The Pharma Innovation Journal 2022; 11(2): 1187-1191

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(2): 1187-1191

www.thepharmajournal.com
Received: 03-11-2021
Accepted: 13-01-2022

Preeti Pachauri
Department of Genetics and Plant Breeding, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

R. S. Sikarwar
Department of Genetics and Plant Breeding, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

Corresponding Author:
Preeti Pachauri
Department of Genetics and Plant Breeding, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

Scientific cultivation of chickpea in India

Preeti Pachauri and R. S. Sikarwar

Abstract
Chickpea is a cool season, drought hardy grain legume crop that is grown in India, Africa, the Middle East, United States of America and Europe. Overall chickpea has great potential to enhance protein availability in drought prone areas. Although many improved chickpea cultivars are now available and many farmers still continue to grow old varieties and landraces. Thus, the achievements of improvement in chickpea research have not fully translated into increased productivity at the farm level. The chickpea productivity can be considerably enhanced by use of improved cultivars and associated improved production technologies. Generally, it was seen that farmers who do not adopt improved cultivars are also unwilling to adopt improved crop production technologies. Thus, improved cultivars provide an efficient vehicle for transfer of other improved crop production technologies. There is an urgent requirement to enhance improved cultivars seed production to ensure adequate availability of quality seed to the farmers. Because of the minor role of the private sector in seed production of legumes, the informal seed system (seed production by non-government organizations, farmers' groups and individual farmers) plays a significant role in increasing availability of quality seed and adoption of improved cultivars. This study provides comprehensive information on improved seed production technologies for growing a healthy seed crop of chickpea and storage of chickpea seed.

Keywords: Chickpea (*Cicer arietinum* L.), desi, Kabuli

Introduction
Chickpea (*Cicer arietinum* L.) belongs to genus Cicer, tribe Cicereae, family Fabaceae, and subfamily Papilionaceae, is a self-pollinated true diploid (2 n = 2 x = 16) with genome size of 738 Mbp (Varshney *et al.* 2013a) [17] and cultivation of this crop is mainly concentrated in semiarid environments (Saxena 1990). Among pulses, chickpea is preferred to most important food legume plants in sustainable agriculture system due to of its low production cost, wider adaptation, ability to fix atmospheric nitrogen and fit in various crop rotations (Singh 1997) [15]. During 2017-18, globally it was grown on 149.66 lakh ha area, with the total production of 162.25 lakh tonnes (FAOSTAT, 2019) [6] and average productivity of 1252 kg/ha. The production of chickpea during 2019-20 in rabi was 12.61 million tonnes (Ministry of agriculture and farmer welfare). It has a high protein (20–22%) with highest nutritional compositions and free from anti-nutritive components compared to any other dry edible grain legumes and thus, it is considered a functional food or nutraceutical. Besides proteins, it is rich in fibre and minerals (phosphorus, calcium, magnesium, iron and zinc), and its lipid fraction is high in unsaturated fatty acids (Williams and Singh 1987) [18]. It has no anti-nutritional factors (Mallikarjuna *et al.* 2007) [9] with high amounts of carotenoids like β-carotene than genetically engineered 'golden rice' (Abbo *et al.* 2005) [1]. It have various common or local names in different countries like Hamas, Hommos, Humz, Nakhi and Melanch in Arabian countries; Keker in the Netherlands; Kichererbse in Germany and Belgium; Ceseror and Cicerolle in France, Ceci in Vatican City and Switzerland, Simbra in Ethiopia; Lablabi in Turkey; Garbanzo or Garbanzobean in Spain; Gravanço in Portugal; and Ovetichie in Russia. Similarly, in India, chickpea is known by various names like Chana or Gram or Bengal gram or Chani in Haryana, Rajasthan, Uttarakhand, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand, etc.; Chhole in Punjab, Jammu and Kashmir and Delhi; Chola in West Bengal; Harbara in Maharashtra; Boot in Orissa; Sanagulu in Andhra Pradesh; Kadale in Karnataka; Kadalai in Tamil Nadu; and Kadala in Kerala, representing its widespread cultivation and knowledge of utilization.

Grain legumes play an important nutritional role in the diet of millions of people in the developing countries and are thus sometimes referred to as the poor man's meat. These legume crops are normally grown in rotation with cereals because of their role in nitrogen fixation (Merga and Haji, 2019) [10].

