. No.	Name of the vegetable	Time of sowing	
		1200 m and above	800-1200 m
1.	Okra	June	May-June
2.	Pea	October	October-November
3.	French bean #	June	June
4.	Radish	Sept.- Oct	Oct.
5.	Carrot	July-Aug.	July-Sept.
6.	Spinach	July August	Aug-Sept
7.	Cucumber	Mar-Apr	Feb-March
8.	Turnip	Aug	Aug-Sept
9.	Beet	July August	Aug-Sept

#seed rotting or germination in pods takes place because of rains if sown earlier

4.5 Okra

The agronomic practices are almost same as to be followed for the crop raised for vegetable production. However, the attention must be paid to maintain the specified isolation distance. YVMV is a very common problem in okra. The affected plants should be rogued out in addition to roguing off type plants, as mentioned in Table-5. In the recent past okra leaf curl, another viral disease, is affecting okra in several parts of the country particularly under north Indian conditions. The care must be taken to rogue out the affected plants as soon as they are spotted.

4.6 Cucurbits

The method of cultivation for seed crop is same like growing for fresh fruits. The details are provided in Table-3 & Table-4. Roguing of seed crop (Table-5) throughout the crop period is a must to maintain the true to the type plants. It is better to train the plants on a bower for increased yield.

Table 4 : Seed Rate, Planting Distance and fertilizer application in different vegetable crops

Crop	Seed rate/ha	Sowing/ Transplanting Distance (cm)	Fertilizers ($N:P_2O_5:K_2O$) kg/ha	Others
Tomato	400g	60x30(Det.) 100x60 (Indet.)	120:60:60	20kg/ha borax & 0.5% Zinc /ha
Brinjal	500g	100x90	120:60:60	
Chilli	650g	45x30	120:80:60	
Capsicum	700g	60x30	120:80:80	20kg/ha borax & 20kg/ha calcium carbonate
Vegetable Peas	100-160kg	23x5-7	60:60:60	
French Bean	50kg (Bush type) 40kg (Pole type)	45x15 (Bush type) 60x30 (Pole type)	120:60:60	
Cowpea	20kg (Bush type) 15kg (Pole type)	45x15 (Bush type) 60x30 (Pole type)	40:60:60	
Okra	18kg (Summer) 10kg (Rainy)	60x15 60x30	120:60:60	
Cauliflower	600g (Early) 400g (Late)	40x30cm (Early) 60x45cm (Late)	120:60:60	25kg/ha borax & 1.5kg/ha ammonium molybdate
Cabbage	600g (Early) 400g (Late)	40x30cm (Early) 60x45cm (Late)	150:60:60	
Radish	8-10kg	Sowing 45x8 cm Stecklings 75x60 cm	100:50:50 100:80:60	10kg boron/ha
Carrot	8-10kg	Sowing 50x10 cm Stecklings 75x60 cm	80:60:80 60:60:80	
Onion	10kg	45x30 cm (Bulb spacing)	100:60:60	

Crop	Seed rate/ha	Sowing/ Transplanting Distance (cm)	Fertilizers ($N:P_2O_5:K_2O$) kg/ha	Others
Bottle gourd	4 kg	5x1m	80:60:60	
Bitter gourd	5 kg	2x0.5m	80:60:60	
Sponge gourd	4 kg	5x1m	80:60:60	
Cucumber	3 kg	2x0.5m	80:60:60	
Muskmelon	3.5 kg	2x0.3m	80:80:60	
Watermelon	4 kg	2x0.5m	80:80:60	

Others

20kg/ha borax & 0.5% Zinc /ha

20kg/ha borax & 20kg/ha calcium carbonate

25kg/ha borax & 1.5kg/ha ammonium molybdate

10kg boron/ha

4.7 Root Crops

Fig. Carrot steckling

The seeds of Asiatic varieties of root crops are produced in the plains while the seeds of temperate varieties are produced in hills. The method of crop raising for seed is nearly the same as for fresh roots. However, the seed can be produced by seed to seed method or transplanted root to seed method. Transplanted root to seed method is better since it gives an opportunity to rogue out off type roots at the time of transplanting thus maintaining only true to the type plants for seed production. In root to seed method fully developed marketable size roots are uprooted, true to the types are selected from them and the stecklings are prepared from selected roots by cutting them in such a way that the plants with only 2-3 inch size above and lower ground parts remain. These stecklings are then transplanted in a compact block as per the details given in table-4.

