ADITUM Journal of Agricultural Research Pesticides and Biofertilizers

Open Access Review Article

Review on the Effect of Plant Population on Yield and Yield Components of Chickpea (Cicer arietinum L.)

Nuru Seid Tehulie* and Kemila Mohammed Yimam
Department of Plant Science, College of Agriculture, Mekdela Amba University, Ethiopia

Article Info

Received: May 31, 2021
Accepted: June 07, 2021
Published: June 16, 2021

***Corresponding author:** Nuru Seid Tehulie, Department of Plant Science, College of Agriculture, Mekdela Amba University, Ethiopia.

Citation: Nuru S Tehulie and Kemila M Yimam. (2021) "Review on the Effect of Plant Population on Yield and Yield Components of Chickpea (Cicer arietinum L.).", Journal of Agricultural Research Pesticides and Biofertilizers, 1(5); DOI:http;//doi.org/05.2021/1.1024.

.

.

Abstract

One of the main reasons of low yield of C. arietinum is improper plant population. Either too low or high Plant population beyond a certain limit often adversely affects the crop yield. Number of plants per unit area influences plant size, yield components and ultimately the seed yield. The use of high plant density in chickpea production decreases soil water evaporation early in the growing season when plant canopy closure is low. In contrast, low plant density may allow weeds to develop more aggressively and limit crop yield potential. Plants grown at lower plant density are usually shorter and branchy, which increases losses during combine harvest. Moreover, plant spacing in the field is also very important to facilitate aeration and light penetration into plant canopy for optimizing the rate of photosynthesis. There is very little information available on the relative contribution of various plant spacing towards yield and yield components and also their interaction. Plant population is a key component of the productivity of chickpea. The yield of chickpea can be improved by planting of optimum density of chickpea cultivars. Optimum density is one of the factors that have effect on yield, but there are some studies that have shown that density does not have a significant effect on yield of cicer and some studies have shown that density have a significant effect on yield of chickpea. Many reports showed us row spacing of 45 cm increased chickpea yield compared to 30 and 50 cm.

Keywords: chickpea; inter-row spacing; intra-row spacing; plant density

1. Introduction:

Chickpea (Cicer arientinum L.) is a cool season annual pulse crop that belongs to the Leguminosae family. It is an ancient crop that is believed to have been first grown in Turkey 7500 years ago (Oplinger et al., 1990). It is the third most important pulse crop after dry beans and dry pea (Singh and Saxena, 1999). Chickpea is grown in wide range of environments comprising about 44 countries in tropical, subtropical, and temperate regions of the world (Muehlbauer and Tulle, 1997).

Chickpea is widely grown across country and serves as a multi-purpose crop (Shiferaw B and Haile Mariam T, 2007). First, it fixes atmospheric nitrogen in soils and thus improves soil fertility and saves fertilizer costs in subsequent crops. Second, it improves more intensive and productive use of land, particularly in areas where land is scarce, and the crop can be grown as a second crop using residual moisture. Third, it reduces malnutrition and improves human health especially for the poor who cannot afford livestock products. It is an excellent source of protein, fiber, complex carbohydrates, vitamins, and minerals. Fourth, the growing demand in both the domestic and export markets provide a source of cash for smallholder producers. Fifth, it increases livestock productivity as the residue is rich in digestible crude protein content compared to cereals.

Two types of chickpea are cultivated in the world: Desi and the Kabuli types. The Desi types have smaller seeds with angular appearance, sharp edges and varying colors. The Kabuli type produces large round seeds with white or pale cream or yellow color. Of the two groups, the Desi types are more widely cultivated in Ethiopia. However, currently, there is considerable interest in the Kabuli type for export. Chickpea is generally grown in drought prone areas, and derives most of its water requirements from residual stored soil moisture rather than from rainfall, chickpea yields tend to trail those of cereals and other legumes cultivated in more favorable areas (Joshi et al., 2001; Bekele et al., 2004).

Inspire of efforts made in the past to increase its production, the productivity of the crop in Ethiopia under farmers condition is low (1.73 t ha-1) (CSA, 2012) as compared to its potential yield of the crop under improved management conditions (3.5 t ha-1). Good yields even from the high yielding varieties cannot be achieved without the adoption of improved package of technology. Seeding densities, appropriate adjustment between the rows, and judicious use of fertilizer, timely sowing and irrigation play a remarkable role in increasing the yield of crops.

Sarwar, 1998 reported that row spacing‟s significantly influenced the number of branches plant-1 and number of seeds plant-1, whereas plant height, number of seeds pod-1, 100-seed- weight, biological yield, seed yield, straw yield and harvest index were not affected significantly by row spacing‟s. Khan et al., 2001 concluded that narrow row spacing of 30 cm produced significantly maximum yield than that of wider row spacing of 70 cm. But Barary et al., 2002 observed the effect of row and plant spacing on seed yield was non-significant. However, 30 cm inter-row spacing and 10 cm intra-row spacing is used for both‟ Kabuli‟ and „Desi „types of chickpea in Ethiopia (FDRE, 2010). In addition, limited research work has been done on the interaction effects of various agronomicpractices such as variety with plant spacing in the country. There is also no site and variety specific recommendation on the plant population density of chickpea cultivars in Ethiopia rather; there is blanket recommendation of 30×10 cm spacing.

