SHODH SAMAGAM

ISSN : 2581-6918 (Online), 2582-1792 (PRINT)

Chickpea : History, Origin and Production

Rajani Singh, Department of Education,
MJ College, Kohka, Junwani Bhilai, Durg, Chhattisgarh, India

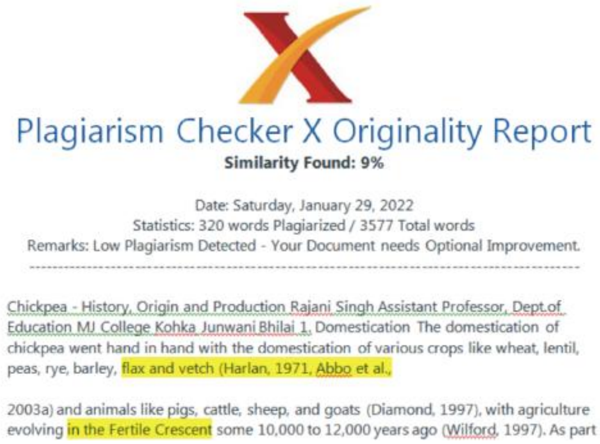
ORIGINAL ARTICLE

Corresponding Author

Rajani Singh, Department of Education,
MJ College, Kohka, Junwani Bhilai,
Durg, Chhattisgarh, India

shodhsamagam1@gmail.com

Received on : 29/01/2022
Revised on : -----
Accepted on : 05/02/2022
Plagiarism : 09% on 29/01/2022


Plagiarism Checker X Originality Report
Similarity Found: 9%

Date: Saturday, January 29, 2022
Statistics: 320 words Plagiarized / 3577 Total words
Remarks: Low Plagiarism Detected - Your Document needs Optional Improvement.

Chickpea - History, Origin and Production Rajani Singh Assistant Professor, Dept.of Education MJ College Kohka Junwani Bhilai 1. Domestication The domestication of chickpea went hand in hand with the domestication of various crops like wheat, lentil, peas, rye, barley, flax and vetch (Harlan, 1971, Abbo et al.,

2003a) and animals like pigs, cattle, sheep, and goats (Diamond, 1997), with agriculture evolving in the Fertile Crescent some 10,000 to 12,000 years ago (Wilford, 1997). As part

ABSTRACT

The domestication of chickpea went hand in hand with the domestication of various crops like wheat, lentil, peas, rye, barley, flax and vetch (Harlan, 1971, Abbo et al., 2003a) and animals like pigs, cattle, sheep, and goats (Diamond, 1997), with agriculture evolving in the Fertile Crescent some 10,000 to 12,000 years ago (Wilford, 1997). As part of this great arc spanning from western Iran, through Iraq, Jordan, Israel to south-east Turkey there manifested an equitable package of domesticates granting all the basic needs of humanity: carbohydrate, oil, protein, animal transport and traction and vegetable and animal fibre for rope and clothing (Diamond, 1997).

KEY WORDS

Domesticates, Carbohydrate, Agriculture Chickpea.

To begin with, the harvesting of wild plants was done in the ancient hunter-gatherer cultures, with the presence of cultivated crops making their appearance felt in archaeological records from 7,500 BC (Harlan, 1971) and earlier dates are possible (Hillman, 2000). It is possible that the beginning of an extended cool dry period caused interest in gathering food supply with the domestication and the beginning of agriculture (Wright, 1968, Smith 1994). Einkorn wheat was domesticated from the wild in what seems to be a period of a few centuries (Heun, 1997), however the current distribution of wild relatives may not follow from the distribution at the period of domestication (Diamond, 1997), and diversified crop may have evolved outside of the centre of origin (Harlan, 1971).

The following have been records of chickpea used as food: 8th millenium BC at Tell Abu Hureyra Syria (Hillman, 1975), 7,500 – 6,800 BC at Cayonu Turkey (van Zeist , 1972), and 5450 BC at Hacilar Turkey (Van der Maesen, 1984), and these records are possibly of wild rather than domesticated (*Cicer arietinum*) chickpea species (Ladizinsky, 1988). The distinguishing seed beak has often disintegrated in carbonized seed remains leading to few archaeological records, however documents exists documenting establishments as a cultivated crop from 3,300 BC onwards in Egypt and the Middle East (Van der Maesen, 1972).