During the winter season there is no legume that is adapted to grow during cool winter season. Chickpea has the potential to fill this winter legume gap and address many problems that are being faced by resource poor farmers, which includes malnutrition, low soil fertility and land degradation. Compared to other legumes, chickpea is a complete food source, supplying both carbohydrates and proteins (Table 1). The aim of this review is to discuss various opportunities for farmers to know about the improved technologies for growing of improved cultivar of chickpea.

Table 1: A nutritional comparison of chickpea and other legumes grown in India

Variables	Chickpea	Groundnut	Soyabean	Cowpea	Bean
Energys(KJ)	364	567	446	116	347
Proteins(g)	19	26	36	8	21
Fats(g)	6.04	49	20	0.5	1.2
Carbohydrates (g)	61	16	30	21	63
Fibers (g)	9	9	9	7	16

General Plant Characteristics: Chickpea is a herbaceous annual plant and the plant height generally ranges from 30-70 cm. The plant is mostly covered with glandular or nonglandular hairs but some genotypes do not possess hair. Based on seed size and color, cultivated chickpeas are of two types *viz*., Macrosperma (Kabuli type) are large seed (100-seed mass >25 g), round or ramhead, and cream-colored and tall in height, with large leaflets and white flowers, and contains no anthocyanin and second Microsperma (desi type) is of small type are and angular in shape with seed color varies from cream, black, brown, yellow to green. The plants are short with small leaflets and purplish flowers, and contain anthocyanin (Cubero 1975) [4]. The seed coat consists of two layers, the outer testa and the inner tegmen, and a hilum. Optimum temperature required to seeds germinate is 28-33 °C in 5-6 days. The portion of the axis above the cotyledon called the epicotyl, elongates and pushes the plumule upward. The growth of the plumule produces an erect shoot and leaves, and the radicle grows to produce the roots (Cubero 1987) [5]. The roots grow 1.5-2.0 m deep. Chickpea roots bear Rhizobium nodules. They are of the carotenoid type, branched with laterally flattened ramifications, sometimes forming a fanlike lobe (Corby 1981) [2]. The chickpea stem is erect, branched, viscous, hairy, herbaceous, green, and solid. The branches are usually quadrangular, ribbed, and green. There are primary, secondary, and tertiary branches (Cubero 1987) [5]. Chickpea leaves are petiolate, compound, and uniimparipinnate (pseudoimparipinnate). Chickpea flowers are complete and bisexual, and have papilionaceous corolla. They are white, pink, purple or blue in color. In colored flowers, the peduncles may be of different colors, the floral part purplish and the racemal green. The axillary inflorescence is shorter than the subtending leaf (Cubero 1987) [5]. There are 10 stamens in diadelphous (9) + 1 condition. The filaments of nine of the stamens are fused, forming an androecial sheath; the tenth stamen is free. The ovary is monocarpellary, unilocular, and superior, with marginal placentation. The ovary is 2-3 mm long and 1-15 mm wide. There are 1-3 ovules, rarely 4. The style is 3-4 mm long, linear, upturned, and glabrous except at the bottom (Cubero 1987) [5]. Pod formation begins 5-6 days after fertilization.

Climate Requirements: Chickpea likes cool, dry and bright weather that's why grown in a winter in the tropics area and as a summer or spring crop in the temperate environments. Abiotic factors that affecting the flowering of chickpea are temperature, day length and availability of moisture are the three major factors. In general, flowering is delayed under low temperatures and also under short-days. Genetic variability exists in chickpea germplasm due to of variation in day length (photoperiod sensitivity) and also of variation in temperature (thermal sensitivity) and has been exploited in development of short-duration cultivars. Chickpea is sensitive to high (>35 °C) as well as low (<15 °C) temperatures at the reproductive stage. Hence, both extremes of temperatures lead to flower drop and reduced pod set (Gaur *et al.* 2010) [7].

