Int.J.Curr.Res.Aca.Rev.2020; 8(4): 24-32

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 8 Number 4 (April-2020)

Journal homepage: http://www.ijcrar.com

doi: https://doi.org/10.20546/ijcrar.2020.804.004

Influence of Different Plant Population Density on Seed Quality of Common Bean (*Phaselous vulgaris* L.)

Mekonnen Gebeyaw*

School of plant science, Haramaya University, East Hararghe Zone, Ethiopia

**Corresponding author*

Abstract

Common bean (*Phaseolus vulgaris* L.) is produced in eastern Hararghe both under sole crop and intercrop systems mainly from farm save seeds. Limited information is available on the influence of plant population density on seed quality of the crop Therefore; this study was conducted at Haramaya University research field to assess the influence of plant population on seed quality of common bean. The treatments were arranged in factorial combination of three improved varieties (Haramaya, Dursitu and Fadis) and three plant populations (320000, 180000 and 115200 ha-1) and laid out in RCBD with three Replications in 2017. The seed quality test in the laboratory was conducted in completely randomized design (CRD) with four replications. Plant population had significant effect on seedling shoot length, dead seeds, seedling vigor index I and II. Moreover, one or more of the possible two factors interactions significantly influenced Seed quality parameters except speed of germination, vigor index I, abnormal seedlings, hard and fresh ungerminated seeds. The seed quality of Haramaya was exceeded by Fadis variety. Generally, the research findings suggested that the importance of using optimum plant population and high yielding variety to increase the quality seed produce and the productivity of the crop in the study area.

Article Info

Accepted: 04 March 2020
Available Online: 20 April 2020

Keywords

Germination, Speed of germination and Vigor index.

Introduction

Background and Justification

Common bean (*Phaselous vulgaris* L.) is one of the most important legumes worldwide because of its high commercial value, extensive production, consumer use and nutrient values (Popovic *et al*., 2012). It is an annual crop which belongs to the family Fabaceae and it grows best in warm climate at a temperature of 18 to 24 C (Teshale *et al*., 2005).Furthermore; the crop is the most important food legume and offers a low cost alternative to beef and milk, as a source of protein, iron, fibers and complex carbohydrates (Hacisalihoglu *et al*., 2005; Mwale *et al*., 2008). In Ethiopia common bean is the third most produced legume next to faba bean and field pea. The annual cultivation of common bean total area coverage and total production was estimated to be 705,452.38 hectares and 16,011,998.4tons, respectively (CSA, 2016). It is one of the major grain legumes widely cultivated and grown as source of protein and cash by small holder farmers in the eastern and southern Ethiopia (Fekadu, 2013). It is grown suitably in areas with an altitude ranging between 1200 to 2200 meter above sea level with range of 16 to 28 ºC temperature and a rainfall of 350-500 mm well distributed over the growing season.

It performs best on deep, friable and well aerated soil with good drainage, high nutrient content and PH range of 5.8 to 6.5 (MOARD, 2010). Moreover it is used for human utilization and export. It grows in most of the agro-ecology zones of low and mid altitude areas of the country. A market demand for the common beans both in the domestic and export market has become the main mechanism for the growing trends in quantity of production (Frehiwot, 2010).

Common bean is used as one of the cheapest source of protein apart from being the major source of cash income in Ethiopia. Its reasonable protein content (22%) made it the poor man's meat securing more than 16.7 million rural people against hidden hunger (CSA, 2014). It is usually consumed in the form of boiled grain, which is locally known as Nifro (Kristin *et al*., 1997; Mekibib, 1997). Its short growth period earlier than other crops made it an ideal food deficit filler crop. Its suitability for double or triple production per year enabled its production on off season free lands and relatively cheaper labor force. In addition to this, it plays an important role in the soil fertility amendment practices of low input farming systems (Legesse *et al*., 2006).