5. HARVESTING, SEED EXTRACTION and SEED YIELD

5.1 Solanaceous Crops

Individual plants with good fruiting should be marked and ripe fruits be collected for seed purpose.

Fig. Tomato seed extraction

In tomato, the extraction of seed from ripe fruit is done by fermenting the crushed fruits for 1-2 days and then washing with water so that the seeds settle down and pulp and skin float which are easily separated. Seed separation can also be done using commercial grade HCl @ 100 ml per 10 kg of tomato pulp. It takes only about half an hour's time after which the seeds are cleaned up and dried to specified moisture content (Table-6). The quantity of fruit required to produce 1 kg of tomato seed varies from 160-210 kg depending on the variety. On an average 100-150 kg/ha tomato seed can be obtained.

In brinjal, the ripe fruits turned yellow are cut into pieces, water is added and allowed for fermentation. Seeds thereafter are washed, sieved and dried. About 200-300 kg seeds can be obtained from a hectare of brinjal crop. Acid method can also be used for seed extraction in brinjal.

Fig. Cut Brinjal Fruits

Fig. Cut Brinjal Fruits being fermented

In chilli and capsicum, the ripe fruits are harvested and dried. Drying can be done by spreading the fruits under the sun which may take 10-15 days time depending upon the light intensity or the fruits can be dried in hot air oven at about 54.4°C in 2-3 days. The seeds are extracted by breaking open the dried fruits by hand.

Fig. Optimum harvest stage for seed

An axial flow vegetable seed extracting machine can alternatively be used for seed extraction from tomato, brinjal and chilli fruits. The machine can extract tomato seeds @1.25 kg per man hour, brinjal @ 1.8 kg per man hour and chillies @ about 3.0 kg per man hour. On an average about 200-300 kg/ha of seeds in chilli and about 100-150 kg/ha of seeds in capsicum can be obtained. Chilli seeds can also be separated through mechanical chilli seed extractor developed by PKV, Akola.

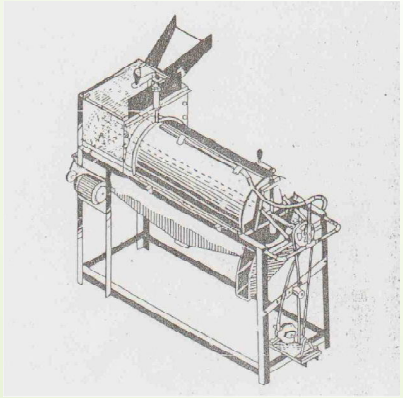

Fig. Axial Flow Vegetable Seed Extracting Machine

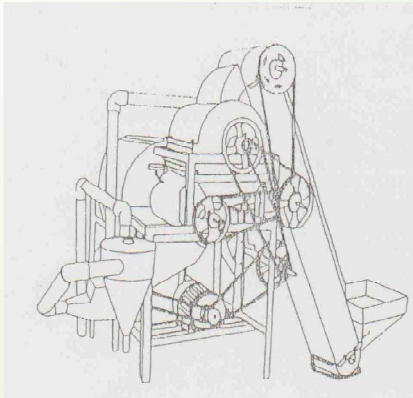

Fig. Chilli Seed Extractor developed by PKV, Akola

5.2 Vegetable Peas and Beans

Fig. Pea planting being collected for threshing

When almost 90% pods on the plants mature and turn dry, the whole plants are uprooted and collected on the threshing floor. After about a week the seeds are separated out from the pods by threshing and winnowing. The ripe and dry pods can also be picked up by hand and threshed on small scale. Usually the moisture content of seeds at this time is higher therefore the drying must be resorted to maintain the specified moisture content of these crops (Table-6). On an average, from a hectare of seed crop about 1000-1500 kg pea, 800-1000 kg French bean, 600-800 kg cowpea, Dolichos bean and 700 kg cluster bean seeds can be obtained.

