Technical Manual on Quality Seed Production of Lentil

Ashutosh Sarker, Harsh K Dikshit & Jyoti Kumari

Indian Agricultural Research Institute (IARI), New Delhi, India
International Center for Agricultural Research in the Dry Areas (ICARDA)
Aleppo, Syria

2011

प्रबीर कुमार बसु, आई० ए० एस०
सचिव
P.K. BASU, I.A.S.
Secretary

भारत सरकार
कृषि मंत्रालय
कृषि एवं सहकारिता विभाग
Government of India
Ministry of Agriculture
Department of Agriculture & Cooperation

Message

The significance of quality seed production for agriculture lies in its cascading impact not only for making a crop commercially viable but for generating huge income and employment opportunities for farmers and the agribusiness. India has predominantly been a rice-growing and rice-consuming population. For sustainable production of cereals it is being felt that pulses crop should be an essential part of Rice Based Cropping System. This crop not only enhances soil health but also contributes to meeting the nutritional requirement of a growing population.

Lentil is an important *Rabi* pulse crop especially in Eastern India. There is good potential for the significant increase in its area and productivity. Availability of quality seed of improved varieties has been an area of concern to realize the potential for increasing the production of Lentil.

In this context, we had sought active involvement of ICARDA for Transfer of Technology to the farmers in selected areas of the region. Seed production is an important component of the project assigned to ICARDA in this regard. I am pleased to note that ICARDA has developed a **Technical Manual on Quality Seed Production of Lentil.** This Manual would fulfil the knowledge gap for the farmer to produce quality seed of Lentil. I expect our extension staff to take advantage of this manual in extending the key techniques to the seed growers more effectively.

I congratulate the team led by Dr. Ashutosh Sarker, Coordinator, ICARDA South Asia & China Regional Program, for bringing out this self-explanatory publication.

New Delhi
14th June, 2011

(P.K. Basu)

भारतीय कृषि अनुसंधान संस्थान, नई दिल्ली-110012 (भारत)
INDIAN AGRICULTURAL RESEARCH INSTITUTE
(A UNIVERSITY UNDER SECTION 3 OF UGC ACT. 1956)
NEW DELHI-110012 (INDIA)

हरि शंकर गुप्त, पीएच.डी. (आई.आई.टी.), एफ.एन.ए.ए.एस.
निदेशक एवं कुलपति
H.S. Gupta, Ph.D. (IIT KGP), FNAAS
Director & Vice-Chancellor

Phones : (Off.) 011-2573 3367, 2584 3375
(Res.) 011-2584 6774, 2573 3973
Fax : +91-11-2584 6420
E-mail (off.): director@iari.res.in
personal : hsgupta@lycos.com

Foreword

Lentil (Lens culinaris Medikus subsp. culinaris) ranks next only to chickpea among cool-season legume crops grown in India with an area of 1.38 million hectare and production of 0.95 million tonnes during 2008-09. It is grown throughout the northern, north-eastern and central India for grains, which are used as dal and in various other preparations. Lentil contains an average of 28% protein, 2.5% fat, 2.2% mineral, 12.2% fibre and 67% carbohydrate. It is rich in phosphorus, iron, zinc and carotene. It is generally grown as rainfed crop during rabi season after rice, maize, pearl millet or kharif fallow. It is also grown as intercrop with barley, linseed, mustard and autumn planted sugarcane. In north-eastern parts of the country, lentil is also cultivated as paira crop with rice in which seeds of lentil are broadcasted in the standing crop of rice just before its harvest.

Inspite of development and release of large number of improved varieties, India imports lentil to the tunes of about 33 thousand tonnes (FAO, 2008) per year to meet the demand of growing population of India. There is urgent need for popularization of improved lentil varieties in main growing areas of country, where farmers still grow old cultivars/landraces on their marginal lands as rainfed crops, so that farmers gain enough produce. Quality seed production of the improved varieties will ensure better seed replacement rate and realization of the yield potential.