Despite the common bean significance contribution to Ethiopian people food and nutrition security and income generation, its production and productivity is low. Among many factors that contribute to the low yield of common bean, low access of seeds of improved varieties and farmers do not use the optimum plant population for producing quality seed. Most Ethiopian farmers, in general, practice higher intra- row spacing (lower plant population) than research recommendations which result in low quality seed (Ali *et al*., 2003). Whereas practicing lower intra-row spacing (higher plant population) results in competition of plants for the same resource. This leads to reduction of seed size and other quality related traits of seeds, because the seed yield of common bean is the result of many plant growth processes which ultimately influence the yield components and the highest seed yields obtained when all factors of input for the crop growth have maximized (Tessbo *et al.*, 2004).

The quality seeds boost the productivity of crops by significant folds and thus, it is one of the most economical and efficient inputs to agricultural development (FAO, 2006). Wide fluctuation in the germination and emergence of legume seeds faced in the field is often caused by the use of poor quality seeds produced through crowded plant population (Huda, 2001). The farmers' Seed multiplication activities should meet desired standards of quality attributes during different stages of production (Copeland, 1976). Seed physical and physiological quality can be affected by genetic factors as well as the ecological conditions and pre-and postharvest management practices followed by farmers (Katungi *et al*., 2009). Moreover production practices such as plant population per unit area may not affect only yield but also quality of seeds. Poor quality seeds resulted from sowing and harvesting when environmental conditions are unfavorable, poor storage conditions (Martins *et al*, 1988). In eastern Ethiopia, common bean is produced from wide range of cultivars under varied cropping systems. The farmers have different seed sources in which seeds are produced from wider range of plant population. In this part of the country, lack of understanding for producing quality seed with appropriate plant population is the bottle neck problems that aggravates for low quality and yield of the crop (Fekadu, 2007). Therefore, generating information from research is required on influence of plant population density on common bean seed quality which has paramount importance to overcome the production problems and increase the productivity of the crop.

Objective of the study

To examine the influence of different plant population density on seed quality of common bean (*Phaselous vulgaris* L.)

Materials and Methods

Description of the study area

The seed quality test was conducted in seed science and technology laboratory of Haramaya University.

Experimental material

The three varieties of common bean viz. *Haramaya*, *Dursitu* and *Fadis* were used for the experiment. The seeds of the varieties were taken from Haramaya University common bean Improvement project. The description of the varieties is given in Table 1.

Treatments and Experimental Design

The seed quality test was conducted in completely randomized design with four replications

The treatments consisted of factorial combinations three plant population density specified by (intrarow spacing) and three common bean varieties as a result, 9 treatment combinations were formed.

Experimental procedures

The physiological (germination and vigor) seed quality test was conducted using the sample seeds which were taken from in each variety of each plant population density amounting to 1 kg as a composite sample results from thoroughly mixed of primarily sample. The sample seeds were taken from in each variety of each plant population density in seed lot that was harvested, and then the composite sample divided by using a seed divider into four equal parts until 250g was obtained. Each sample was sorted to four components including (I) pure seed, (ii) other crop seeds, (iii) inert mater and (IV) weed seeds. After the physical seed quality test was completed, 200 pure seeds were randomly selected from the total pure seeds obtained from the sample seeds.

The seeds were treated by Mankuzeb fungicide to remove the microorganisms and to prevent the growth of fungus. The sterilized seeds were divided into four replication and each 50 seed with in replication placed on the double layered cotton cloth to drain the water from seeds. The sample seeds were used for standard germination test which was conducted using sand as substratum, the sand was sieved to discard particles bigger than 0.8 mm and smaller than 0.05 mm in diameter and for every test new sand was used. The 50 seeds of each treatment was sown in 10 rows on a uniform layer of moist sand in one tray and then covered to a depth of 10 mm with sand as one replication, which was left loose. The seeds were kept moist with gently applied water until the germination test completed. The germination of seeds in each flat tray filled with sand was counted every day starting five days of sowing. The number of normal and abnormal seedlings was counted separately. Abnormal seedlings are badly diseased, discolored or distorted seedlings. In addition to that other seed quality parameters were taken after the seed germination which was indicated in the data collection section.

Data collection

Thousand seeds weight (TSW)

Randomly taken thousand seeds of each variety combination with each plant population in each replication was weighted in gram and recorded.