Varieties: Improved varieties for Uttar Pradesh: K-850, Pusa-256, Pusa-372, Pusa-1003,Vardan, Uday, Alok, Vishwas, Samrat, Gaurav, Radhey, Awarodhi, Sadabahar, Sadbhawna,, Pragati, Surya, KWR108, Pant G-186, Pant G 10, WCG-3 Vallabh Kaller Chana, JG-14 etc**.** The brief description of some of the important varieties of chickpea for India is given below in Table 2 (Kiran Yadav 2009) [8]:

Table 2: Varieties of chickpea for India

S. No.	Desi and Small seeded varieties	Description
1	Awarodhi:	This variety matures in 150-155 days. This is a medium tall, semi erect type variety. Grains are brown in color. This variety is resistant to wilt disease. Yield potential is 25-30 quintals/hectare.
2	Pusa-256	It matures in 145-150 days. Grains are bold and brown in color. This variety is equally suitable for timely and late planting. It is resistant to Ascochyta blight. Yield potential is 22-25 quintals/hectare.
3	JG-315:	This variety matures in 145-150 days. It is suitable for growing in rainfed areas. This variety is resistant to wilt disease. Yield potential is 25-30 quintals/hectare.
4	Pusa-362	It matures in 145-155 days. Grains are medium in size. This variety is suitable for late planting in irrigated conditions; it is resistant to wilt disease. Yield potential is 25-30 quintals/hectare.
5	Gora Hisari:	It matures in 140-150 days. Grains are bold and light brown in color with good cooking quality. This variety is suitable for irrigated areas only. Yield potential is 18-20 quintals/hectare.
6	K-850:	This variety was developed at C.S. Azad University of Agriculture and Technology, Kanpur from a cross Banda local and Etah bold. It is medium tall (45-60 centimeters) with upright growth habit. It is an early variety maturing in 145-150 days. Flowers are violet. Pods mostly double seeded. Seeds are round, smooth, reddish-brown, attractive and very bold (340g/1000 seeds). This variety has been released for whole of Uttar Pradesh. It has a yield potential of 25-30

		quintals/hectare.
7	Pant G-114:	It was developed from a cross G-130 and 1540. It is a medium maturing variety (150 days) having semi-erect, light green foliage. The seeds are brown and of medium size. The variety is moderately resistant to blight. It has high yield potential (30-35 quintals/hectare) and wide adaptation and consistency in performance in entire northern plains of the country.
8	H-355	Developed from a cross G-140 and 526 in 1977. It matures in about 160 days. It is suitable for irrigated and wilt prone areas. Seeds are small in size and brownish-yellow in color. Its average yield is 20-25 quintals/hectare, it is especially suitable for wilt prone areas of Madhya Pradesh.
9	Radhey:	It is a medium maturing variety (150 days). Plants are tall, semi-spreading with light green foliage. Flowers are pink in color. Seeds are smooth, light brown and bold. It is suitable for growing in eastern, Central and Bundelkhand tracts of Uttar Pradesh. It has yield potential of 25-30 quintals per hectare.
10	RS-11:	It is a white flowered mutant from RS-10. It is drought resistant. Seeds are medium bold and brown in color. It is medium in maturity. It has yield potential of 20-25 quintals/hectare. It is suitable for growing in heavy soils and irrigated conditions of Rajasthan.
11	PUSA-209:	It was developed at I.A.R.I, New Delhi, from a cross P-827 and C-235 and was released for general cultivation in 1980 for Rajasthan, Delhi, Uttar Pradesh, Haryana and Punjab. The crop matures in about 145-165 days. Plant height is about 65 cm. Seeds are attractive and medium bold (135 g/1000 seeds) and light brown in color. Its yield potential is about 25-30 quintals per hectare.
12	Phule G-5:	It is a pink seeded variety with medium seed size, round smooth seed coat, preferred for parching purpose. Its average yield is 12-15 quintals/hectare.
13	C-3	It matures in 90-100 days. Seeds are yellowish-brown and of medium size. Its average yield is about 15 quintals/hectare.
	Kabuli Gram Varieties	
1	RLB Chana Kabuli 1	Developed in 2020 and best for sowing in October. It mature in 100-104 days and average yield is 16 quintals/hectare. It is resistant to wilt and dry root rot diseases.
2	C-104:	It is medium in maturity, seeds are of salmon color and very bold. It is suitable for growing in the irrigated areas in Punjab. In Uttar Pradesh also, it has given very good yield. It should be avoided in humid areas where there is severe attack of blight disease. The average yield is 15-20 quintals/hectare.
3	L-550:	It is tall, semi-spreading, medium maturing variety with light green foliage. It is very early in flowering among the kabuli types and matures about ten days earlier than C-104. It matures in 160 days. Its average yield is about 18-22 quintals per hectare. It has shown consistently higher yield in the northern plains and central zone of the country.
3	Pusa-1003:	It matures in 130-135 days. This variety is suitable for growing in irrigated conditions. Seeds are bold. This variety is resistant to wilt. Yield potential is 28 quintals/hectare.
4	Sadabahar:	It matures in 145-160 days. Grains are green in color. It is tolerant to wilt. Its yield potential is 25-30 quintals/hectare.