Cicer reticulatum is the progenitor wild relative for domestic chickpea, the only one present in the primary gene pool, with restricted distribution in south-east Turkey where it was possible domesticated (Ladizinsky and Adler, 1975, Ladizinsky, 1998). The species have similar seed proteins, are interfertile and are similar morphologically, but a reciprocal inversion, a paracentric inversion, or by location of chromosomal satellites, may lead to difference between a domestic accession and *C.reticulatum* (Ladizinsky, 1998).

Only 1 species *C. echinospernum* is present in the secondary pool, and the difference between these species and the domestic is a single reciprocal translation while the hybrids are generally sterile (Ladizinsky, 1998). Genetical isolation of other annual and perennial *Cicer sp* is present in the tertiary gene pool and equally distant from the domestic as per AFLP diversity analyses (Nguyen *et al.*, 2004).

The food and medicinal/herbal uses of Chickpeas are mentioned by Homer in the Iliad (1,000 – 800 BC), and in Indian, Roman and medieval European literature (Van der Maeson, 1972). The spread of the crop with the cluster of founder crops went from the Fertile Crescent into Europe and western-central Asia from the *circa* 5,500 BC onwards (Harlan, 1992, Damania, 1997, Harris, 1997).

The years from 2,000 BC, though a 1st millennium BC date mark the appearance of chickpea in India. There were marked changes with domestication including initially the loss of dormancy, and then reduced pod dehiscence, larger plant size, larger seed size and variants with greater erect habit and diminished anthocynin pigmentation (Smartt, 1984, Ladizinzky, 1987). However, the key to domesticating chickpea was the change from a winter habit accompanied by an autumn sowing to a spring habit, which discarded/diminished the danger of lethal infestation of the endemic aschochyta pathogen complex (Abbo *et al.*, 2003a).

Figure 1: Seed of ATFCC accession 40504 of desi chickpea CA0805 originating from India, with pod shell.

There has been a different evolutionary sequence in the domestication of chickpea as compared to that of domestication of other founder crops in the fertile crescent (Abbo *et al.*, 2003b). The appearance of large seed type in archaeological findings have been associated with domestication, and there has been a gap of no fossil remains between 9000 – 6000 BP for large seeded chickpeas, as compared to the continuous records for other founder crops.

There is a strong evidence of the presence of adaptation to winter cropping in the annual and perennial wild relatives in the region. A polygenetic trait – the loss of responsiveness to vernalisation has been the main differentiation between wild and domestic. A characteristic of domestic chickpea is larger plants and seed as compared to the wild progenitor, *Cicer reticulate.*

Winter rainfall is predomination in the Fertile Crescent; it is also conducive to devastating aschochyta blight which may leads to total yield loss in winter grown susceptible chickpea varieties. A reprieve from this disease can be obtained by summer cropping provided there is a relatively dry spring and summer. There is a much more severe occurrence of this disease in chickpea than in winter cropped pea and lentil. The advent of summer cropping and the loss of vernalisation, coinciding with the introduction of summer crops – sesame, millet and sorghum around 6000 BP enabled chickpea to make its appearance again as a significant crop (Abbo *et al.*, 2003a).

As compared to other grain legume crops, diminishing of pod shattering and loss of seed dormancy seems not to be the key characteristics for domestication in chickpea (Ladizinsky, 1987). Chickpea is cultivated widely in the dry winter areas of India, and in the summer crop regions of the Mid-east and North America, whereas it was not possible to do winter cropping in Australia due to the appearance of *Aschochyta* blight. Chickeap has now re-emerged with the presence of disease resistant varieties (Pande *et al*., 2005).

Reliance on residual stored soil moisture is a trait of Domestic chickpea and it has been selected for adaptation. As a result of evolution of summer cropping there was a temporal separation of the reproductive phases amongst the cultivated and the wild chickpea progenitor. This separation of wild relatives as a recurring source of genetic variation has led to the rough spots in genetic diversity of the domestic species – the 'founder effect' with domestication of this progenitor, the restricted distribution of the progenitor and the change from a winter to a summer crop Abbo *et al.*, 2003b).

Evolution of crop types

The genus *Cicer* contains the domestic chickpea and its wild relatives. The genus *Cicer* is in the family *Fabaceae* within the tribe *Cicerae* (USDA, 2005). The diploid chromosome number is 16, while 14 has been documented for some landraces, the species *C.songaricum* and for some accessions of *C.anatolicum* (Van der Maesen, 1972).