Moisture content (MC)

Ten gram of seeds from each variety and each plant population combination in each replication was taken from the sample seeds, grinded weighted poured in a small container and covered with aluminum foil for pre-dry measurement. Samples were dried in an oven adjusted at temperature of 130 ^{0}c +/-^{0}c1for two hours. At the end of two hours containers were placed in desiccators for 30 minutes. After cooling, the container weighed with its cover and contents, and the moisture content of seeds was determined by the following formula ISTA (2014).

$$\text{Moisture content of seed (\%)} = \frac{M_2\text{-}M_3}{M_2\text{-}M_1} \text{x100}$$

Where; M_1 is the weight of the container; M_2 is the weight of the container with the weight of the seed and M_3 is the weight of the seed with the container after oven dried.

Standard germination test (SGT)

Germination test was done for all seed samples obtained from different plant population density of three varieties and two hundred (200) seeds of the pure seeds components was divided into four replicates of fifty (50) seeds each, which was sown in germination sand. On the final days of the standard germination test, germinated seedlings was divided into normal seedlings, abnormal seedlings, hard, fresh and dead seeds to determine the percentage of each category of seedlings (ISTA, 2014).

$$\text{Germination percentage (\%)} = \frac{\text{Number of Normal seedlings}}{\text{Total seeds sown}} \text{x100}$$

Speed of germination (SP)

The same procedures was used with that of germination percentage, but the only difference was, the number of normal germinated seeds daily recorded, until there was no further germination. It was calculated by adding the ratio of daily counts of normal seedlings divided by the number of days of germination.

$$\text{Speed of germination} = \frac{N1}{C1} + \frac{N2}{C2} + \ldots\ldots \frac{NF}{C_F}$$

Where: N1= number of normal seedlings at first count, N2= number of normal seedlings at
Second count, NF= number of normal seedlings at final count, C1= days to the first count,
C2= days to the second count and CF= days to the final count.

Seed vigor test

The seedlings shoot length and root length was measured after the final Count in the standard germination test by randomly taken ten normal seedlings from each treatment combination from each replication. The shoot and root length was measured from the point of attachment to the tip of the shoot and root of the seedlings, respectively. The average seedling shoot and root length was determined as per ISTA (2014).

Seedling dry weight (SDW)

Ten randomly taken seedlings treatment combination from each replication was placed in an envelope to be dried in an oven at a temperature of 80 ^{0}C +1^{0}C FOR 24 hours. The dried seedlings were weighed in gram using a sensitive balance ISTA (2014).

Vigor Index I and II

The seedling vigor index I and II were calculated according to the Formula described by Abdul-Baki and Anderson (1973) as follows:

Seed vigor index I= GP x SL (mean shoot length and mean of root length). Where: GP is germination percentage and SL is seedling length (mean of shoot length and mean of root length). Seed vigor index II= GP x SDW (g)**,** where: GP germination percentage and SDW is Seedling dry weight.

Data analysis

The data was subjected to analysis of variance (ANOVA) following standard procedure as indicated by Gomez and Gomez (1984).The ANOVA was computed with *Genstat201616th edition.* The comparison of treatment combinations was done following the significance of mean squares using Least Significant Difference (LSD) at 1% and5% probability level.

Results and Discussions

The analysis of variance showed that significant differences among plant populations observed for thousand seed weight, seedling shoot length, and seedling vigor index I and II, seedling dry weight and dead seeds. Moreover the main effects of variety had significant influence on almost all seed quality parameters, except non significant on the percentage of abnormal seedlings and fresh ungerminated seeds. Plant population by influencing the establishment of optimum canopy structure that leads to interplant competition and it results under sized and immature seeds.