I congratulate Dr. Ashutosh Sarker, Coordinator for South Asia Program & Food Legume Breeder, South Asia Regional Program, ICARDA, and Dr. H. K. Dikshit and Dr. (Mrs.) Jyoti Kumari (Division of Genetics, IARI) for their

sincere efforts in bringing out this technical manual on "Quality Seed Production of Lentil". The manual is well written and covers all the aspects of quality seed production of lentil. It also provides the information on popular varieties grown in India along with a list of varieties suitable for different states/region. I hope this technical manual will be useful for the researchers, seed growers and farmers for their use in growing the seeds of improved varieties adopting proper practices quality seed production.

June 09, 2011
New Delhi

(H.S. Gupta)

INTRODUCTION

Lentil (*Lens culinaris* Medikus subsp. *culinaris*) is an important cool-season food legume crop grown in South Asia, North America, Southern Europe, North Africa, West Asia, Central Asia and Ocenia. It is grown for grains, which are used as *daal* (split, whole or dehulled) and in various other preparations. Lentil is an important dietary source of energy, protein, carbohydrates, fiber, minerals, vitamins and antioxidant compounds. The splitted / dehulled seed of red lentil is used as *daal*, consumed with rice or wheat, lentil soup or deep-fried and eaten as snack. The straw is a valued animal feed most particularly in the Near East and in the Mediterranean environment. Lentil straw has higher digestibility, protein, calcium and phosphorus compared to wheat straw. In addition, lentil straw is more palatable than various cereal straws. Lentil seeds contain 28.3% protein, 2.5% fat, 12.2% fibre and 67% carbohydrate. It is rich in phosphorus, iron, zinc and carotene. It is generally grown in India as rainfed crop during winter season after rice, maize, pearl-millet or rainy season fallows. In the north-eastern, eastern and central parts of the country, lentil is also cultivated as *paira* crop with rice in which seeds of lentil are broadcasted in the standing crop of rice just before its harvest. It is grown on a wide range of soils ranging from light loamy sand to heavy clay soils in the north-eastern region and in moderately deep black soils of Madhya Pradesh and Maharashtra.

Lentil occupies 1.38 million hectare area with a production 0.95 million tonnes in India during 2008-09. It is mainly cultivated in Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Jharkhand, Bihar, West Bengal, Assam and Kota division of Rajasthan. In the last three decades, the area under lentil has increased by 85%, production by 151%, and productivity by 34%. The increase in area has been mainly in Uttar Pradesh (UP), Madhya Pradesh (MP), Rajasthan and Bihar, whereas, in West Bengal, Punjab, Haryana and Maharashtra the area has shown declining trends. In UP, the area has increased from 166 thousand ha in 1970-71 to 521 thousand ha in 2008-09 and production from 100 thousand tonnes to 460 thousand tonnes during the same period. The productivity has enhanced from 604 to 883 kg/ha due to availability of improved varieties like PL 639, DPL 15, DPL 62 and PL 406. In MP, the area and production have increased from 271 thousand ha and 108 thousand tonnes in 1970-71 to 500 thousand ha and 238 thousand tonnes in 2008-09, respectively. The productivity increased from 401 to 474 kg/ha as a result of improved and bold- seeded varieties like JLS 1, JL 3, IPL 81, etc. In Bihar, the area has increased from 140 thousand ha to 164 thousand ha and production from

90 thousand tonnes to 129 thousand tonnes during the 35-year period from 1970-71 to 2008-09. Productivity has increased significantly from 643 to 785 kg/ha due to availability of high yielding and rust resistant varieties. World lentil production had been gradually increasing during the 10 years from 2.76 million tonnes in 1997-1998 to 3.6 million tonnes in 2008-09. Asia represents about 55% of the world production. Among the main lentil producers which joined late, production has been growing upwards in Canada, the United States (US), Australia and China, but has been relatively stable in conventional growing countries like India, Turkey, Syria, Iran, Nepal and Bangladesh. Canada and the US produce mainly the green type lentils with yellow cotyledons, whereas, the rest of the world produces mainly the red type.