Self pollination is present in the domestic crop. The flower bud stage completes pollination and it has been observed that bees visit open flowers in the field (Van der Maesen, 1972). Typically only one seed per pod is set. Kabuli domestic types which have a large seed appear to have led to the evolution of smaller seeded desi types (Moreno and Cubero, 1978).

The flower bud stage completes pollination and it has been observed that bees visit open flowers in the field (Van der Maesen, 1972). Typically only one seed per pod is set. Kabuli domestic types which have a large seed appear to have led to the evolution of smaller seeded desi types (Moreno and Cubero, 1978). Analyses of molecular diversity distinctly separates the two groups, which contain further subgroups within each (Iruela et al. 2002).

The kabuli types, also known as 'macrosperma', are identified by large seeds, leaves, pods and a taller stature. (Van der Maesen, 1972, Morena and Cubero, 1978). The seeds and flowers are mainly white however there is a presence of other colours with a low frequency. Genetic diversity distribution in the kabuli is much narrower than in the predominant desi chickpea type.

The desi have small seeds, leaflets, pods and a small stature. There is evidence of wide genetic diversity in the desi types for seed, pod, flower and vegetative colour, plus variation in seed surface and shape (Morena and Cubero, 1978). Mostly kabuli has a seed shape of a ram's head.

These two types differ in geographic distribution, with desi present widely from the eastern Mediterranean to central Asia and the Indian sub-continent, while the kabuli tends to be restricted to the western Mediterranean (Moreno and Cubero, 1978).

There is strong evidence in favour of the hypothesis of recent evolution of the kabuli types from the desi, and association with desire for white seed colour and better food quality (Moreno and Cubero, 1978). This is consistent with the presence of very limited distribution of the the *C.reticulatum* progenitor in south-eastern Turkey, with a predated reproductive separation from the summer crop domesticates, and complete cross compatibility with each of the kabuli and desi types. The cytoplasm of the desi and kabuli types are also near uniform. This suggests no evolution of hybridisation barriers. (Moreno and Cubero, 1978).

There are separate morphological types in the desi and kabuli groups, with little appearance of intermediate forms (Iruela *et al*., 2002). Modern plant breeding programs do not have these differences and they attempt to mix large seed size with the vigour and local adaptation of desi types (Yadav et al., 2004). Other geographic characterization of traits in the desi include a strong presence of black seed in Ethiopia, and certain parts of Turkey, Iran and India, but not central Asia Asia (Van der Maesen, 1972). The desi types from India with small stature can be associated with tormentose leaves (Yadav pers comm).

Centres of Diversity

The Fertile Crescent is the primary center of diversity, and the location of crop domestication. The geographic spread of chickpea secondary centres of diversity have emerged from over 2000 years in Mediterranean Europe, northeast Africa, the Indian subcontinent and some more recently in Mexico and Chile with post-Columbus introduction (Van der Maesen, 1972).

Old landraces and wild relatives of chickpea are distributed in three main regions from 8^0 - 52^0N latitude and 8^0W – 85^0E longitude: 1, a western region in small areas over north Africa, Ethiopia, Crete and Greece; 2, Asia-minor – Iran, Caucasus and 3, central Asia, Afghanistan and the Himalayan region (Van der Maesen , 1972).

The domestic chickpea is now mostly cultivated in Australia, southern South America, the Balkans, Ethiopia, both the European and African Mediterranean regions, East Africa, southern Asia from Myanmar to Iran, and the Mid-east region encompassing Iraq, Israel and Turkey (Van der Maesen, 1972).

The greatest diversity in the largest genebank for chickpea landraces at ICRISAT with 17250 accessions is from India (6930) followed by Iran (4850), Ethiopia (930), Afghanistan (700), Pakistan (480), Turkey (470), Mexico (390), Syria (220), Chile (139), former Soviet Union (133), and various from south America, north America, north Africa, east Africa, and southern Europe.