Thousand seed weight and seedling fresh weight

The variation of seeds moisture content and seedling fresh weight is due to the variation on the ability of the seed nourishment of the young seedlings due to the different plant populations, that able to produce good seed, improper size as well as nutrient content inside and the nature of the variety. The seed samples of *Fadis* variety at a plant population of 115200 (40x12.5cm) followed by 180000 (40 x10cm) had significantly the highest mean values of 316.7 and 293.0g for thousand seed weight, respectively, without significant differences between the mean values, and The seed samples of *Dursitu* variety at a plant population of 320000 (7.5x40cm) and 115200 (40x12.5cm) as well as the seed samples of *Haramaya* variety at a plant population of 115200 (40x12.5cm) had significantly lower mean values of 169.9, 178.8 and 228.9g, respectively, for thousand seed weight without significant difference among the mean values (Table 3). On the other hand, the seed samples of *Fadis* variety at a plant population of 115200 (40x12.5cm) followed by 320000 (7.5x40cm) had significantly the highest mean values of 11.234 and 10.392 cm for seedling fresh weight, respectively, without significant differences between the mean values, and the seed samples of *Dursitu* variety at a plant population of 115200(40x12.5cm) and 320000 (7.5x40cm) as well as the seed samples of *Haramaya* variety at a plant population of 115200 (40x12.5cm) had significantly lower mean values of 6.608, 7.017 and 7.333cm, respectively, seedling fresh weight without significant difference among the mean values (Table 3).

Speed of germination and seedling vigor

The seed samples of the varieties, *Haramaya* and *Fadis* had higher speed of germination mean values of 7.30 and 7.71 respectively, significantly different from the mean values of *Dursitu* variety and between the two varieties of mean values (Table 4). This was due to the fact that, larger sized seeds have the ability to germinate faster than small sized seeds. This finding was in agreement with, higher and quicker germination on bigger sized seeds could be due to the presence of higher amount of carbohydrates and other nutrients than in medium and small sized seeds because the nutrient carbohydrate give more energy for the seed germinate faster (Gunaga *et al*., 2011).

Table.1 Description of three common bean varieties

Variety Name	Pedigree	Year of release	Yield (ha^{-1})	Breeding center	Days to Maturity
1.Haramaya	G-843	2006	15-30	HU	85-110
2.Dursitu	DOR-811	2008	17-30	HU	85-100
3. Fadis	ECAB-0060	2012	10-22	HU	80-95

Source MoARD (1998): Crop Variety Register (1995-2013), in farmer's field.

Table.2 Treatment combination

Plant population (ha^{-1})	**Variety**		
320000(7.5x40cm)	Haramaya	Dursitu	Fadis
180000(10 x40cm)	Haramaya	Dursitu	Fadis
115200(12.5x40cm)	Haramaya	Dursitu	Fadis
320000(7.5x40cm)	Haramaya	Dursitu	Fadis
180000(10 x40cm)	Haramaya	Dursitu	Fadis
115200(12.5x40cm)	Haramaya	Dursitu	Fadis
320000(7.5x40cm)	Haramaya	Dursitu	Fadis
180000(10 x40cm)	Haramaya	Dursitu	Fadis
115200(12.5x40cm)	Haramaya	Dursitu	Fadis

Table.3 Interaction effect of variety and plant population on thousand seed weight and seedling fresh weight of common bean at Haramaya in 2017

	Thousand seed weight			Seedling fresh weight		
Plant population (ha^{-1})	Haramaya	Dursitu	Fadis	Haramaya	Dursitu	Fadis
320000(7.5x40cm)	238.1^{b}	169.9^{c}	253.9^{b}	8.725^{c}	7.017^{d}	10.392^{ab}
180000(40 x10cm)	247.4^{b}	190.4^{c}	293.0^{a}	8.708^{c}	7.017^{d}	10.025^{b}
115200(40x12.5cm)	228.9^{b}	178.8^{c}	316.7^{a}	7.333^{d}	6.608^{d}	11.234^{a}
LSD (5%)		29.75			0.852	
Grand mean		235.2			8.56	

Means in columns and rows in each seed quality parameter followed by the same letter (s) are not significantly different from each other at 5% probability level. LSD (5%) =least Significant difference at P=0.05

Table.4 Effect of variety and plant population on speed of germination, seedling vigor index I and hard seeds of common bean

Variety	Speed of germination	Vigor index I	hard Seeds
Haramaya	7.302[b]	2235[a]	0.7841[b]
Dursitu	4.429[c]	1461[c]	0.8992[a]
Fadis	7.709[a]	2086[b]	0.7354[c]
LSD (5%)	0.2874	94.8	0.027
Grand mean	6.480		0.8062
plant population(ha^{-1})			
32000(7.5x40cm)	6.404	1952[a]	0.7973
180000(10x40cm)	6.590	1856[b]	0.7962
115200(12.5x40cm)	6.446	1974[a]	0.8252
LSD (5%)	NS	94.8	NS
Grand mean	6.480	1927	0.8062