Objective:

To review the effect of inter- and intra- row spacing on yield and yield components of chickpea

2. Litrature Review

2.1. Botany and Development of Chickpea

Chickpea seeds have a seed coat, two cotyledons, and an embryo. The seed coat consists of two layers, the outer testa and the inner tegmen, and a hilum. The hilum is the point of attachment of the seed to the pod. There is a minute opening above the hilum called the micropyle, and a ridge formed by the funicle called the raphe. The embryo consists of an axis and two fleshy cotyledons. The pointed end of the axis is the radicle and the feathery end is plumule.

Chickpea seeds germinate at an optimum temperature varying within (28-33°C) and proper moisture level in about 5-6 days. Germination begins with the absorption of moisture and swelling of the seed. The radicle emerges first followed by the plumule. 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. The first true leaf has 2 or 3 pairs of leaflets plus a terminal one. The plumular shoot and lateral branches grow continuously to develop into a plant (Cubero, 1987).

Chickpea plants have a strong taproot system with 3 or 4 rows of lateral roots. The parenchymatous tissues of the root are rich in starch. All the peripheral tissues disappear at plant maturity and are substituted by a layer of cork (Cubero, 1987). The roots grow 1.5-2.0 m deep and bear Rhizobium nodules. They are of the carotenoid type, branched with laterally flattened ramifications, sometimes forming a fanlike lobe (Corby,1981).

The chickpea stem is erect, branched, viscous, hairy, terete, herbaceous, green, and solid. The branches are usually quadrangular, ribbed, and green. There are primary, secondary, and tertiary branches (Cubero, 1987). Primary branches arise from the ground level as they develop from the plumular shoot as well as the lateral branches of the seedling. They are thick, strong, and woody, and may range from one to eight in number. Secondary branches develop at buds located on the primary branches. They are less vigorous than the primary branches. Their number ranges from 2 to 12. The number of secondary branches determines the total number of leaves, and hence, the total photosynthetic area. Tertiary branches arise from the secondary branches. The primary branches form an angle with a vertical axis, ranging from almost a right angle (prostrate habit) to an acute angle (erect). Generally, stems are incurved at the top, forming a spreading canopy.

Chickpea leaves are petiolate, compound, and uniimparipinnate (pseudoimparipinnate). Some lines (genotypes) have simple leaves. The rachis is 3-7 cm long with grooves on its upper surface. Each rachis supports 10-15 leaflets each with a small pedicel. The leaflets do not end at the true terminal position (the central vein continuing the rachis) but at the sub terminal position (the central vein oblique to the rachis). This indicates the presence of two terminal leaflet buds, one of them being aborted or transformed into a mucro or foliar shoot which is sometimes quite large (Cubero ,1987).

The leaflets are 8-17 mm long and 5-14 mm wide, opposite or alternate with a terminal leaflet. They are serrated, the teeth covering about two-thirds of the foliar blade. The shape of the leaflets is obovate to elliptical with the basal and top portions cuneate or rounded. Leaves are pubescent.

The solitary flowers are borne in an axillary raceme. Sometimes there are 2 or 3 flowers on the same node. Such flowers possess both a peduncle and a pedicel. The racemose peduncle is 6-30 mm in length. At flowering, the floral and racemal portions of the peduncle form a straight line, giving the appearance that the flowers are placed on the leafy axil by a single peduncle. After fecundation the raceme is incurved. The bracts are 1-5 mm in length.

2.2. Environmental Requirements of Chickpea:

Chickpea is traditionally grown in the northern hemisphere, mostly at relatively high elevations in India and Ethiopia. However, most of the Desi type chickpea is grown between 200 N and 30oN while Kabuli type is grown above 30oN (Saxena and Singh, 1987). These environmental conditions give significance difference in photoperiod, temperature and precipitation, all of which have a profound effect on growth and development (Saxena and Singh, 1987). The crop is a quantitative long-day plant which needs a moderately high temperature for its normal growth. A daily temperature fluctuation with narrow amplitude is also required by the crop. Chickpea grows best on heavy clay soils and in a rough seedbed and it is moderately tolerant to drought conditions (Van der Maesen, 1972). Cool nights, moderate relative humidity, evenly distributed rainfall and well drained seedbeds are conducive to the crop and are considered as the ecological optimum of the crop for its normal growth and development (Van der Maesen, 1972).

