Int. J. Adv. Res. Biol. Sci. (2021). 8(6): 156-164

International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
DOI: 10.22192/ijarbs Coden: IJARQG (USA) Volume 8, Issue 6 -2021

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2021.08.06.018

The Influence of Sowing Date and Inter-row Spacing on Growth, Yield and Yield Components of Mung Bean (*Vigna radiate* L.)in western Oromia, Ethiopia.

Teshome Gutu[1*] and Alemayehu Dabasa[1]
[1]Bako Agricultural Research Center, P.O. Box 03, Bako West Showa, Ethiopia
*Corresponding author: *teshomegt@gmail.com*

Abstract

The experiment was conducted at Bako and Chawaka locations during 2018 and 2019 main cropping season with the objective of to determine an appropriate sowing date and inter row spacing. The experiment consisted of two factors (Late June, Early July and Late July sowing date) and (20cm, 30cm and 40cm inter row spacing). A total of 9 treatments were laid out in Randomized Complete Block Design with three replications in 3x3 factorial arrangement .The result revealed that sowing date and inter row spacing showed highly significant differences for primary branch, number pod per plant, seed per pod, hundred seed weight and grain yield.T he lowest number of primary branch, number pod per plant, seed per pod and hundred seed weight were obtained from Late July sowing date and 20cm inter row spacing. Inter row spacing was positively correlated with yield per unit area but negatively correlated with yield per plant. Early July sowing date gave the highest grain yields (827.78 kg ha^{-1}) at Bako and (1081.07 kg ha^{-1}) at Chawaka. Inter row spacing of 20cm was given the highest grain yield of 812.94 kg ha^{-1} at Bako and 910.18 kgha^{-1} at Chawaka. Therefore inter row spacing of 20cm and early July sowing date was recommended for mung bean production in the study area and similar agroecology

Keywords: Grain yield, inter row spacing, mung bean, sowing date

Introduction

Mung bean (*Vignaradiata* L. Wilczek) belongs to the family Leguminoseae and sub family Papilionaceae.It can be best on fertile, sandy loam soils with good internal drainage and slightly acidic soil, which is an ideal for production (Fanuel and Walelign, 2013). Root growth can be restricted on heavy clays. It is an important pulse crop grown in most of the tropical and sub-tropical parts of the world. Mung bean can be grown at low to medium elevations in the tropics as a rain fed crop. It is a warm season crop requiring 90–120 days of frost- free conditions from planting to maturity (depending on the variety).

According central statistical agency(2019) report, the total area occupied by mung bean in Ethiopia in 2018/19 was 48,074.52 hectares with production of 576,204.64 quintals and the productivity of 11.93 quintal ha^{-1}. In Ethiopia one of the six Ethiopia Commodity Exchange (ECX) trading crops. Beyond its export demands, Mung bean is highly required for local consumption since it has high in protein sources. It can be used as roasted grains or in different items of recipes in combinations with other cereal and/or legume crops.

Among the various agronomic practices, sowing time is the most important factor influencing the yield of mung bean (Malik M.A *et al*., 2006). Optimum sowing time of mung bean may vary from one variety to another and also from one region to another due to variation of agro-ecological conditions (Sarkar *et al*., 2004). Patel *et al*. (1992) reported that the grain yield of two varieties of mung bean was considerably more at the first date of sowing as compared to second date of sowing. Late sowing which result in flowering during the high temperature to low moisture periods will reduce yield. Early sowing date in humid and sub-humid areas of may lead to high disease pressures and maximum yield loss may be observed (Itefa, 2016).

Row spacing affects plant growth and yield due to increased competition with increased plant population. Moreover, the optimum plant population differs with the availability of soil moisture, relative humidity and nutrients. Higher plant population reduced plant growth and yield components but increased yield per unit area (Wans M.N. J. *et al*., 1986)

However, an appropriate agronomic management including sowing date and row spacing of mung bean are unavailable for Western Ethiopia. On the other hand, many local investors are demanding adaptable varieties of mung bean with appropriate twing date, row spacing and fertilizer requirements. Even though, adaptation trials for different varieties of the crops is currently conducting, no specific recommendation of optimum time of sowing date; plant spacing and fertilizer requirements were available for the end users. Therefore, this activity was initiated with the following objectives:

- To determine an appropriate sowing date of mung bean for Sub-humid areas of western Oromia
- To determine an appropriate inter-row spacing to recommend optimum plant density

Materials and Methods

Description of the Study Area

The study was conducted at Bako agricultural research center and Chawaka site for two consecutive years (2018 and 2019). Bako agriculture research center is found between 37°1'00"E to 37°3'40"E and 9°4'20''N to 9°7'20"N and its altitude1650m and Chawaka is located between 35°57'00''E to 36°21'00''E and 8°44'00''N to 9°3'30''N, and its altitude 1237m (Fig.1). Both locations receive a mono modal pattern of rainfall distribution that receives from May to September cropping season, which is the main rain season and the soil of the areas is reddish. Maize, sorghum, finger millet, common bean, soybean, ground nut and sesame are major crops that are commonly grown in the area.