The genebank at ICARDA with a regional mandate for kabuli chickpeas has 12,070 landrace accessions mainly sourced from Iran (1780), Turkey (970), India (410), Chile (340), Uzbekistan (300), Spain (280), Tunisia (270), Morocco (230), Bulgaria (210), Portugal (170), Russian federation (160), Mexico (160), Jordan (150), USA (120), Bangla Desh (110), Tajikistan (110), Azerbaijan (110) and various with less than 100 (south America, tropical Africa, Ethiopia, Algeria, Egypt, Palastine, Italy and north Europe).

The two genebanks mostly reflect the available sources of genetic diversity in landrances with clear preponderance in the Indian sub-continent, the broad Middle East, Iran, and Ethiopia, displaying crucial secondary centres of diversification followed the spread of the crop out of the Fertile Crescent.

From the central Asian republics to Georgia, from Turkey to Ethiopia and in the North and south of the Himalayas, from India to Iran, there is a general blurring between landrace diversity and the distribution of wild *Cicer spp.* (Van der Maesen, 1972).

Yet the primary and secondary gene pools currently, and highly likely in the past, have a very contained distribution in south-eastern Turkey (Ladizinsky, 1998). This curtailed geographic distribution and the division of reproductive phases with the transformation of the crop to a spring habit hints at a decline of introgressive gene flow from wild to domestic gene pools post-domestication (Abbo *et al.*, 2003b).

Hence the genepool that is domestic has grown from a narrow genetic base, albeit with adaptation selection from a broad range of agri-ecological niches; typically spring-summer cropped other than that in the Indian sub-continent with winter cropping on residual moisture (or irrigated), or rainfed winter cropped in Australia in association with growth of *ascochyta* as a major pathogen (Pande *et al.*, 2005).

Conditions for Growth

Climate

Chickpea is suitable for cool weather. The yields are best when the temperature during daytime ranges from 70 to 80°F and the temperature during nighttime are from 64 to 70°F. The crop has drought resistant characteristics as a result of its deep taproot.

The maturity period of varieties adapted to the Pacific Northwest is 84 to 125 days. Maturity can be delayed by the presence of rain or irriguation during the later part of growth. The yield of the crop is not good in regions where precipitation is over 30 inches per year.

Soil

The performance of chickpea is best on sandy or silt loam soils with good drainage. Saline soils are not suitable. Wet soils are not suitable. Low lying regions of fields that are prone to flooding are not to be considered.

Cultural Practices

Seed preparation

The inoculation of chickpea seeds needs to be done at seeding with the proper *Rhizobium* strain. In 2003, research was conducted at the Columbia Basin Agriculture research to show that incoluation of the seed with proper inoculant increases nodulation and yield.

The nodulation of peas and lentils done by *Rhizobium* does not produce nodules on chickpea. Peat or granular form of inoculants are present. Peat-based inoculant is ineffective as compared to granular inoculant. Metering through seed hoppers is done for granular inoculants and thereafter the inoculant is placed in the seed row near the seed, preferably below the seed, at planting.

5 to 10 pounds of granules per acre should be utilized. A fungicide mixture should be used to treat the seeds before planting, especially when planting into cool soil. In 2003, studies conducted near Genesee Idaho show a 30 percent seed yield and a 10 percent plant establishment without seed treatment compared to a standard treatment.

Seedbed preparation

As chickpea seeds are larger than peas or lentils, they are comparatively less sensitive to seed placement than some other crops. However, there is a requirement of a firm, moist seedbed.

An effective strategy for creating a desirable seedbed is the use of a conventional tillage system using primary tillage to bury previous crop residue followed by secondary tillage to incorporate herbicides.

For obtaining adequate stand establishment in direct seed systems where previous crop residue is left on soil surface, proper residue management and drill selection are essential. Residue should be baled and removed or the residue should be chopped into small pieces and spread uniformly for hoe-type no-till-drills to work at optimum levels.

Crop residue should be spread uniformly to avoid leaving thick mats of residue that are difficult to penetrate when using disc-type drills.

Seeding date

It's mostly advantageous to plant the crop early in the spring when limited late-season moisture has a critically negative impact on seed yield. A germination study in the laboratory hand in hand with field trials showed that germination begins at 41°F or higher.

The crop should be planted in March or early April as the crop requires a long growing season to mature and is frost tolerant. In Idaho, the seeding is done by growers traditionally in May when soil temperature reach 45°F or warmer.

Success is achieved following these practices under the higher rainfall and cooler temperature found in Idaho production areas. Later plantings result in reduced yields and further problem with crop drying before harvest in most regions. Late planting may result in reduced grain qualities in some varieties.