In major chickpea growing regions of the world, the average maximum temperature ranges from 21 to 29oC during the day and from 15 to 25oC during the night. The crop needs daily mean temperature of above 15oC to allow fertilization of flowers and pod setting (Trang and Giddens, 1980). Considerable differences in ambient and/or soil temperature requirements have also been noticed among cultivars of chickpea. There is also a considerable variation among cultivars for soil temperature requirement for germination, but generally it should exceed 50C, and preferably be above 15oC. For high yields, bright sunshine is required; cloudy weather, particularly if accompanied by high humidity, reduces flowering and seed setting. Chickpeas are normally grown in areas with an annual rainfall of about 650-750 mm although they can be grown successfully in areas with a rainfall of about 1000 mm/annum. Chickpeas can be grown on a wide range of soil types provided that the drainage is good, and they cannot withstand waterlogging. For optimum results, clay loams are required. In general, chickpea is moderately sensitive to photoperiod and the vegetative period is shortened in long days, but short days (9 hours) do not prevent flowering (Kay, 1979).

2.3. Chickpea Area, Production and Yield Trends in the World:

Chickpea is the most important food legume crop in the world grown on about 11 million ha worldwide with a total production of 9 million tons in 2006-08 (Akibode and Maredial, 2011). South Asia is by far the largest producer of chickpea (76%) in the world with a share of more than 80% of area harvested. The share of developing world in total area and production of chickpea is 95% and 93%, respectively. The region of Middle East and North Africa is the second most important region for chickpea area and production followed by Sub-Saharan Africa. The South East Asia and Latin American and Caribbean region as have more than 100 thousand ha of chickpea but are relatively insignificant players from the global perspective.

The regions that have seen a substantial increase in area harvested under chickpea in the last 14 years include the South East Asia region (by 67%) and the developed countries (rest of the world) (by 48%). Over the same period, the area also increased by 18% in Sub Saharan Africa and marginally in South Asia (less than 1%). Both the Latin American and Caribbean region and Middle East and North Africa regions have seen declining area and production of chickpea in the last 14 years (Akibode and Maredia1, 2011).

World chickpea yields have increased by 10% from 1997 to 2010.Yields in South Asia, the leading producer of chickpea, increased by 5% in the same period. In Middle East and North African regions, the next important chickpea producing regions, yields declined by 2%. The region of South East Asia saw chickpea yields double in the last 14 years from 0.6 t ha-1to 1.2 t ha-1 (Akibode and Maredia1, 2011).

India is by far the largest chickpea growing country in the world. The two South Asian countries (India and Pakistan) together cover more than 75% of total world chickpea area. The other top chickpea growing countries from the developing world include Iran and Turkey (5% share in world chickpea area each), and Myanmar and Ethiopia (2% share each). Mexico ranked next followed by many other small producers having less than 1% share in world chickpea area (Akibode and Maredial, 2011).

2.4. Chickpea Sub-sector in Ethiopia:

Chickpea is one of the major pulse crops (including faba bean, field pea, haricot bean, lentil and grass pea) in Ethiopia and in terms of production, it is the second most important legume crop after faba beans (Menale et al., 2009). It contributed about 16% of the total pulse production during 1999-2008 and the total annual average (1999-2008) chickpea production was estimated at about 173 thousand tones.

2.4.1. Production, productivity and future potential:

The largest growing regions of chickpea in Ethiopia are Amhara, Oromia and few districts of Tigray and SNNPR (EEPA, 2004; FDRE, 2010). Although chickpea is widely grown in Ethiopia, the major producing areas are concentrated in the two regional states of Amhara and Oromia. These two regions cover more than 90% of the entire chickpea area and constitute about 92% of the total chickpea production (Menale et al., 2009).

The top 7 chickpea producing zones (North Gondar, South Gondar, North Shewa, East Gojam, South Wello, North Wello and West Gojam) are found in Amhara region and account for about 80% of the country‟s chickpea production. In the Oromia region, the major producing zones are West Shewa, East Shewa and North Shewa, which account for about 85% of the total area and production in the regional state.

Chickpea is grown widely across the highlands and semi-arid regions of the country (Geletu et al., 1996). According to the recent estimation of CSA (2011) the total production of chickpea in Ethiopia was about 284,639.8 tons from an area of 213,187 ha. It is less than the total production obtained from 2008/09 which was 312,080.0 tons from 233,440 ha area. Therefore, chickpea showed a decreasing trend both in terms of production and total area coverage in 2009/10 as compared to during 2008/09. However, in 2012 the area increased to 231,000 ha with production volume of more than 400,000 tons, with productivity of 1.73 t ha-1(CSA, 2012), while global productivity is less than a ton ha-1(Akibode and Maredial, 2013).

The two types of chickpea, Kabuli and Desi, are currently produced in Ethiopia. The production of Kabuli types is currently limited to few areas and covers about 25 to 30% (personal communication). Desi type chickpea is traditionally widely grown in the country. Several new Desi and Kabuli type chickpea varieties have been developed by DZARC through collaborative research programs involving ICRISAT and ICARDA (Shiferaw et al., 2007). Most of the improved chickpea varieties with their appropriate agronomic practices have been demonstrated to farmers particularly in the neighboring districts (woredas) such as Ada‟aLiben, Akaki and Gimbichu for further dissemination of the technologies. Although these woredas are well known for their production of desi type chickpeas, they also constitute leader farmers in the production and marketing of high-value improved Kabuli type chickpeas.