5.3 Okra

Fig. Okra fruits ready for harvest

The okra fruits are harvested when they become dry on the plant. Care should be taken to harvest the fruits before splitting starts at the ridges on the pods. If splitting takes place the seeds become exposed which affects their quality. The seeds are taken out from the pods by opening the dried pods. The seeds are dried to specified moisture level, cleaned, treated and stored. For one year storage 21°C temperature and 12% humidity should be maintained. An hectare of okra crop gives about 1000-1200 kg seeds/ha.

5.4 Cole Crops

The seed crop should be harvested when most of the pods turn yellow. After that it is dried and seeds are threshed out from the pods. On an average, seed yield of 300-400 kg/ha from cauliflower, 400-500 kg/ha from cabbage and about 400 kg/ha of knol khol can be obtained.

5.5 Root Crops

The seed crop of radish should be harvested when most of the pods turn yellow. After that it is dried and seeds are threshed out from the pods. A hectare of radish seed crop yields 600-1000 kg seed.

Fig. Umbels of carror seed crop

In carrot the seeds are formed in umbels. The first and largest umbel is formed on main flowering stalk and known as primary or king umbel. Secondary umbels are formed at the terminus of branches from the main flowering stem and flower in a sequence from the top to the bottom of the inflorescence. Tertiary umbels originate on secondary umbel stem.

The seeds from primary umbels are heavier, more mature and of high quality. In carrot, all the umbels do not mature together therefore harvesting is done two three times. However, the seed crop can be harvested when all the secondary umbels mature and tertiary umbels turn yellow. A hectare of carrot seed crop yields 450 to 500 kg seeds.

In turnip, the harvesting is done when the pods mature becoming brownish-red. After threshing, the seeds are separated out. About 500-600 kg seeds/ha can be obtained from turnip.

5.6 Cucurbits

The harvesting is done when fruits are fully mature or become dry. Generally, the seeds are extracted by cutting open the fruits longitudinally.

Fig. A fully mature bitter gourd fruit ready for harvest for seed

In watermelon, pumpkin etc. seeds are embedded in the pulp and for these different methods are applied for seed extraction :

a) **Mechanical methods** - In this method machines like Axial Flow Vegetable Seed Extractor are used to separate out the pulp from seeds.

b) **Chemical methods** - In this method commercial HCl is used to separate the pulp from seeds within 15-20 minutes. Thereafter the seeds are washed in water and dried to prescribed moisture levels.

From a hectare of seed crop, 300-500 kg bottle gourd seeds, 100-300 kg bitter gourd seeds, 300-400 kg Luffa, pumpkin, cucumber & round melon seeds, 200-300 kg muskmelon seeds and 400-500 kg watermelon seeds can be obtained.

5.7 Onion

Seed is ready for harvest when first formed seed in the heads get blackened. During harvesting and curing of the seed fairly high temperatures and low humidity is desirable. Two to three pickings may be necessary to harvest the heads. Seed heads are cut, snapped off, keeping a small portion of the stalk attached. Seed heads after

harvest should be thoroughly dried. Seeds from heads are removed by flailing, dried under sun or by drier and stored (The moisture content should not be more than 6-8 %). Seed yield is 850 - 1000 kg/ha.

Table 5 : Important roguing stages & permitted off types for production of differnt vegetable seeds.