Means in column in each seed quality parameter and main factor followed by the same letter (s) are not significantly different from each other at 5% probability level. LSD (5%) =least significant difference at P=0.05, NS = nonsignificant and CV=Cofiecent of variation

Table.5 Interaction effect of variety x plant population on dead seeds of common bean varieties evaluated at Haramaya in 2017

	Dead seeds		
	Variety		
Plant population (ha^{-1})	Haramaya	Dursitu	Fadis
320000(7.5x40cm)	0.7176[bc]	0.7264[a]	0.7106[cd]
180000(40 x10cm)	0.7240[ab]	0.7083[d]	0.7094 [cd]
115200(40x12.5cm)	0.7094[ab]	0.7106[cd]	0.7083[d]
LSD (5%)		0.00822	
Grand mean		0.71386	

Means in columns and rows in each interaction followed by the same letter(s) are not significantly different from each other at 5% probability level. LSD (5%) =least significant difference at P=0.05

Table.6 Main effects of variety and plant population on seed quality parameters of common bean after harvest at Haramaya in 2017

Variety	SHL	VI II	SDW
Haramaya	17.12[a]	0.8414[b]	1.022[b]
Dursitu	16.57[a]	0.4023[c]	0.767[c]
Fadis	11.57[b]	1.2113[a]	1.386[a]
LSD (%)	0.675	0.0566	0.0832
Grand mean	15.09	0.818	1.058
Plant population			
320000(7.5x40cm)	15.62[a]	0.8577[a]	1.103[a]
180000(40 x10cm)	14.79[b]	0.7796[b]	0.994[b]
115200(40x12.5cm)	14.85[b]	0.8177[ab]	1.078[a]
LSD (%)	0.675	0.0566	0.0832
Grand mean	15.09	0.818	1.058

LSD (0.05) =Least Significant Difference at 5% level. Means in column followed by the same letters are not significantly different at 5% level of significant according to LSD test. SHL=seedling shoot length, VI II= vigor index II, SDW= seedling dry weight

The percentage of hard seeds was significantly influenced by variety in which significantly difference between the three mean values of 0.74, 0.78 and 0.89% observed in seed samples of *Fadis*, *Haramaya* and *Dursitu* varieties, respectively (Table 4). The variation on the number of hard seeds might be due to the nature of the variety, which might be related with physiological dormancy of the seed. This means that Physiological dormancy prevents embryo growth and seed germination until chemical changes occur for eliminating dormancy of the seed. Carlos *et al.*, (2015) observed that common bean seed quality parameters such as germination, emergence and seedling vigor can be controlled genetically through dormancy.

The variety *Haramaya* had the highest mean values of 2235 seedling vigor index I, significantly different from the mean values of *Fadis* and *Dursitu* variety ,and within a plant population of 115200(12.5x40cm) the highest mean value of seedling vigor index I(1974) was recorded (Table 4).This might due to the variety *Haramaya* have the highest germination percentage and seedling length whereas the variety *Dursitu* have the lowest germination percentage and seedling length, this results seedling vigor index I variation between the two varieties. This indicates that seedling vigor index I was directly related with seedling length and germination percentage. Gore *et al.,* (1997) reported that higher seedling vigor index I was probably due to the associated effect of germination percentage and seedling length.

The percentage of dead seeds was significantly influenced by the interactions of the tow factors *Dursitu* and *Haramaya* varieties produced from seeds at a plant population of 180000 (10 x 40 cm) and 32000(7.5x40cm) results the largest mean values of 0.7240 and 0.7264, significantly different from all mean values of dead seeds, but nonsignificant difference between the two mean values (Table 5). The variation of dead seeds might be due to; seeds which emerged from lower plant population have a chance for proper resource utilization. As a result the seed built properly and contain ingredients that able to the seed germinate faster and grow as a normal plant by resisting any adverse environmental condition, because the seed capable to nourish the young seedlings without scarcity of initial nutrients.