Yields of chickpeas in the majority of traditional smallholding farms range from 0.3-0.6 t ha-1. However, improved varieties developed by Ethiopian Agricultural Research Organization (EIAR) reported to yield up to 2.9 t ha-1(EEPA, 2004). According to the recent estimation of CSA , (2011) the productivity of chickpea in Ethiopia shows a slight decrease or remained constant in 2009/10 (1.335 t ha-1) as compared to that obtained in 2008/09 (1.337 t ha-1).There is a wide potential to increase the production by utilizing improved varieties in the future. The chickpea development plan prepared by MOA estimated to achieve 1.4 million tons of chickpeas from 509,749 ha as a long-term plan

(EEPA, 2004). This is possible not only by the use of improved varieties but also by the use of proper agronomic practices (such as appropriate plant spacing, land preparation and other cultural practices) bridging the gaps and solving the problem through research work.

2.4.2. Economic importance:

The crop provides an important source of food and nutritional security for the rural poor, especially those who cannot produce or cannot afford costly livestock products as source of essential proteins. The consumption of chickpea is also increasing among the urban population mainly because of the growing recognition of its health benefits and affordable source of proteins (Shiferaw et al., 2007). In Ethiopia chickpeas are consumed widely fresh as green vegetables, sprouted, fried, roasted and boiled forms (EEPA, 2004). Chickpea seed has 25.3-28.9% protein, 38-59% carbohydrate, 3% fiber, 4.8-5.5% oil, 3% ash, 0.2% calcium and 0.3% phosphorus. Digestibility of protein varies from 76-78% and its carbohydrate from 57-60% (Hulse, 1991).

Raw whole seeds contain per 100 g: 357 calories, 4.5-15.69g moisture, 0.8-6.4g fat, 0-225mg b-carotene, 0.21-1.1mg thiamin, 0.12-0.33mg riboflavin and 1.3-2.9mg niacin (Duke, 1981; Huisman and van der Poel, 1994).The limiting amino acid concentrations are 0.52mg for methionine, 1.45mg for lysine and cystine, 0.71mg for threonine and 0.16 mg for tryptophan (Williams et al., 1994). It is also used to rehabilitate depleted fallow lands by playing active role in crop rotation practices/programs.

In the export market, chickpea contributes a significant portion of the total value of pulse exports. For example, chickpea constituted about 48% of the pulse export volumes in 2002.During this period of time, the exported volume accounted for about 27% of the total quantity of chickpea production while the balance remained for domestic market (Shiferaw et al., 2007). Due to the improvement of production in the country and new markets demand, Ethiopian chickpeas have gained an important place in India and Pakistan (2000-2002). In 2002 alone the country exported 48,549.9 tons of chickpeas valued at 14.6 million USD mainly to Pakistan, India, UAE, Panama and Bangladesh, taking 73, 7, 6.5, 5.5 and 2.5 percent share of the export (EEPA, 2004).

The average annual chickpea export was 34,308 MT, with an estimated annual foreign currency earnings equivalent to US$ 20.93 million each year between 2005 and 2010. Both the volume and value for chickpea showed more accelerated growths than those for common bean. Destinations of Ethiopian chickpea export include 32 countries in Asia, the Middle East, Africa and Europe. Pakistan, UAE and Sudan accounted for about 34%, 27% and 14% of the total volume. Bangladesh, India, Singapore, Saudi Arabia, Djibouti, Israel and Jordan were among the top 10 destinations for Ethiopian chickpea export. For many smallholder farmers this meant improved income, food security, nutrition and investment in businesses such as seed production and livestock raising. Overall, the increased productivity and production have helped Ethiopia to increase its revenue and diversify exports, instead of relying totally on few export cropping such as coffee (Tsedeke, 2011).

2.5. Plant Density:

Chickpea is grown at a plant density of 33 plants m-2 in a flat- or broad bed-and-furrow system at ICRISAT Asia Center, Patancheru, India. The plant density ranges from 25 to 30 plants m-2 in a ridge-and-furrow system. Tall and erect cultivars gave high seed yield at a higher plant density (25 to 30 plants m-2) due to their apical pods (Calcagno et al. 1988).

The optimum plant population depends upon the genotype and the environmental conditions under which the crop is grown. In India, a population of 33 plants m-2appears to be the best (Saxena, 1980; Singh, 1983). In Iran, yield increase was recorded with an increase in population up to 50 plants m-2under irrigated conditions and up to 25 plants m-2in non irrigated spring-sown chickpea (Anonymous, 1976). A decrease in row spacing from 60 cm to 30 cm increased the yield of winter chickpea by 52% in western Jordan (Kostrinski, 1974). A similar response was observed in Cyprus (Photiades ,1984). In Syria, when the population density was raised from 18 to 28 plants m-2in winter, there was a significant increase in yield, but the same response was not observed in the spring-sown crop (Saxena, 1980). Compact, upright-growing plants responded better to increased plant density than the spreading type (Singh, 1981). In Bangladesh, a plant density of 30 plants m-2at a seed rate of 60 kg ha-1was found to be appropriate for good growth and yield (Paramanik et al., 1990). Higher plant densities have been reported to be more appropriate for late sowing. At Kanpur (India) chickpea sown in early December at densities of 33 plants m-2and 44 plants m-2 gave yields of 1.96 t ha-1and 2.11 t ha-1, respectively (Ali, 1988). Shakhawat and Sharma (1986) reported that in late-sown conditions, increase in seed rate (from 70 kg ha-1to 140 kg ha-1), reduction in row spacing (from 30cm to 22.5 cm), and sowing in bidirectional rows gave a higher yield.