Method and rate of seeding

As a result of variation in seed size seeding rates may vary. The range of seeding rates are from three to four seeds/sq ft. This is equivalent to 150 to 200 pounds per acre for the Kabuli types and 80 to 95 pounds per acre for the Desi types. Higher grain yields can be obtained with higher seeding rates (four to five seeds /sq ft) but it's not economically feasible.

Recent research studies discovered that there are no major differences in grain yield at 6- or 12-inch row spacing. The locations tested receive about 11 and 15 inches of annual precipitation respectively. It is advisable to plant the seed at a depth of 1.5 to 2.5 inches. The seed-to-soil contact is improved by packing the soil after seeding. Header losses are reduced as a result of packing by levelling the soil surface and allowing the combine header to be lowered closer to the ground.

Fertilizer and lime

At the Columbia Basin Agricultural Research Center a research was conducted on the fertility needs of chickpeas. The research discovered that chickpeas are minimally responsive to fertilization with nitrogen (N), phosphorus (P), sulphur (S) or zinc (Zn) under the conditions of the trials.

The requirements of nitrogen for chickpea are not very well defined, as the crop achieves nitrogen fixation from air. Only when soil test values in the top foot of soil are very low, nitrogen fertilization increases yield or quality.

In order to enhance seeding development some growers add 15 to 30 pounds of N before planting or at planting. High levels of N fertility can inhibit crop nitrogen fixation and nodulation. Good nitrogen sources are ammonium sulphate (21-0-0-24) to supply both N and S and ammonium phosphate-sulphate (16-20-0-14) to supply N, P, and S.

Like other pulse crops, chickpea requires potassium, phosphorus and micronutrients for growth. Fertilizer can be banded, broadcast or drilled with seed. The application of P when broadcast may need to be at a higher rate than application of banded, as P is not much mobile in soil. Fertilizer should not come in contact with seed, especially if the contents include potassium or nitrogen.

The salts in nitrogen and potassium fertilizers effect chickpea highly. In case there is a need of large applications, make applications of fertilizers before or during seedbed preparation to avoid salt effects.

There is a requirement of adequate amounts of sulphur in chickpea plants to help them fix atmospheric nitrogen. Elementary forms of sulphur are not advisable. Sulphur in elementary forms must first be converted to sulphate by soil bacteria before plants can absorb the sulphur.

In order to avoid the need for bacterial conversion of elemental sulphur to sulphate it is advisable to use sulphate forms, such as ammonium sulphate or ammonium phosphate sulphate which allow plants to readily take up sulphate. Soil acidity increases (lowering of soil pH) as a result of the use of elemental sulphur.

Apply boron and molybdenum as required, on the basis of soil tests or personal experience. A dosage of 1 to 2 pounds of boron per acre is recommended if the results of soil tests show boron levels below 0.5 ppm. Boron should be applied as broadcast (no banding), as it is toxic when placed too near the seed. In northern Idaho, it is customary to add an ounce of molybdenum per acre in case the soil pH is less than 5.7. Seed treatment is the effective application method for Molybdenum. If pH falls below 5.3 consider liming soil to a pH of 6.0. Reduction in yields have been observed due to low soil pH.

Crop Production

Chickpea has been produced world-wide 6.6 million tonnes in 2000-2001, and 9.5 million tonnes in 1998-1999 (Agriculture and Agri-Food Canada, 2005). The country estimates for production in 2004-2005 are as follows:

1. The majority of chickpea was produced in India with over 5 million tonnes, followed by Pakistan (600,000t), Turkey (600,000t), Iran (240,000t), Myanmar and Ethiopia each with 170,000t, Mexico (150,000t) and Australia (131,000t) (Agriculture and Agri-Food Canada, 2005).
2. An amount of less than 100,000t is produced in Canada, USA, Syria and Spain and a lot of countries contribute to the remaining 330,000t of world production.
3. In India the northern states of Rajasthan, Haryana, Uttar Pradesh and Madhya Pradesh are leading producers, and production extends all the way to southern India (Van der Maesen, 1972).

Prospects

For end uses for chickpea as a food group there exists a wide variety of seed characteristics and plant types. There is widespread cultivation from the tropics to high latitudes and in a range of management packages from rainfed with spring sowing, dryland on residual moisture and rainfed with winter sowing and spring – summer irrigated. There are a lot of opportunities for a greater strategic use of domestic germplasm and that of wild relatives, development of pest and disease management integrated packages and improved crop management.