The seed samples of the varieties, *Haramaya* and *Dursitu* had higher seedling shoot length mean values of 17.12 and 16.57 respectively, significantly different from the mean values of *Dursitu* variety and between the two varieties of mean values (Table 6). The variation of seedling shoot length might be due to the nature of the variety, even if those are found in the same species. Plant populations also have a role on seedling shoot length with the mean value of 15.62 at 320000 (7.5x40cm) plant populations. On the other hand, the seed samples taken from plant population of 320000(7.5x40cm) had significantly the highest mean value of 1.103 and 0.8577 for seedling dry weight and seedling vigor index II respectively (Table 6). Which means that secondary seeds which emerged from the highest plant population have the highest interims of seedling stem length than lower population plants this was the results of mutation of gens for stem height at the time of resource competition which leads to inheritance of such characteristics for the seedlings which have long stem length. This idea was in agreement with the quantitative trait loci were detected for mutation and associated with genes controlling fertility, biotic and abiotic stress response, plant development and morphology (Nagel *et al*., 2009).

Conclusion and recommendation are as follows:

In Ethiopia legumes are the major sources of protein where common bean accounts for the largest proportion next to faba bean and field pea. However, the productivity of the crop in Ethiopia is much lower than the yields of other common been producing countries of the world. This might be attributed partly by the use of low quality seeds produced through improper amount of plant population density. Therefore, this research was conducted to examine the influence of different plant population density on seed quality of common bean.

The treatments were arranged in factorial combination of three improved varieties (*Haramaya*, *Dursitu* and *Fadis*) and three plant population (320000, 180000 and 115200 ha^{-1}).The seed quality test in the laboratory was conducted in completely randomized design (CRD) with four replications in 2017at Haramaya University. Seed quality test indicated that moisture content, seedling shoot length, vigor index I and II, seedling fresh and dry weight and dead seed were significantly affected by the interaction of variety x plant population that was enabling to determine the seed quality of the crop after harvest.

In conclusion, it is recommended that the highest quality seed of common bean was obtained when the use of irrespective varieties with in lower or intermediate plant populations. Moreover conducting further study on the effect of farmers' saved seeds and plant population from both farmers' cultivars and improved varieties on seed quality related traits is very important.

References

Abdulbaki, A.A. and J.D.Anderson.1973.Vigor determination in Soybean by multiple criteria. *African Journal of Crop Science,* 10:31-34.

Ali, K., Gemechu, A.S., M.R, Beniwal, S. Makkouk and Halila, M. 2003. Food and forage barley, *Euphytica* 17:5-14.

Carlos Eduardo, Marcos Antonio, Rosana Goncalves, America Wagner and Claudio Horst. 2015.Germination and emergence of passion fruit (*Passiflora edulis*) seeds obtained by self- and open-pollination Journal of agronomy, 37(4):89-93.

Copeland, L.O. 1976. Principles of Seed Science and Technology. Burgess Pub.Com; Minncapolis, Minnesota.pp.164-165.

CSA (Central Statistical Agency).2014.Agricultural Sample survey, report on area production of major crops (private peasant holdings, Meher season). Addis Ababa statistical Bulletin 578.

CSA (Central Stastical Agency). 2016. Agricultural Sample survey, report on area production of majour crops (private peasant holdings, Meher season). Addis Ababa statistical Bulletin 578.

FAO. 2006. Fertilizer and plant nutrition Bulletin 16. FAO, Rome Italy, pp.76.

Fekadu Gurmu. 2007. Participatory Varietal Selection of Haricot Bean (*Phaseolus vulgaris* L.) Varieties in Umbullo Wacho and Beresa Watersheds in the Southern Region. In: *Proceedings of Irish Aid Supported Operational Research Review Workshop 11-13 January 2007*. Hawassa University, Hawassa, Ethiopia.

Fekadu Gurmu. 2013. Assessment of Farmers' Criteria for Common Bean Variety Selection: The case of Umbullo Watershed in Sidama Zone of the Southern Region of Ethiopia. *Ethiopian Journal for research and innovation foresight*, l5:4- 13.