2.5.1. Spacing and Optimum Population:

Both too narrow and too wide spacing do affect grain yields through competition (for nutrients, moisture, air, radiation, etc) and due to the effect of shading. In the latter case (too wide spacing), yield reduction can occur due to inefficient utilization of the growth factors. Normally, as population increases yield also increases proportionally. After, it reached a certain level the yield declines.

Population density is also dependent on the moisture availability and nutrient status of the soil. Hence, optimum planting density should be determined through research works (Solomon, 2003). The spacing between stands is largely determined by the extent of the root and shoot systems of the crop plant in question.

The spacing between stands per hectare, in turn, determines the number of stands per hectare (Onwueme and Sinha, 1991). The number of stands per ha, and the number of plants per stand together determine the number of plants per ha, or the plant density. A number of factors also influence spacing like fertility status of the soil, growth pattern of the crop and cultural practices (Martin et al., 1976). In addition, in row crops, the space between rows as well as within rows depends up on factors such as moisture, type of crop, the climate and the variety of a particular crop. Competition in cultivated crop is commonly between plants of like or similar genotype, all sown at the same time and each with similar environmental conditions. often, the immediate objective in planning studies on plant densities to determine the optimum sowing rate, the data rarely included a sufficiently wide range of densities to permit the definition of the relationship of density to yield, however, a few studies have varied densities from low to very high values. A major factor influencing optimum seed rate for any particular crop is the genotype (Mekonnen, 1999). Genotype by plant density interaction was found to be evident in faba bean (Amare et al, 1993), field pea (Rezene, 1994), chickpea and lentil (Million, 1994). The population and growth habit interaction affected seed yield in soybean and the interaction was also large for plant height. However, growth habit differences were consistent across populations for days to maturity and number of main stem nodes (Ouattara and Weaver, 1994).

2.5.2. Importance of spacing and optimum population:

Establishment of optimum population per unit area of the field is essential to get maximum yield. Under conditions of sufficient soil moisture and nutrients, higher population is necessary to utilize all the growth factors efficiently. The level of plant population should be such that maximum solar radiation is utilized. The full yield potential of an individual plant is fully exploited when sown at wider spacing. Yield per plant decreases gradually as plant population per unit area increases. However, the yield per unit area is increased due to efficient utilization of growth factors. High plant density brings out certain modifications in the growth of plants such as an increase in plant height, reduction in leaf thickness, alteration in leaf orientation, and leaves become erect, narrow and are arranged at longer vertical intervals to intercept more sun light (Singh and Singh, 2002).

The crop plants should cover the soil as early as possible to intercept maximum sunlight to produce higher dry matter as the intercepted solar radiation and dry matter production are directly related. Closely spaced and quick growing crops like soybean which can intercept more light within a short period gives higher yield as compared to wider spaced crops. As such, for the proper light interception at various growth stages, optimum plant population is necessary.

As plant density increases, the amount of dry matter in vegetative parts also increases. Both the biological and economic yields increase with increasing plant population up to a certain point and subsequently no addition in biological yield can be obtained and economic yield decreases. Therefore, the optimum plant population of individual crop should be worked out under suitable environmental conditions (Singh and Singh, 2002).

2.6. Effect of Plant Spacing on Yield Components and Yield of Chickpea:

The plant population density that produces maximum yield or optimum plant population density of crops, including chickpea, is affected by genotype, environment and their interaction. A range of optimum plant population density has therefore, been reported for various chickpea varieties and environments. A great variation exists in number of plants m-2 for obtaining higher yield of chickpea. Based on the size of the seed, EARO, 2004 and FDRE, 2010 recommended that the optimum seed rate for chickpea in Ethiopia ranges from 60-140 kg ha-1. Million, 1995 reviewed that seeding rate of chickpea in the Central Highlands of Ethiopia showed no or minimal yield differences. According to this study, seeding rates of 70-80 kg ha-1was recommended for chickpea. Whereas, AUA, 1994 showed that seed yield on Mariye chickpea variety was significantly influenced by seeding rates (i.e., 70, 80, 90 and 100 kg ha-1) effects at Debre-Zeit and the highest seed yield of 1.7 t ha1was obtained from the lowest seeding rate (70 kg ha-1) and compared with this rate, sowing chickpea at seeding rates of 80 and 90 kg ha-1resulted in 35 and 45% seed yield reductions at Debre-Zeit. However, the results from Akaki showed that seed yield was non-significantly influenced by seeding rates.