Vegetable Crops		Minimum number of field inspections and roguing stages	Off type (%) Maximum permitted	
			F	C
1.	Cowpea	2: From flowering to fruiting	0.10*	0.20
2.	Garden pea	3: First before flowering, second at flowering and third at edible pod stage	0.10*	0.50*
3.	Chilli & Capsicum	3: First before flowering, second at flowering and third at the mature fruit stage	0.10*	0.20*
4.	Cauliflower, Cabbage & Knol khol	4: First before the marketable stage, second start of curd head formation, third when most plants have formed curd and fourth at flowering stage	0.10*	0.20**
5.	Lettuce	3: First before full grown stages in non-heading types, second full grown stage in non-heading type and third at flowering	0.10*	0.20*
6.	Carrot	4: First 20-30 days after sowing, second at lifting and replanting, third at flowering and fourth at maturity to verify the true nature of umbels	0.10*	0.20**
7.	Onion	4: (When seed crop is raised by the transplanting method) First early (20-30 days after sowing), second when bulbs are lifted, third when bulbs are replanted and fourth at flowering 3: (When seed crop is raised by seed to seed method) First 20-30 days after sowing, second when bulbs are formed and third at flowering	0.10**	0.20**

Vegetable Crops		Minimum number of field inspections and roguing stages	Off type (%) Maximum permitted	
			F	C
8.	Radish and Turnip	3: First 20-30 days after sowing, second when lifted and replanted and third at flowering	0.10**	0.20**
9.	Okra	3: First before flowering, second at full flowering and fruiting and third at mature fruit stage.	0.10**	0.20**
10.	Tomato	3: First before flowering, second during flowering and the immature fruit stage and third at mature fruit stage	0.10*	0.20*
11.	Brinjal	3: First before flowering, second during flowering and the immature fruit stage and third at mature fruit stage	0.10*	0.20*
12.	Cucurbits	3: First before flowering, second during flowering and the immature fruit stage and third during mature fruit stage	0.10**	0.20**
13.	Spinach beet (Palak)	3: First at cotyledon leaf stage, second during vegetative growth, third at bolting and flowering	0.10**	0.20**

* Maximum permitted at the final inspection; ** Maximum permitted at and after flowering; F= Foundation seed; C = Certified seed.

Table-6 : Seed standards for different vegetables

Crop	Class of seed	Germination (%)	Pure seed (%)	Inert natter (%)	Other crop seed Max.	Weed seed Max.	Moisture (%)	
		(Min.)	(Min.)	(Max.)	(no/kg)	(no/kg)	Ordinary pack	Vapour proof pack
Tomato	FS	70	98	2	5	None	8	6
	CS	70	98	2	10	None	8	6
Brinjal	FS	70	98	2	None	None	8	6
	CS	70	98	2	None	None	8	6
Chilli Capsicum	FS	60	98	2	5	5	8	6
	CS	60	98	2	10	10	8	6

Crop	Class of seed	Germination (%)	Pure seed (%)	Inert natter (%)	Other crop seed Max.	Weed seed Max.	Moisture (%)	
		(Min.)	(Min.)	(Max.)	(no/kg)	(no/kg)	Ordinary pack	Vapour proof pack
Okra	FS	65	99	1	None	None	10	8
	CS	65	99	1	5	None	10	8
Cabbage	FS	70	98	2	5	5	7	5
	CS	70	98	2	10	10	7	5
Cauliflower	FS	65	98	2	5	5	7	5
Knol Kkol	CS	65	98	2	10	10	7	5
Radish	FS	70	98	2	5	10	6	5
	CS	70	98	2	10	20	6	5
Carrot	FS	60	95	5	5	5	8	7
	CS	60	95	5	10	10	8	7
Beet	FS	60	96	4	5	5	9	8
	CS	60	96	4	10	10	9	8
Spinach	FS	60	96	4	5	5	9	8
	CS	60	96	4	10	10	9	8
Amaranthus	FS	70	95	5	5	10	8	6
	CS	70	95	5	10	20	8	6
Lettuce	FS	70	98	2	None	5	8	7
	CS	70	98	2	None	10	8	7
Onion	FS	70	98	2	5	5	8	6
	CS	70	98	2	10	10	8	6
Garden pea	FS	75	98	2	None	None	9	8
	CS	75	98	2	5	None	9	8
Cowpea	FS	75	98	2	5	5	9	8
	CS	75	98	2	10	10	9	8
French bean	FS	75	98	2	None	None	9	7
	CS	75	98	2	None	10	9	7
Cucurbits	FS	60	98	2	-	-	7	6
	CS	60	98	2	-	-	7	6