Frehiwot M. 2010. Profile of Haricot bean production, supply, demand and marketing issues in Ethiopia, Ethiopia Commodity Exchange Authority, Addis Ababa, Ethiopia.

Gore, S.V., R.B. Patil and G. R. Wankhade. 1997. Effect of maturity period and harvesting time on seed quality in soybean *(Glycine max* L.) cultivars. *Seed Res.* 25(1): 45-49.

Gunaga, R.P., Doddabasava and R.Vasudeva. 2011. Influence of seed size on germination and seedling growth in Mammae Suriga, *Karnataka Journal of Agriculture Science* 24:15-16.

Hacisalihoglu, G.D., Edwinr, and M. Longo. 2005. Differential Response of common bean genotypes to mycorrhizal colonization. *Proceeding of Horticultural science,* 118: 150-152.

Huda, M.N. 2001.Why Quality Seed? Reality& Vision Bangladesh Context. Evergreen Printing& Packaging, Dhaka pp.9-156.

ISTA (International Seed Testing Association). 2014. International Rules for Seed Testing, Bassersdorf, Switzerland.

Katungi, E., Farrow, A., Chianu, J.,Sperling, L., Beebe, S. 2009. Common bean in Eastern and Southern Africa: A Situation and Outlook Analysis. International Centre for Tropical Agriculture, 61pp.

Kristin, A.S., Serna, R.R., Perez, F.I., Enriquez, B.C., Gallegos, J.A.A, Vallejo, P.R., Wassimin, Kelley J.D. 1997. Improving common bean performance under drought stress. Crop Science, 37:43-50.

Legesse DG, Kumssa T, Assefa M, Taha J, Gobena T, Alemaw A, Abebe Y, Mohhamed, Terefe H. 2006. Production and Marketing of White Pea Beans in the Rift Valley, Ethiopia, National Bean Research Program of Ethiopia.

Martin, B.A., O.S. Smith and M.O.Neil.1988. Relationships between laboratory germination tests and field emergence of maize inbreds, *Journal of crop science*; 28: 801-805.

Mekibib Feriw. 1997. Farmer participation in common bean genotype evaluation, the case of Eastern Ethiopia experimental Agriculture, 33: 39- 48.

MoARD (Ministry of Agriculture and Rural Development).1998.Crop variety registration.

MoARD. 2010. Ministry of Agriculture and Rural Development. Crop Variety Register Issue no. 8.

Mwale, M.V., M.J. Bokosi, M.C. Masangano, M.B. Kwapata1, V.H. Kabambe and C. Miles. 2008. Yield performance of dwarf bean (*Phaseolus vulgaris* L.) lines under researcher designed 48 farmer managed system in three bean agro-ecological zones of Malawi. *African Journal*, 20(16): 47-53.

Nagel, M., Vogel, H., Landjeva, S., Buck-Sorlin, G., Lohwasser, U., Scholz, U. and Borner, A. 2009. Seed conservation in exist gene banks genetic studies on longevity in barley, *Euphytica* 17:5-14.

Popovic, T., Starovic, M., Aleksic, G., Zivkovic, S., Josic, D., Ignjatov, M. and Milovanovic, P. 2012. Response of different beans against common bacterial blight disease caused by *Xanthomonas axonopodis Phaseolis. Bulgariea Journal of Agriculture. Science*, 18:701-707.

Teshale Assefa, Girma Abebe, Chemeda Fininsa, Bulti Tesso and Abdel Rahman Tawaha. 2005. Participatory Bean Breeding with Women and Small Holder Farmers in Eastern Ethiopia. *World Journal of Agricultural Sciences*, 1:28-30.

Tessbo M., H. Ogindo and S. Walker. 2004. Yield evaluation of maize and bean intercropping in semi-arid regions of South Africa. *African Crop Science Journal*, 12(4): 51-58.

How to cite this article:

Mekonnen Gebeyaw. 2020. Influence of Different Plant Population Density on Seed Quality of Common Bean ((Phaselous *vulgaris* L.). *Int.J.Curr.Res.Aca.Rev.* 8(4), 24-32.
doi: https://doi.org/10.20546/ijcrar.2020.804.004