A field experiment conducted in 2005 at Kermanshah (Iran) showed significant differences between the planting dates and planting density effects on plant height, number of branches plant-1, distance between 1st pod to soil, number of pods plant-1, number of grains plant-1, biological yield and grain yield (Shamsi, 2005) and reported that the maximum grain yield belonged to plants sown on 6th November at a row spacing of 30 cm. However, the maximum number of pods plant-1and grains plant-1belonged to plants spaced at 40 cm row spacing.

Ali et al., 1999 indicated that the increase in intra and inter- row spacing of chickpea mutant (CM2) significantly increased the plant height, numbers of pods plant-1 and plot-1and suggested that to obtain better yield from (CM2), crop should be sown at 23 plants m -2 instead of previously reported optimum population of 33 plants m-2. Mirazaei et al. ,2010 revealed that pod number, number of empty pods, and number of seeds per pod, weight of hundred seed, seed yield, biological yield, and harvest index were significantly influenced by seeding densities and maximum numbers of empty pods plant-1, seeds pod-1, seed weight and biological yield were significant at the density of 25 plants m-2. However, maximum harvest index and highest grain yield were achieved at a density of 45 plants m-2.

Growth and grain yield response of gram (Cicer arietinum L.) cultivar Paidar-1991 to different seeding densities (40, 50, 60, 70 and 80 kg ha-1) and row spacing‟s (30, 45 and 60 cm) indicated that the seed yield and growth characteristics such as plant height, number of branches plant-1, number of seeds pod-1, and 1000-seed weight were influenced significantly by seeding densities (Sharar et al., 2001). According to this study, maximum seed yield of 2299.56 kg ha-1was obtained at seeding density of 70 kg ha-1, whereas row spacing had no significant effect on plant height, seed yield and yield components.

A research conducted to determine the best equidistance arrangement with different densities of chickpea (Cicer arietinum var. Philip) in Iran showed non-significant effect on seed yield, seed number pod-1but it had significant effect on pod number plant-1, seed weight and number of lateral branches (Biabani, 2007). The results indicated that the highest seed yield (4665) was obtained from treatment row spacing and plant to plant distance of 18 cm x 18 cm.

Ahmadkhan et al. , 2010 concluded that 45 cm row spacing with 75 kg seed rate ha-1of chickpea affected positively different agronomic parameters like number of pods plant-1, number of seeds pod-1and 100 seed weight which ultimately contributed to increased biological yield, grain yield and harvest index further, 45 cm single row spacing with 75 kg seed rate ha-1 was the optimum planting geometry for efficient light interception and photosynthetic activity and same was proposed to the farmers for better yield in chickpea under given environmental conditions.

Beech and Leach, 1989 grew chickpea at row spacings of 18, 36, 53 and 71 cm with plant population densities of 14, 28, 42 and 56 plants m-2 and reported that row spacing had a little effect on above ground dry matter production and seed yield, whereas Singh and Singh, 1989 obtained the highest seed yield of 1.99 t ha-1at row spacing of 45 cm. Sarwar, 1998 reported that row spacing significantly influenced the number of branches plant-1and number of seeds plant-1, whereas, plant height, number of seeds pod-1, 100-seed weight, biological yield, seed yield and harvest index were not affected significantly by row spacing.

3. Summary and Conclusion:

One of the main reasons of low yield of C. arietinum is improper plant population. Either too low or high Plant population beyond a certain limit often adversely affects the crop yield. Number of plants per unit area influences plant size, yield components and ultimately the seed yield. The use of high plant density in chickpea production decreases soil water evaporation early in the growing season when plant canopy closure is low. In contrast, low plant density may allow weeds to develop more aggressively and limit crop yield potential. Plants grown at lower plant density are usually shorter and branchy, which increases losses during combine harvest. Moreover, plant spacing in the field is also very important to facilitate aeration and light penetration into plant canopy for optimizing the rate of photosynthesis. There is very little information available on the relative contribution of various plant spacing towards yield and yield components and also their interaction. Plant population is a key component of the productivity of chickpea. The yield of chickpea can be improved by planting of optimum density of chickpea cultivars. Optimum density is one of the factors that have effect on yield, but there are some studies that have shown that density does not have a significant effect on yield of cicer and some studies have shown that density have a significant effect on yield of chickpea. Many reports showed us row spacing of 45 cm increased chickpea yield compared to 30 and 50 cm.