Contact details of major organizations involved in vegetable seed production

Name of Organization	Address	Phone	Fax / Email
Government Organizations			
AAU, Anand	The Incharge, Main Vegetable Research Station, AAU, Anand – 388 110	02692-225818/ 261311	02692-261520 rs_mvrs@yahoo.co.in
APHU, Lam	The Principal Scientist & Head, APHU, Hort. Res. Station, Lam, Guntur-522 034	0863-2524644 & 2524017	0863-2524073 aphuhrslam@gmail.com
BCKV, Kalyani	The Officer Incharge, AICVIP, Directorate of Research BCKVV, Distt. Nadia, Kalyani-741 235 (W.B.)	033-25828407-	03473-233275 chattopadhyay.arup@gmail.com
CCSHAU., Hisar	The Professor& Head Deptt. of Veg. Crops., C.C.S. H.A.U., Hisar-125 004 (Haryana)	01662-289207	01662-234952 & 234613 vegscience@hau.ernet.in
CSAUA&T, Kalyanpur	The Prof. & Head Deptt. of Veg. Science CSAUAT, Kalyanpur, Kanpur-208 024 (U.P.)	0512-2580289	0512-2210408 dp_singhcsa@yahoo.co.in
GBPUA&T, Pantnagar	The Prof. & Head, Deptt. of Vegetable Science, G.B. Pant Univ. of Agril & Tech., Udham Singh Nagar, Pantnagar-263 145 Uttaranchal	05944-235199	05944-233473, 33608 dr.yvsingh@rediffmail.com

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HARP, Ranchi	The Head, Hort. & Agroforestry Res. Prog. (ICAR Res Comp for Eastern Region) Namkum, Ranchi-834 010 (Jharkhand)	0651-2260207/ 2260141	0651-2260141 sk_harp@yahoo.co.in
IARI New Delhi	The Head, Division of Veg. Science, IARI, New Delhi-110012	011-25846628, 25847148	011-25766420, 25847148 vegscipusa@gmail.com head_vegsci@iari.res.in
IARI (RS), Karnal	The Head, IARI (R.S.) Station, Agrasain Marg, Karnal -132001	0184-2272169, 2266672	0184-2266672
IARI (RS), Katrain	The Head, IARI Research Station, Katrain-175129, Kullu Valley (H.P.)	01902-240124, 241280	01902-240124 headrsk@yahoo.com
IGKV, Raipur	The Head, Deptt. of Horticulture, IGKVV, Raipur-492 012 (M.P.)	0771-2425219, 2497012 Ext.136	0771-2442131, 2442302 glsigau@rediffmail.com
IIHR, Bangalore	The Head, Division of Vegetable Crops IIHR, Hessaraghatta Lake Post, Bangalore-560089 (Karnataka)	080-28466420-23 ext.-224	080-28466291 vegetables@iihr.ernet.in
IIVR, Varanasi	The Director, IIVR P.B. No. 01, P.O. Jakhini (Shanshahpur)., Varanasi-221305 (U.P.)	0542-2635236 0542-2635247	05443-229007 directoriivr@gmail.com
JNKVV, Jabalpur	The I/C AICRP (Vegetables), Deptt. of Veg. Crops, College of Agriculture, JNKVV, Jabalpur-482004 (M.P.)	0761-2481771, 2481773 Ext. 345	0761-2481074/ 2418236 drswapansengupta@gmail.com

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KAU, Vellanikkara	The Prof. & Head, Deptt. of Olericulture, College of Horticulture, Kerala Agril. University, Vellanikkara-680654 (Kerala)	0487-2371918	0487-2370019 psadhankumar@yahoo.co.in
MAU, Parbhani	The Sr. Research Officer (Veg.), Hort. Research Sation Sub Campus MAU, Parbhani -431402	02452-223801-8 ext: 4250	02452-220899 aicvipmaupbn@yahoo.com
MPKV, Rahuri	The Sr. Vegetable Breeder Deptt. of Horticulture MPKV, Rahuri-413722 (M.S.)	02426-294150, 294150 (farm)	02426-243302 hodhort@indiatimes.com
NDUA&T., Faizabad	The Prof. and I/C AICVIP Dept. of Veg. Crops N.D.U.A.T., Faizabad-224 229 (U.P.)	05270-262118, 262023, 262076	gcy@indiatimes.com
NHRDF, Nasik	The Director (NHRDF), Chitegaon Phata, Post Uarhe Darna, Tsl. Niphad Distt.- Nasik-4222001 (M.S.)	02550-237551, 237816	02550-237947 nhrdf_nsk@sancharnet.in. nasik@nhrdf.com