Plant growth and development

Seedling emergence: Germination of chickpea seedlings is hypogeal, and their cotyledons remaining below the soil surface (Gaur *et al.* 2010) [7]. In arid regions, chickpea is sown deep as surface moisture is often inadequate to allow sufficient crop establishment. Emergence occurs in 7-15 days after sowing, depending on soil temperature and sowing depth (Pulse Australia. Chickpea Production).

Plant growth: Crop germinates, matures, senesces, and dies within 100 to 225 days from sowing, depending on conditions of environment before and after flowering, the magnitude of seed yield, and the rate and synchrony of seed filling (Croser *et al.* 2003) [3]. Chickpea has an indeterminate growth habit in which vegetative growth continues even after the start of flowering. The duration of vegetative growth before flowering generally ranges from 40 to 80 days depending on the variety, location, availability of soil moisture and weather conditions. Excessive vegetative growth is a problem of long growing season environments, as in northern and eastern India when there is plenty of soil moisture and maximum temperatures are favourable for chickpea growth, flowering and podding will continue on the upper nodes (Gaur *et al.* 2010) [7]. However, water deficits at the flowering and the post-flowering stages have been found to have greater adverse impact than at the vegetative stage (Randhawa *et al.* 2014) [12].

Pollination and fertilization: Pollination in chickpea takes place before the flower bud opens, when the pollen and the receptive female organ are still enclosed within a fused petal, called the keel. Chickpeas have typical papilionaceous flowers. Anthesis in chickpea takes place throughout the day. Anther dehiscence occurs inside the bud 24 h before the opening of the flower. Thus, chickpea flowers are truly cleistogamous and self-fertilized. After dehiscence the anthers become shriveled while the standard and wing petals are fully expanded. Under favorable conditions, the time taken from fertilization to the first appearance of pod (pod set) is about 6 days (Gaur *et al.* 2010) [7].

Maturity: After setting of pod, the pod wall grows rapidly in 10 to 15 days while seed growth occurs later. After pod development and seed filling, leaves senescence begins. In presence of plenty of soil moisture, flowering and podding will continue on the upper nodes. Chickpea can tolerate high temperature in presence of enough soil moisture and ready to harvest when 90% of the stems and pods loose their green color and turn light golden yellow (Gaur *et al.* 2010) [7].

Seed production technology: For the production of chickpea seed high priority should be given to maintenance of genetic and physical purity of the seed. Chickpea sowing is done in the month of October or November. Late sowing (December-January) should be avoided as the late-sown crop may experience moisture stress and high temperatures at the critical stage of pod-filling, leading to reduced yield and seed quality. Chickpea is a self-fertilized crop has a very low outcrossing percentage (0- 1%). In India, an isolation distance of 10 m for foundation seed and 5 m for certified seed is required. Chickpea is well suited to well-drained, non-acidic soils with medium to heavy clay texture with a pH ranging from 6.0 to 8.0 (Pulse Australia. Chickpea Production). The previous crop debris and stubble from the field should be removed as these can harbor the pathogens that cause root diseases, such as collar rot. Chickpea growth is good in loose tilth and field is in good drainage condition. Sowing of kabuli