DEFINING QUALITY SEED

Seed is the most critical input in crop production. The production potential of a crop depends on seed quality. High quality seed can be defined as 'seed of adapted variety with high varietal, species, and genetic purity; high germination and vigour; free from seed borne pests and pathogens; and properly cleaned, treated, tested and labeled'.

- **Genetic quality:** Genetic quality refers to genetic makeup of the variety contained in the seed, which provides the potential for higher yield, better grain quality and greater tolerance to biotic and abiotic stresses.
- **Physical quality:** Physical quality includes freedom from contamination of other crops, common and noxious and parasitic weed seeds, seed size, seed weight, and uniformity of seed lot.
- **Physiological quality:** Physiological quality refers to viability, germination and vigour of seed, which determines the potential germination and subsequent seedling emergence and crop establishment in the field.
- **Health quality:** Seed health includes absence of infection from seed borne pests and pathogens (fungi, bacteria, virus, nematodes, insects *etc.*)

QUALITY CHARACTERISTICS

For capitalizing markets for human consumption careful consideration of quality is vital.

- **Seed size:** Both seed size and uniformity are important. Bold and uniform seeds are preferred. Variation in seed size cause processing problems.
- **Seed colour:** Preference for seed colour are generally market specific. Human food markets have low tolerance for discoloured seed (caused by disease, environmental staining or prolonged storage).
- **Split, chipped or broken seeds:** Lentil is eaten or processed whole, so the damage to whole grain is not acceptable.
- **Admixture and foreign seeds:** The level of admixture and foreign seeds in the sample is important as they influence the amount of product that can be used for processing.
- **Insect damage:** Insect damage is more visible in large seeded lentils. In small seeded types insect damage affects yield more than quality.

SEED PRODUCTION MANAGEMENT

Seed is a living biological product and it requires utmost care for ensuring physiological quality. Maintenance of varietal identity and purity is important to meet the expectations of farmers/consumers. Therefore, seed production should be strictly monitored throughout crop growth period from planting to harvesting, cleaning, storage and marketing. Seed production must consider:

i. Selection of production site.

ii. Isolation to avoid contamination.

iii. Roguing to remove contaminants.

iv. Ensuring cleanliness of machinery to avoid admixtures during planting, harvesting, cleaning, treatment and storage.

v. Ensuring seed quality by applying strict quality assurance system.

Selection of Seed Source and Production Site

Seed from unreliable source may result in a crop which is a varietal mixture/ contaminated, mixed with weeds, does not germinate well and produces poor crop. Farmers should procure seed only from reliable

source. In case reliable sources of seed are not available, farmers can be trained to produce their own seed through mass selection in the field.

- Well rotated field should be selected for source seed.
- Rogue out off types and other varieties.
- Remove noxious weeds and other crops.
- Destroy plants affected with seed borne diseases.
- Bulk harvests the entire field after inspection.
- Properly clean, pack and store the seed.
- Conduct simple germination and purity tests.

Seed should be produced in

- Favourable environment to avoid loss due to biotic (diseases and insect pests) and abiotic stresses (drought, flooding, salinity, frost *etc.*).
- Areas where the variety is adapted and recommended to prevent genetic shift.
- Fertile well drained and leveled areas.
- Easily accessible fields for supervision, inspection and transportation to the processing plant.

Seed Bed Preparation

The land identified for seed production should be free from other varieties of the same crop species for at least 1-2 years. The seed production field must be isolated from other cultivars of the same species to avoid mechanical admixture and/or cross- pollination. Proper tillage is essential for enhanced germination, emergence and crop establishment. It improves soil aeration, moisture conservation and reduce weeds, disease and pest infestations. Well tilled field promotes root and nodule development in seedling.