4. References:

1. Akibode,S. and Maredia1,M. 2011. Global and Regional Trends in Production, Trade and Consumption of Food Legume Crops. Department of Agricultural, Food and Resource Economics. Michigan State University. Report Submitted to SPIA, March 27.
2. Amare, G; Mekonnen, W. M. and Asfwa,T. 1993. Effect of method and rate of seeding on faba bean yield. pp. 18-19 In: Nile Valley Regional Program on Cool Season Food Legumes. Annual Report 1991/92, Ethiopia. ICARDA/NVRP-024.
3. Barary, M., D. Mazaheri and T. Banai. 2002. The effect of row and plant spacing on the growth and yield of chickpea (Cicer arietinum L.). 24thSept. Proc. Aust. Agron. Conf. Aust. Soc. Agron. 15:38-48.
4. Beech, D.F. and G.L. Leach.1989. Effect of plant density and row spacing on the yield of chickpea (cv. Tyson) grown on the Darling Down, South-eastern Queens land. Australia Journal of Experimental Agriculture 29(2):241-246.
5. Bekele Shiferaw, Bantilan C, Gupta SC and Shetty SVR. 2004. Research spillover benefits and experiences in inter-regional technology transfer: Assessment and synthesis of some findings. Research Report. ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), Patancheru, India. pp 131.
6. Bouyoucous, C. J., 1951. Reclamation of the Hydrometer Method for Making Mechanical Analysis of Soils. Agronomy Journal 43: 434-438.
7. Calcagno, F., G. Gallow, G. Venora, M. Laiani and L. Raimando, 1988. Effect of plant density on seed yield and its components for ten chickpea genotypes grown in Sicily, Italy. International Chickpea Newsletter 18: 29 - 31.
8. Chapman, H.D., 1965.Cation Exchange Capacity by Ammonium Saturation. Method of soil analysis. American Society of Agronomy. Black, C.A., L.E. Ensminger and F.E. Clark (Eds.). Madison Wisconsin, USA.
9. CSA (Central Statistics Agency), 2011. Report on Area and Crop Production forecast for Major Grain Crops (For Private Peasant Holding, Meher Season). Crop Production Forecast Sample Survey, 2010/11 (2003 E.C.) (Conducted from September 12 to October 25, 2010). Addis Ababa, Ethiopia.
10. CSA (Central Statistics Agency), 2012.Agricultural sample survey. Report on Land Utilization, Statistical Bulletin 302. Addis Ababa, Ethiopia: Central Statistics Authority
11. Corby, R. 1981. Seeds of Leguminosae. Pages 913-915 in Advances in legumes systemics. Part 2 (Polhill, R.M., and Raven, P.H., eds.). Kew, UK: Royal Botanic Gardens.
12. Cubero, J.I. 1987. Morphology of chickpea. Pages 35-66inThe chickpea (Saxena, M.C., and Singh, K.B., eds.). Wallingford, Oxon, UK: CAB International.
13. Duke, J.A., 1981. Handbook of Legumes of World Economic Importance. Plenum Press, New York. p. 52-57.
14. EEPA (Ethiopian Export Promotion Agency), 2004. Ethiopian Pulses Profile. Product Development and Market Research Directorate. Addis Ababa, Ethiopia.
15. EARO (Ethiopian Agricultural Research Organization), 2004. Directory of Released Crop Varieties & their Recommended Cultural Practices. Addis Ababa, Ethiopia.
16. FDRE (Federal Democratic Republic of Ethiopia), 2010. Extension Package for Pulse Production and Improved Management Practices. Agricultural Extension Directorate. Amharic version. Addis Ababa, Ethiopia.
17. Geletu Bejiga, Million Eshete and Yadeta Anbessa. 1996. Improved cultivars and production technology of chickpea in Ethiopia. Debre Zeit Agricultural Research Center (DZARC), Debre Zeit, Ethiopia.
18. Hulse, J.H, 1991. Nature, Composition and Utilization of Grain Legumes. p. 11-27. In: Uses of tropical Legumes: Proceedings of a Consultants' Meeting, 27-30 March 1989, ICRISAT Center. Patancheru, India. ICRISAT Center. Patancheru, India.
19. Khan, R.U., A. Ahad, A. Rashid and A. Khan. 2001. Chickpea production as influenced by row spacing under rainfed conditions of Dera Ismail Khan. Online J. Biolog. Sci. 1(3):103-104
20. Jackson, M. L. 1958. Soil Chemical Analysis Practice Hall of India. New Delhi.
21. Kay, D.E. 1979. Crop and Product Digest–Food Legumes. No. 3, London: Tropical Products Institute, pp. 50-51.
22. Kostrlnskl, J. 1974. Agricultural Research Organization. Special Publication. Volcani Center, No. 34. 51 pp.
23. Martin, J.H., W.H. Leonardo and O.L. Stamp, 1976. Principles of Crop Production. 3rd ed. Macmillan publishing Co., Inc. New York.
24. Menale Kassie, Bekele Shiferaw, Solomon Asfaw, Tsedeke Abate, Geoffrey Muricho, Setotaw Ferede, Million Eshete and Kebebew Assefa, 2009. Current Situation and Future Outlooks of the Chickpea Sub-sector in Ethiopia. ICRISAT, Nairobi, Kenya.