chickpea should never be irrigated immediately after sowing, particularly in deep black soils because the kabuli chickpea seeds have thin seed coat and deteriorate faster as compared to desi type and are also more susceptible to seed rot and seedling damping off (Gaur *et al.* 2010) [7]. Crop may be sown by seed drill or local plough at a row spacing of 30-40 cm and seed rate of 75-100 kg /hectare depending upon size of seed with 8-10 cm deep sowing because it can be treated with 0.25 percent Thiram or Carbendazim (Bavistin) before sowing. Chickpea is a leguminous crop and fulfills its nitrogen requirement (about 75%) through symbolic nitrogen fixation process which last 3 to 4 weeks after sowing. However, soil with low organic matter and poor nitrogen supply may require 20-25 kg/hectare of nitrogen before the formation of nodules. Besides nitrogen, if soils are deficient in phosphorous then phosphorous (40-60 kg/hectare) supply is required (Kiran Yadav, 2009) [8]. If soils are low in potassium (K), an application of 17 to 25 kg K ha-1 is recommended. There will be no response to application of K in soils with high levels of available K. Two irrigations is required because chickpea is a rainfed crop, one each at branching and pod filling stages, are recommended for higher yield (Gaur *et al.* 2010) [7].

Weed management

Chickpea, growth is slow in its early time and short stature plant, is highly susceptible to weed competition and if weeds are not controlled at proper time then there may be considerable losses may occur and integrated weed management practices can be achieved by application of herbicides and hoeing twice at 20 and 40 days after the crop germination (Sunil *et al.*, 2011) [16]. Fluchloralin (Basalin) 1 kg/hectare in 800-1000 liters of water as pre-planting spray may be used in the soil before sowing as an effective herbicide (Kiran Yadav, 2009) [8].

Plant protection: In general, soil borne diseases of chickpea (Fusarium wilt, stem rot, rust, etc.) are more prevalent in central and peninsular India, whereas foliar diseases (Ascochyta blight etc.) are important in northern, northern-western and eastern India. Among the insect-pests, pod borer is the most severe yield reducer throughout India, while the bruchids cause severe damage in storage (Pande *et al.*, 2011) [13]. The diagnostic symptoms of these diseases and insect-pests and their control measures are as follows in Table 3 and 4:

Table 3: Major diseases of chickpea and their control measures:

S. No.	Diseases	Symptoms and Control measures
1	Wilt (Fusarium orthocerus)	Treat the seed with Benlate T or a mixture of Benlate of Thiram (1:1) at the rate of 2.5 g per kg of seed and use resistant variety RLBGK 1, JG11, JG130, JAKI 9218, KAK2, JGK 1, JGK 2, Birsa and channa-3.
2	Sclerotinia stem rot (Scleritinia sclerotiorum)	Use only healthy seeds free from sclerotia. After harvest, the diseased plants should be destroyed by burning. Treat the soil with a mixture of fungicides like Brassicol and Captan at the rate of 10 kg per hectare.
3	Rust (Uromyces ciceris arietini)	With the appearance of first symptoms, spray the crop with 0.2% Mancozeb 75 WP followed by two more sprays at 10 days interval.
4	Ascochyta blight	It is a seed born and can spread through debris hence should be remove and destroy the debris of crop plant and use resistant variety Him chana-1, Gaurav and vardan, seed treatment with thiram @ 3g/kg and foliar spray of chlorothalonil @ 2 ml/L.

Table 4: Major insect-pest of chickpea and their control measures

S. No.	Insect-Pest	Control Measures
1	Pod Borer (Helicoverpa armigera)	It invades the crop from seedlings to maturity. Larvae feed on leaves, flowers and pods. Highly resistant sources not available. Hence, use of moderate resistant cultivars like ICCV 10, Vijay, ICCV 7 and ICCL 86103. Spray endosulfan 2ml/L and indoxacarb @ 1ml/L or Spray neem seed extract (5%).
2	Bruchids (Callosobruchus chinensis)	The adult and grub feed on the grain by making a small hole and white egg are seen on damaged seed. Keep clean seed in pest proof containers and spray malathion (0.05%) at maturity together with fumigation of aluminum phosphide required.

Roguing: In field roguing done timely because it not only varietal purity but also protects the seed crop from seed-borne diseases. The off-type plants, other crop species (with similar seed size), weed plants, parasitic weeds such as Cuscuta spp. and plants infected with seed-borne fungal diseases and viruses should be removed time to time from the fields (Gaur *et al.*, 2010) [7].

Harvesting and threshing: The crop should be harvested at the time of leaves start to senesce and start shedding, pods turn yellow, plants are dry, and seed feels hard and rattles within the pod. Threshing can be done using commercially available power threshers.