Sowing Method, Date of Sowing and Seed Rate

Seed must be planted in rows. Row planting requires less seed, facilitates mechanical weed control and access for rouging, pesticide spray, and field inspection. The time of sowing depends on variety and area of adaptation. A seed crop must be planted at recommended time, otherwise, the growth

and development may be affected, reducing seed yield. Planting early is beneficial but may increase risk of early dry spell, frost and weed damage. Seed rate varies with variety, seed size, location, method and time of planting. The recommended seed rate ensures right plant population for competition with weeds and higher seed yield. The recommended seed rate in lentil is 35-40 kg/ha for small seeded varieties and 50-60 kg/ha for bold seeded varieties.

Isolation

Appropriate isolation distance must be maintained to prevent contamination by mechanical mixture or cross-pollination by insects etc. In self-pollinated crops like lentil the isolation distance is 2-5 meters.

Irrigation

Irrigation is essential for a good seed crop. The pre-sowing irrigation is necessary to ensure proper germination and optimum plant stand. The seed crop must receive adequate water during establishment/vegetative growth and early phase of seed development. Surface irrigation is preferred. Overhead irrigation may affect pollination and encourage foliar diseases.

Fertilizer Application

Balanced supply of fertilizers is essential for seed production as it has direct influence on seed development, seed quality and yield. One hundred kg D.A.P. is enough for one hectare land and can be applied as basal dose before planting. Zinc and sulphur may also be applied if required.

Weed Control

Common, noxious and parasitic weed seeds are introduced into the fields along with lentil seed. Enhanced use of fertilizers and ineffective control measures encourages weed infestation.

The application of pre-emergence weedicide Stomp (pendimethylene) effectively controls weeds up to 20-25 days after germination. One hand weeding after first irrigation ensures complete control.

Roguing

Roguing is removal of undesirable plants. The rogues include off type genetic variants of the same variety, other varieties of same crop, other

crops with similar growth habit and seed characters, noxious weeds and plants infected with seed borne diseases. Seed fields should be rogued as soon as the rogue plants are identified. Rouging is most effective at flowering, post-flowering and maturity. The whole plant must be removed during rouging from the field.

Management of Diseases

The production of healthy seed includes combination of several practices like

- Use of disease-free seed lots.
- Zoning of disease production areas.
- Off-season seed production.
- Proper rotation and isolation of seed fields.
- Roguing of diseased plants.
- Sprays to avoid disease build up.
- Field inspection and testing.
- Efficient cleaning of seed lots.
- Seed treatment with chemicals.

Harvesting

Harvesting includes cutting and threshing as separate operations. Lentil seed is harvested manually. Dry weather during ripening and harvesting is essential to maintain seed quality. Delay in harvesting helps in reducing moisture content but increases shattering losses. Harvesting can be started when seed moisture content is around 12% to avoid mechanical damage and maximize storability. There should not be leftover seed of any other variety or weeds on the threshing floor. It must be ensured that the floor is clean. Varieties should be harvested in a sequence that minimizes mechanical mixing between them. Keep different varieties separately to avoid admixture.

Seed Cleaning

The harvested seed is inspected for operations like drying, fumigation and cleaning. If seed moisture is high it should be thoroughly dried before cleaning. If insects are present the seed must be fumigated. The seeds to

be stored should be free from inert matter, seeds of weed plants, other crops, other varieties, damaged, diseased or shriveled seeds of the same variety. Winnowing removes chaff, straw and other light materials from the seed lot. Hand cleaning should be done to remove seeds of different sizes and heavy materials using sieves of different sizes.

Seed Treatment

Seed health is the most important component of seed quality. Seed infection may result in low germination, reduced field establishment, poor plant development, severe yield loss or total crop failure. Chemical seed treatment is an efficient and economical method of controlling both external and internal seed infections. It disinfects seed, checks the spread of harmful organisms, promotes seedling establishment and improves seed quality. Seed treatment is easy to apply, safer to handle, cheaper, better targeted against the organism and less influenced by the environment. Choice of chemical depends on the economic importance of the target organism, its location, infection level and efficacy of the chemical. Generally, broad spectrum seed treatment fungicides are recommended both for external and internal seed borne diseases. Seed treatment with benomyl 0.3% or thiram + benomyl (1:1, 0.3%) reduces wilt incidence and increases grain yield significantly. Seed treatment may be done with strong dyeing colour to discourage human consumption or use for animal feed.