There are existing strategies for managing the typically better economic returns with cereals combined with greater production risks with chickpea, for general farm plans that include chickpeas.

The ultimate determination of the success of the crop lies with the consumer and market competition based on the quality and price of food products. Reduction in crop risk and increased production can lead to opportunities in the major cropping regions.

REFERENCES

1. Agriculture and Agri-Food Canada (2005) Chickpeas: situation and outlook. Bi-weekly bulletin. www.agr.gc.ca/mad-dam/e/bulletine/v14e/v14n03e.htm.
2. Pande, S. Siddique, K.H.M. Kishore, G.K. Bayaa, B. Gaur, P.M. Gowda, C.L.L. Bretag, T.W. amd Crouch, J.H. (2005) Ascochyta blight of chickpea (*Cicer arietinum L.)*: a review of biology, pathogenicity, and disease management. Australian Journal of Agricultural Research, 56,317 – 322.
3. USDA (2005) GRIN species of *Cicer.* www.ars-grin.gov/cgi-bin/npgs/html/splist.pl?2600
4. Nguyen, T.T. Taylor P.W.J. Redden, R.J. and Ford, R. (2004) Genetic diversity estimates in *Cicer* using AFLP analysis. Plant breeding 123, 173-179.
5. Yadav, S.S. Turner, N.C. Meuhlbauer, F.J. Knights, E.J. Redden, B. McNeil, D. Berger, J. and Kumar, J. (2004) Enhancing adaptation of large seeded kabuli chickpea to drought prone environments. 4th International Crop Science Congress, Brisbane.
6. Abbo, S. Berger, J. and Turner, N. (2003b) Evolution of cultivated chickpea: four bottlenecks limit diversity and constrain adaptation. Functional Plant Biology 30, 1081-1087.
7. Abbo, S. Shtienberg, D. Lichtenzveig, J. Lev-Yadun, S. and Gopher, A. (2003a) The chickpea, summer cropping, and a new model for pulse domestication in the ancient near east. The Quarterly review of Biology 78(4), 435-448.
8. Wu, Y. and S. Guy. 1999, 2000, 2001, 2002, 2003. *Northern Idaho Extension Small Grain and Legume Variety Performance Trials*. Agricultural Experiment Station Progress Reports 330, 337, and 341. University of Idaho, Moscow, ID.
9. Machado, S., C. Humphreys, B. Tuck, T. Darnell, and M. Corp. 2003. Variety, seeding date, spacing, and seeding rate effects on grain yield and grain size of chickpeas in eastern Oregon. In *2003 Columbia Basin Agricultural Research Center Annual Report*, SR 1047, pp. 25–31. Oregon State University, Corvallis, OR.
10. Ireula, M. Rubio, J. Cubero, J.I. Gil, J. and Millan, T. (2002) phylogenetic analysis in the genus C*icer* and cultivated chickpea using RAPD and ISSR markers. Theoretical and Applied Genetics 104:643-651.
11. Siemens, M.C., M.K. Corp, and R.F. Correa. 2002. Effects of header modifications on garbanzo bean harvesting losses. In *2002 Columbia Basin Agricultural Research Center Annual Report*, SR 1040, pp. 37–43. Oregon State University, Corvallis, OR.
12. *Agricultural Research Update*. 1999. MSU Eastern Agricultural Research Center, North Dakota State University, Williston Research Extension Center, Regional Report No. 5.
13. Mahler, R.L. 1999. *Northern Idaho Fertilizer Guide*. University of Idaho, College of Agriculture. Cooperative Extension System, Agricultural Experiment Station, CIS 826 (revised).
14. Damania,A.B. (1998) Diversity of major cultivated plants domesticated in the Near East. In The Origins of Agriculture and Crop Domestication. ICARDA, Aleppo, Syria (Eds. Damania, A.B., J.Valkoun, G.Willcox and C.O.Qualset), 51-64.
15. Arris,D.R. (1998) The spread of neolithic agriculture from the levant to western Central Asia. In The Origins of Agriculture and Crop Domestication. ICARDA, Aleppo, Syria (Eds. Damania,A.B., J.Valkoun, G.Willcox and C.O.Qualset), 54-64.