Seed Storage: The ideal seed moisture level is 10-12% for short-term storage (up to 8 months). After drying, the seed should be either stored in polythene-lined gunny bags or in safe storage structures (metal bins or earthen containers) and rodent free room. Bruchids (*Callosobruchus spp*.) are the most serious storage pests of chickpea and all other food legumes (Gaur *et al.*, 2010) [7].

Yield: A well managed crop of Desi gram varieties gave about 20-27 q/ha while Kabuli varieties gave 15-20 q/ha grain yield.

Reference

1. Abbo S, Molina C, Jungma NNR, Grusa KA, Berkovitch Z, Reifen R, *et al*. Quantitative trait loci governing carotenoid concentration and weight in seeds of chickpea (*Cicer arietinum* L.). Theor Appl Genet. 2005;111:185–195.
2. Corby R. Seeds of Leguminosae in Advances in legumes systemics. Part 2 (Polhill, R.M., and Raven, P.H., eds.). Kew, UK: Royal Botanic Gardens, 1981, Pages 913-915.
3. Croser JS, Clarke HJ, Siddique KHM, Khan TN. Low-temperature stress: implications for chickpea (*Cicer arietinum* L.) improvement. Critical Reviews in Plant Sciences. 2003;22(2):185–219.
4. Cubero JI. The research on chickpea (*Cicer arietinum*) in

Spain. Pages 117-122 in Proceedings of the International Workshop on Graih Legumes, 13 - 16 Jan 1975, ICRISAT, Hyderabad, India: International Crops Research Institute for the Semi-Arid Tropics, 1975.
5. Cubero JI. Morphology of chickpea. In the chickpea (Saxena, M.C., a n d Singh, K.B.). Wallingford, Oxon, UK: CAB International, 1987, Pages 35-66.
6. Food and Agriculture Organization. FAOSTAT Statistical Database of the United Nation Food and Agriculture Organization Statistical Division. Rome, 2019.
7. Gaur PM, Tripathi S, Gowda CLL, Ranga Rao GV, Sharma HC, Pande S, *et al*. Chickpea Seed Production Manual. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 2010, 28pp.
8. Kiran Yadav. Chickpea (*Cicer arientinum* L.). GBPUAT, Pantnagar, 2009.
9. Mallikarjuna N, Sharma HC, Upadhyaya HD. Exploitation of wild relatives of pigeonpea and chickpea for resistance to *Helicoverpa armigera*. EJ SAT Agric Res Crop Improv. 2007;3(1):4–7
10. Merga B, Haji J. Economic importance of chickpea: Production, value, and world trade. Cogent Food and Agriculture, 2019, 5(1). https://doi.org/10.1080/23311932.2019.1615718
11. Pulse Australia. Chickpea Production: Southern and Western Region. http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ southern-guide.
12. Randhawa N, Kaur J, Singh S, Singh I. Growth and yield in chickpea (*Cicer arietinum* L.) genotypes in response to water stress. African Journal of Agricultural Research. 2014;9(11):982–992.
13. Pande S, Sharma M, Ghosh R, Rameshwar T, Reddy DR. Chickpea Diseases and Insect-Pest Management Manual. Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics, 2011.
14. Saxena MC. Problems and potential of chickpea production in nineties. In: Chickpea in the nineties: proceedings of the second international workshop on chickpea improvement, ICRISAT Center, Patancheru, India, 1989-1990 Dec.
15. Singh KB. Chickpea (*Cicer arietinum* L.). Field Crops Res. 1997;53:161–170.
16. Sunil CM, Shekara BG, Ashoka P, Murthy KK, Madhukumar V. Effect of integrated weed management practices on nutrient uptake in aerobic rice. Research on Crops. 2011;12(3):629–632.
17. Varshney RK, Song C, Saxena RK, Azam S, Yu S, Sharpe AG. Draft genome sequence of chickpea (*Cicer arietinum* L.) provides a resource for trait improvement. Nat Biotechnology Epub January 27. Available from, 2013. http://www.nature.com/nbt/journal/ vaop/ncurrent/full/nbt.2491.html.
18. Williams PC, Singh U. Nutritional quality and the evaluation of quality in breeding programmes. In: Saxena M.C., Singh K.B. (Eds) The chickpea. CAB International, Wallingford, 1987, pp. 329–390.