Fumigation

Fumigation should be done to control storage pests. Generally, aluminum or magnesium phosphine is used as it is easy to handle and has no effect on germination. Fumigants have advantage of penetrating different types of containers, *viz*. jute bags, paper bags *etc*.

Fumigants are active in gaseous phase and fumigation is effective only if applied under air tight condition. Fumigation must be done under proper hygienic conditions.

Seed Packing and Storage

Proper packing is essential for storage, handling, marketing and distribution. For seed packing generally jute bags of different size and shape are used. Attractive packing is important for promotion and marketing of seed.

Seed shows maximum germination at physiological maturity then it gradually declines. Superior storage conditions maintain the initial seed quality. Seeds must be stored only in new bags as old bags can be source for contamination and insect infestation. The most important factors affecting the seed storage are temperature and relative humidity. The crop should be harvested at full maturity and the seed should be dried to safe moisture content, cleaned and stored in favourable conditions well protected from storage pests and diseases. The typical storage pests damaging the lentil seeds are Callosobruchus and Bruchidius species.

CONSTRAINTS TO SEED PRODUCTION

The major constraints to lentil seed production are:

Crop mechanization: Mechanization is limited due to crop stature. Mechanization on seeding and chemical weed control is successful. However, mechanized harvesting remains a major constraint.

Lack of trained personnel: Due to less area under this crop there is scarcity of technicians trained in lentil seed production. There is need for training and upgrading the capabilities of scientists involved in lentil seed production management.

Low value: The cost of lentil seed production is moderate. Farmers growing lentil seed should get assured fair price based on production cost.

SEED CERTIFICATION STANDARDS

The Seed Certification Standards are :

Land Requirements

Land used for seed production of lentil should be free from volunteer plants.

Field Inspection

A minimum of two inspections should be done, the first before flowering and the second during flowering and fruiting stage.

Field Standards

Isolation

Contaminants	Minimum distance (meters)	
	Foundation	Certified
Fields of other varieties	10	5
Fields of the same variety not conforming to the varietal purity requirements for certification	10	5

Specific requirement

Factor	Maximum permitted (%)*	
	Foundation	Certified
Off-types	0.10	0.20

*Maximum permitted at final inspection.

Seed Standards

Factor	Standards genetic purity for each class	
	Foundation	Certified
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seeds (maximum)	5/kg	10/kg
Weed seeds (maximum)	10/kg	20/kg
Other distinguishable varieties (maximum)	10/kg	20/kg
Germination including hard seeds (minimum)	75%	75%
Moisture (maximum)	9%	9%
For vapour-proof containers (maximum)	8%	8%

Table 1: Varietal description of popular lentil varieties released by AICRP in India.

Variety	Pedigree	Released by	Year of release	Duration (days)	Yield (q/ha)	Area of cultivation	Special features
K75 (Mallika)	Local selection	CSAUA&T, Kanpur	1986	130-135	12.0 -14.0	NEPZ, CZ	Bold-seed
LH 84-8 (Sapna)	L 9-12 × JLS 2	CCSHAU, Hisar	1991	135-140	15.0	NWPZ	Bold-seed, tolerant to rust & wilt
PL 4	UPL 175 × (PL 184 × P 285)	GBPUA&T, Pantnagar	1993	140-145	16.0	NWPZ	Small-seed, rust resistant & wilt tolerant
L 4076 (Shivalik)	PL 639 × PL 234	IARI, New Delhi	1993	130-135	14.0	NWPZ, CZ	Bold-seed, tolerant to rust & wilt
DPL 15 (Priya)	PL 406 × L 4076	IIPR, Kanpur	1995	130-135	15.5	NWPZ	Bold-seed, tolerant to rust & wilt
L 4147 (Pusa Vaibhav)	(L 3875 × P 4) × PKVL 1	IARI, New Delhi	1996	130-135	17.8	NWPZ	Small-seed, rust resistant & wilt tolerant
DPL 62 (Sheri)	JLS 1 × LG 171	IIPR, Kanpur	1997	130-135	17.2	NWPZ	Extra bold-seed, resistant to rust & wilt

Contd....