25. Mekonnen, D. 1999. Effects of spacing and nitrogen fertilization on yield and related traits of finger millet [Eleusine coracana (L.) Gaerth] growth on soils of Bako area, Western Ethio pia. M.Sc. Thesis, Alemaya University, Ethiopia.
26. Million Eshete. 1994. Chickpea and Lentil Agronomy Research. In Cool season food and forage legumes of Ethiopia: Proceedings of the National Cool -season Food and Forage Legumes Review Conference, 16–20 December 1993, Addis Ababa, Ethiopia (Tilaye A, Bejiga G, Saxena MC and Solh Md B, eds.). Aleppo, Syria: ICARDA; and Addis Ababa, Ethiopia: Ethiopian Agricultural Research Organization.
27. Muehlbauer, F.J. and A. Tulle. 1997. Cicer arietinum L. NewCrop FactSHEET.Center for New Crops & Plant Products, Purdue University.
28. Olsen, S.R., and L.A. Dean. 1965. Phosphorus. In: Methods of Soil Analysis. American Society of Agronomy, 9: 920-926.
29. Oplinger, E.S., L.L. Hardman, E.A. Oelke, A.R. Kaminski, E.E. Schulte, and J.D. Doll. 1990. Chickpeas (garbanzo baen). Alternative Field crops Manual. University of Wiconsin Coop. Ext., University of Minnesota Center for AlternativePlant and Animal Products and the Minnesota Ext. Service.
30. Onwueme I.C., and T.D., Sinha. 1991. Field crop production in Tropical Africa, Principles and practice, CTA (Technical center for agriculture and rural cooperation) The Netherlands.
31. Panwar, K. S., A.S. Faroda, D.S. Malik, L.P.S. Ahhawat, K.K. Dhingra, M.R. Rao, R. C. Singh, D.R. Dahiya, Singh, Atar and R.P. Roy Sharma, 1980. Response of chickpea varieties to seed rates and row spacings. Silver Jubilee Society of Agronomy. 9:54-55
32. Parihar, S. S. 1996. The effect of row and plant spacings on the growth and yield of chickpea. Indian Journal of Agronomy 41(4):604-607.
33. Parvez, A.Q. Gardner, F.P. and K.J. Boote. 1989. Determinate and indeterminate type soybean cultivar responses to pattern, density and planting date. Crop Science, 29:150-157
34. Photiades, I. 1984. The effect of sowing date and plant population on the performance of chickpeas. Miscellaneous Reports No.4. Agricultural Research Institute. Nicosia, Cyprus: Ministry of Agriculture and Natural Resources. 5 pp.
35. Rezene Fessehaie. 1994. Weed research in cool-season food legumes. In: Proceedings of the First National Cool Food Season Legumes Review Conference, 16-20 December.1993. Addis Ababa, Ethiopia.
36. Saxena, M.C., 1980. Recent Advances in Chickpea Agronomy. Pages 16-98 in Proceedings of the International Workshop on Chickpea Improvement, 28 Fe b - 2 Mar 1979, ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi -Arid Tropics.
37. Saxena, M.C. and K.B. Singh. 1987. The chickpea .CAB International, The international Center for Agricultural Research in the Dry Areas. Aleppo Syria
38. Shiferaw, B., and Hailemariam, T. 2007. Structure and functioning of chickpea markets in Ethiopia: Evidence based on analyses of value chains linking smallholders and markets. IPMS Working Paper6, ILRI, Nairobi, Kenya. 55 pp.
39. Sharar MS, Ayub M, Nadeem MA, Noori SA. 2001. Effect of different row spacing‟s and seeding densities on the growth and yield of gram (Cicer arietinum L.). Department of Agronomy,University of Agriculture, Faisalabad, Pakistan. Pakistan Journal of Agricultural Science, 38: 51-53.
40. Singh N.P., and R.A. Singh. 2002. Scientific crop production, X press Graphics, Delhi-28, 1sted., India
41. Schneider, K. and L. Anderson, 2010. Yield Gap and Productivity Potential in Ethiopian Agriculture: Staple Grains and Pulses.
42. Evans School Policy Analysis and Research (EPAR) of the Bill & Melinda Gates Foundation. Evans Schools of Public Affairs, University of Washington. Brief No. 98.
43. Singh, K.B., 1981. Yield Potential of Tall Chickpeas at Increased Plant Density. International Chickpea Newsletter, 4: 10-11.
44. Solomon Abate. 2003. Effects of irrigation frequency and plant population density on growth, yield components and yield of haricot bean (Phaseolus vulgaris L.) in Dire Dawa Area. M.Sc. Thesis Presented to Haramaya University, Ethiopia.
45. Trang, K.M. and J. Giddens. 1980. Shading and temperature as environmental factors affecting growth, nodulation and symbiotic nitrogen fixation by Soybeans. Agronomy Journal, 72: 305-3.
46. Tsedeke Abate, 2011. The Tropical Legume II Project Review and Planning Workshop for Chickpea in India scheduled for 5-6 September 2011. ICRISAT-Patancheru campus, Hyderabad, India.
47. Van der Maesen, L.J.G. 1972. Cicer L. A monograph of the genus with special reference to a chickpea (Cicer arietinum L.), its ecology and cultivation. Communication of the Agricultural Universitry, Wageningen 72: 10.