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OUAT, Bhubaneswar	The Veg. Breeder & Officer-in-Charge (AICVIP),2nd Floor, Administrative Building, Directorate of Reseach, OUAT, Bhubaneswar-751 003 (Orissa)	0674-2391692-Dean Office VC-Phone0674-2392677	0674-2397780 vegresouat@yahoo.com
PAU, Ludhiana	The Head, Deptt. of Veg. Crops, Punjab Agril. University Ludhiana-141004 (Punjab)	0161-2401960 ext.-370 &2404460	0161-2404460 hodvegpau@gmail.com
PDOG, Pune	The Director, Project Directorate of Onion & Garlic, Rajgurunagar-410 505, Distt. Pune (MS)	02135-222026/ 222697	02135-224056 director@nrcog.res.in
PKV, Akola	The Junior Breeder cum Hort., Deptt. of Hort., chilli & Veg. Res. Unit, PKV, Akola-44404 (M.S.)	0724-2258201 Ext-1048	0724-2258219 dr@pdkv.mah.nic.in
RAU., Agric Res. Station, Durgapura	The I/C AICRP (Vegetable Crops), Deptt. of Horticulture, Rajasthan Agric. Univ., ARS Durgapura, Jaipur-302018 (Rajasthan)	0141-2550391& 2550392 2550643, 2550259	0141-2550229 0141-2721194 vsyhortjpr@gmail.com
SKUAS&T, Srinagar	The Prof. & I/c AICRP(VC), Div. of Olericulture, Shere-E-Kashmir Univ. of Agril. & Tech. Shalimar, Srinagar-191 121 (J&K)	0194-2462124	0191-2462124 machattoo@gmail.com

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TNAU, Periyakulam Centre	The Dean Horticulture College & Research Institute, T.N.A.U., Periyakulam East-625604	04546-231319	deanhortpkm@tnau.ac.in
TNAU., Coimbatore	The Head, Department of Vegetable Crops Hort. College & Res. Institute, T.N.A.U., Coimbatore-641003 (Tamil Nadu)	0422-6611283 0422-2431222 ext. 283	0422-2430781 0422-6611283 Vegetables@tnau.ac.in
VPKAS, Almora	The Director, VPKAS, Almora-263 601 (Uttranchal)	05962-230208	05962-231539
YSPUH&F, Solan	The Prof. & Head, Deptt. of Veg. Crops, College of Horticulture, Dr. Y.S. Parmar University of Hort. &Forestry, Solan-173230 (H.P.)	01792-252329	01792-252242 vgcuhf@yahoo.com
Private Organizations			
Ajeet Seeds	The Managing Director, Ajeet Seeds Ltd., Gut No. 233, Chittegaon, Tq. Paithan, Dist. Aurangabad – 431 105 (MS)	02431-251445, 251444	02431-251833 aurangabad@ajeetseed.com
Ankur Seeds	The Managing Director, Ankur Seeds Pvt. Ltd. 27, New Cotton Market Layout, Nagpur-440 018 (M.S.)	0712-2725117& 2726148	0712-2723455 contact@ankurseeds.com