Contd....

JL 3	Local Selection	JNKVV, Sehore	1999	115-120	14.3	CZ	Bold-seed, wilt tolerant
IPL 81 (Noori)	K 75 × PL 639	IIPR, Kanpur	2000	110-120	12.5	CZ	Bold-seed, rust & wilt tolerant
KLS 218	KLS 133 × L 9362	CSAUA&T, Kanpur	2005	120-125	13.8	NEPZ	Small-seed, rust resistant
HUL 57	Mutant of HUL11	BHU, Varanasi	2005	121	14.0	NEPZ	Small-seed, rust resistant
VL 507	ILL 7978	VPKAS, Almora	2006	160-170	12.4	NHZ	Large-seed, wilt resistant
IPL 406 (Angoori)	DPL35 × EC 157634/382	IIPR, Kanpur	2007	125-130	17.0	NWPZ	Large-seed, rust resistant
WBL 77 (Moitree)	ILL 7723 × BLX 88176	Behram-pur (W.B.)	2008	115-120	14.0	NEPZ	Rust resistant

NWPZ: North-West Plain Zone (Punjab, Haryana, UP & northern Rajasthan),
NEPZ: North-East Plain Zone (UP, Bihar, Jharkhand, West Bengal, Assam, Orissa),
CZ: Central Zone (MP, Chhattisgarh, Maharashtra, Bundelkhand region of U.P., southern Rajasthan and Gujarat).

Table 2 : State wise recommended varieties.

State	Small-seeded	Bold-seeded
Jammu & Kashmir	PL 406, PL 639	-
HP	PL 406, PL 639	Vipasha, VL 507
Punjab	LL 56, LL 147, PL 4, Vaibhav	L 4076, Sapna, Priya, Sheri
Haryana	PL 4, Vaibhav	L 4076, Sapna, Garima, Priya, Sheri
Delhi	Pant L 4, Vaibhav	L 4076, Sapna, Priya, Sheri
Uttaranchal	VL Masoor 1, VL Masoor 4	VL 507
UP (West)	PL 4, Vaibhav	L 4076, Sapna, Priya, Sheri
UP (East)	PL 406, PL 639, HUL 57	Mallika
UP (Bundelkhand)	-	Mallika, L 4076, JL 3, Noori
Bihar & Jharkhand	PL 406, PL 639, Arun, KLS 218, HUL 57	Mallika
West Bengal	PL 406, PL 639, Ranjan, Moitree, KLS 218, Subrata	Mallika
MP & Chhattisgarh	-	JL 1, Mallika, L 4076, JL 3, Noori
Maharashtra	-	Mallika, L 4076, Noori, JL 3
Rajasthan	-	Mallika, L 4076, JL 3, Noori, IPL 406

Acknowledgement

We are grateful to National Food Security Mission (NFSM), Department of Agriculture and Co-operation, Government of India for granting aid to implement the lentil enhancement project. Ours has been an honest attempt to educate people in the field of lentil research and development; and we would like to take this occasion to express our deepest gratitude to NFSM, without whose guidance, this endeavour wouldn't have been a success. The authors are also thankful to our collaborators who have contributed immensely in the development of improved lentil varieties for the benefit of Indian farmers.

For further information, please contact

International Center for Agricultural Research in the Dry Areas (ICARDA)
South Asia & China Regional Program (SACRP)

NASC Complex, Pusa Campus, DPS Marg,
New Delhi - 110 012
Phone: +91(11) 25847505; Fax: +91(11) 25847503

Printed at Venus Printer and Publishers, New Delhi - 110028
Phone : 25891449, 45576780, Mobile : 9810089097