16. Ladizinsky, G. (1998) Plant evolution under domestication. Kluwer Academic Publishers, Dordrecht, the Netherlands. Pp.174-176.

17. Diamond, J. (1997) Location, location, location: the first farmers. The American association for the advancement of science 278 (number 5341, issue 14). 1243-1244.

18. Harlan, J. (19710 Agricultural origins: centers and noncenters. Science 174, 468-474.

19. Heun, M. Schafer-pregl, R. Klawan, D. Castagna, R. Accerbi, M. Borghi, B. Salamini, F. (1997) Site of einkorn wheat domestication identified by DNA fingerprinting. Science 278, 1312-1314.

20. Whitford, J. (1997) New clues show where people made the great leap to agriculture.

21. Wright, H.E. (1968) Geological aspects of the archeology in Iraq.

22. Smith,B.D. (1995) Emergence of agriculture. Scientific American Library, series #54, pp231.

23. Wiese, M.V., W.J. Kaiser, L.J. Smith, and F.J. Muehlbauer. 1995. *Ascochyta Blight of Chickpea*. University of Idaho College of Agriculture, CIS 886 (revised).

24. Kaiser, W.J., F.J. Muehlbauer, and R.M. Hannan. 1994. Experience with Ascochyta blight of chickpea in the United States. In F.J. Muehlbauer and W.J. Kaiser (eds.). *Expanding the Production and Use of Cool Season Food Legumes*, pp. 849–858. Kluwer Academic Publishers.

25. Harlan, J. (1992) Crops and man. American Society of Agronomy, crop Science Society of America, Madison Wisconsin, USA. , 63-262.

26. *Alternative Field Crops Manual.* 1992. Chickpea (garbanzo bean). University of Wisconsin Extension; Cooperative Extension, University of Minnesota: Center for Alternative Plant and Animal Products; and the Minnesota Extension Service.

27. Hillman, G.C., Colledge, S.M. and Harris, D.M. (1989) Plant-food economy during the epipaleolithic period at Tell Abu Hureya, Syria: dietary diversity, seasonality, and modes of exploitation. Forages and farming

28. Ladizinsky, G. (1987) Pulse domestication before cultivation. Economic Botany 41(1), 60-65.

29. Murray, G.A., K.D. Kephart, L.E. O'Keeffe, D.L. Auld, and R.H. Callihan. 1987. *Dry Pea, Lentil, and Chickpea Production in Northern Idaho*. University of Idaho Agricultural Experiment Station Bulletin 664.

30. Pumphrey, F.V., T.R. Toll, and B.L. Klepper. 1985. Edible legume seed yield use. In *1985 Columbia Basin Agricultural Research*, SR 738. Oregon State University, Corvallis, OR.

31. Smartt, J. (1984) evolution of pulse legumes. 1. Mediterranean pulses. Experimental Agriculture 20, 275-296.

32. Muehlbauer, F.J., R.W. Short, W.J. Kaiser, D.F. Bezdicek, K.J. Morrison, and D.G. Swan. 1982. *Description and Culture of Chickpeas*. Washington State University Cooperative Extension, EB1112.

33. Moreno, M. and Cubero, J.I. (1978) Variation in *Cicer arietinum* L.. Euphytica 27, 465-485. New York Times (November 18).

34. Ladizinsky, G. and Adler, A. (1976) The origin of chickpea *Cicer arietinum* L.. Euphytica 25, 211-217.

35. Hillman, G.C. (1975) The plant remains from Tell Abu Hureya in Syria: a preliminary report. In The excavation of Tell Abu Hureya in Syria: a preliminary report, A.M.T.Moore. Proceedings of the Prehistory Society 41, 70-73.

36. Zohary, D. and Hoft, M. (1973) Domestication of pulses in the old world. Science 182,887-894.

37. Van der Maesen, L.J.G. (1972) *Cicer* L., a monograph of the genus, with special reference to the chickpea (*Cicer arietinum* L.), its ecology and distribution. Mendelingen Landbouwhogeschool Wageningen Nederland,1-341.

38. Van Zeist,W. and Bottema, S. (1972) vegetation history of the eastern Mediterranean and the near east during the last 20,000 years. In Paleoclimates, palaenvironments and human communities in the eastern Mediterranean region in later prehistory.

****