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Beejo Sheetal	The Chief Executive Beejo Sheetal Hybrid Seeds Co. Ltd., P.B. No. 72, A-2, Mama Chowk, Jalna-431203 (M.S.)	02482-232588, 232717 Dr. Mirkhee-Res. Executive-02482-236588	02482-230398 bejosheetal@hotmail.com bejosheetal@rediffmail.com
Century Seeds	The Managing Director, Century Seeds Pvt. Ltd., Lusa Tower, BA, 22-24, Mangolpuri Industrial Area Phase-II, New Delhi-110 034	011-7019890, 7017061	011-7017568
Clause	The Manager, Clause Tezier India 6-1-20/2 Walker Town, New Bhoiguda Secunderabad-500025 (A.P.)	040-27504677	customer support@ clause tezier India.com
Durga Seeds	The Managing Director, Durga Seed Farm 172, Industrial Area Phase-I Chandigarh-160002	0172-2650193 2656854	0172-2656954
East West Seeds	The Managing Director, East West Seeds India Pvt. Ltd., Gut No. 66, Village Narayanpur (BK), P.O. Waluj, Aurangabad-431133	0240-2563567, 2557070	0240-2563566

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Indo-American Hybrid Seeds	The Vice President (R&D)-Vegetables, Indo-American Hybrid Seeds(India) Pvt. Ltd., 7th, Banashankari-Kengeri Road, Channasandra, Bangalore-5060061	080-26760111	gopalnagariahs@gmail.com kpvshetty@indamseeds.com
J. K. Agri. Genetics	The General Manager (R&D) Hybrid Seeds, J. K. Agri. Genetics, Ltd. 1-10-177,4th floor, Varun Tower , Begumpet, Hyderabad-500016	040-55316858 040-66316838	040-27764943 info@jkseeds.net
Kaveri Seeds	M/S Kaveri Seeds Company Ltd., # 513B, 5th Floor, Minerva Complex, S.D. Road Secunderabad-500003 (A.P.)	040-27899833, 27721457	info@kaveriseeds.in
Krishidhan Seeds	The Chief (R & D) Krishidhan Seed Pvt. Ltd., Sai Capital, 9th Floor, Opposite ICC Complex, Sena Pati Bapat Road, Shivaji Nagar, Pune-411005 (M.S)	02482-252328 020-2571400,25661205	02482-232328 krishidhanseeds@sify.com
Mahyco Ltd.	The Head, Vegetable Research Centre Maharashtra Hybrid Seed Co. Ltd, Bettanagere Village Husker, Post - Dosanapura Hobli, Bangalore North Taluk- 502123	080-27700632 & 27737299	080-27737301 ravi.kankanallu@mahyco.co.in

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Meta Helix/ Dhaanya Seeds	The Manager, Meta Helix Life Sciences Pvt. Ltd., Plot No. 3, KIADB 4th Phase, Bommasandra, Bangalore-560099	080-7870235, 7836086	080-7836084 08110-415074 info@dhaanya.com
Namdhari Seeds	The Managing Director, Namdhari Seeds Co., 119, 9th Floor Main Road Ideal Rajarajeshan Nagar, Banglore-560 039	080-7282401, 7282653	080-8602168 namdhariseeds@namdhariseeds.com
Nath Bio-Genes	The Director (Technical), Nath Bio-Genes(India) Ltd. Nath House, Nath Road, P.B. No. 318 Aurangabad-431005 (M.S.)	0240 – 2376314 to 17, 2376686, 2376687,2376905	0240 – 2376188 baig@nathseeds.com
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Nunhems Seeds	The Managing Director, Hamberg Seeds 10-1-127/1, Masab Tank, Hyderabad-500028	040-23324040, 23324242	040-23323737
Nuzi Veedu Seeds	The Vice President Vegetable Business, Nuzi Veedu Seeds Pvt. Ltd., 905, Kanchan Junga Building, Barakhanba Road, Connaught Place, New Delhi-110001	011-23766237 / 38	011-23766241 sktripathi@nsindia.com

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Seed Innovation	The Vegetable Coordinator, Seed Innovation Pvt. Ltd., 501 Subhum Sirirampada Plot No. 6-3-1090/A/1, Rajbhavan Road Somajiguda, Hyderabad-500082	040-23170341	
Seed Works/ U.S. Agri. Seeds	The Sr. Manager Seeds Works India Pvt. Ltd., 437, Avenue 4, Banjara Hills, Hyderabad-500034	040-3356354, 3356355	040-3356359 seedworks@satyam.net.in
Seminis Seeds	The Managing Director, Seminis Vegetable Seeds, Gut No. 24, Paithan Road, Chitegaon, Aurangabad (M.S.) – 431 105	02431-251468-70	02431-251466
Shri Ram Bioseed	The Dy. Manager- Veg. Research, Bioseeds Research India Pvt. Ltd., Plot No. 206, Road No.14, Jubilee Hills, Hyderabad- 500033 (A.P.)	040-23555801-806	040-23555530 sbgi@bioseedindia.com
SPIC PHI Seeds	The Asstt. Manager (BR), SPIC Ltd, Kelamangal Road, Hosur Cattle Farm Road, Hosur-635110 (T.N.)	04344 – 262253/ 262757	04344-262531 spichosur@eth.net
Sreema Seeds	The Manager, Sreema Seeds Pvt. Ltd. , N.H.-5, Naya chowk Madhupatna, Cuttack-753010 (Orissa)	0671-2345033, 2345573	0671-2343310 sreemaa_seeds@yahoo.com

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Sri Venkateswara Hybrid Seeds	The Manager, Sri Venkateswara Hybrid Seeds Company, Gosha Hospital Road, Adoni-518301 (A.P.)	08512-25249/ 253027	08512-253027
Sungro Seeds	The Scientist Incharge, Sungro Seeds Ltd., 3rd Floor, Sungro Chamber, B.N. Block, Local Shopping Centre, Shalimar Bagh, Delhi – 110 052	011-7488272, 7471117, 7472574 011-27488272, 27472574, 27475524	011-7470333, 7475525 011-27470333 dasgupta@sungroseeds.com
Syngenta	The Development Manager, Syngenta India Ltd., Seed Sector, WAOGHOLI, Gate No. 2347, Pune -Nagar Road, Taluk, Haveli, Pune – 412 207	020-30615304 020-27050283	020-27050468 asish.patel@syngenta.com
Tokita Seed	The AGM (R&D) Tokita Seed India (P) Ltd. 360,13th 'A' Main, 80 feet Road, A Sector Yelahanka New Town, Bangalore-560064	080-28460254	080-28460749 sham@tokitaindia.com
Tulasi Seeds	Dr. Sunil Kumar , Incharge(AICRP) "Tulasi House" # 6-4-6, Arundelpet 4/5, Guntur-52202 (A.P.)	0863-2321374, 2224947, 2223254, 2229300	0863-2221161 seeds@tulasigroup.com
Uniphos Seeds	The Vegetable Breeder, Uniphos Seeds & Bio Genetics, (A Division of Adenta Ltd.), 203-205, Iind floor , Bhuvana Towers, S.D. Road, Secunderabad-500003 (A.P.)	040-66284000	040-27890138 bhushanaho@uniphosseeds.com

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Vijay Seeds	The Sr. Research Officer Vijay Seeds Co. Ltd A-9/17 Additional Industrial Area, MZDC, Jalna-431203	02482-230654, 234247	02482-230499
Vishal Seeds	The Research Officer Vishal Seeds Pvt. Ltd., 8-2-108/3, Opposite Hastina Puram North, Nagarjuna Sagar Road, Vanasthalipuram Post, Hyderabad – 500070 (AP)	040-24244241, 24242385	vishalseeds@usa.net
Vivaswan Agritech	The Director Research Vivaswan Agritech Pvt. Ltd 125, Bhawani Peth, Gul Ali, Pune-411 042 (M.S.)	020-26386208	
VNR Seed	The Managing Director, VNR Seed, 1st Floor, No. 1, Durga College Complex, K.K. Road, Raipur-492 001 (M.P.)	0771-2572008, 4937846, 2572080	gomchi@vnrseed.com vnrseedbhilai@rediffmail.com
Zuari Seeds	The Managing Director, Zuari Seeds Pvt. Ltd, # 759, Sector-A, III-Phase, Yelahanka New Town, Bangalore – 560 064	080-8562266, 8460862	080-8562538