Figure 1. Map of the study area

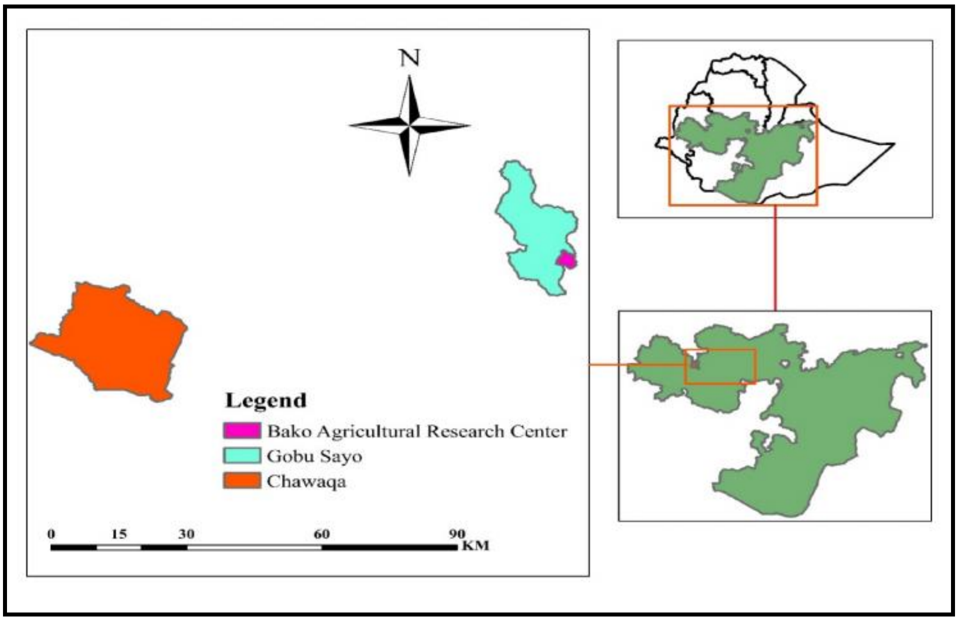

Table 1: Physico-chemical properties of experimental soil before planting

Soil characteristic	Value		
	Bako	Chawaka	Description
Textural class	Clay loam	Clay loam	
pH (1:2.5 H2O)	5.03	5.22	acidic
Organic matter (%)	1.55	1.99	low according to Berhanu (1980)
Organic carbon	0.90	3.43	
Total nitrogen (%)	0.14	0.17	moderate according to Tekalign *et al.* (1991)
Available phosphorous (ppm)	9.84	5.91	low According to Tekalign *et al.* (1991)

Table 2: Weather data of the experimental sites (2018 and 2019)

Month	Rain fall(mm)	Temperature(C^0)			Relative humidity (%)
		Min	Max	Mean	
January	0	13.65	30.6	22.125	48.00
February	13.25	14.10	32.95	23.525	45.05
March	56.95	13.75	32.00	22.875	46.00
April	73.35	12.55	32.75	22.65	48.85
May	147.85	14.40	30.75	22.575	50.65
June	324.35	14.55	27.00	20.775	54.50
July	165.4	14.15	26.00	20.075	53.85
August	187.3	14.50	25.35	19.925	54.50
September	127.9	14.30	26.75	20.525	53.00
October	65.4	14.25	27.65	20.95	52.80
November	37.45	13.55	29.25	21.40	53.65
December	11.55	13.80	29.80	21.80	52.00

(Source: Bako weather station)

Treatments and Experimental Design

The experiment consisted of two factors. Three Sowing date (Late June, Early July and Late July) and three inter row spacing (20cm, 30cm and 40cm). Recently adapted mung bean variety to the study areas (Chinese) was used as a test crop. A total of 9 treatments were laid out in randomized complete block design with three replications in factorial arrangement. The space between plants was 10cm and population of plants according to inter row spacing were 500,000, 333,333 and 250,000 plants ha^{-1} for 20cm, 30cm and 40cm respectively. 100 kg ha^{-1} NPS fertilizer was used.

Experimental Procedures and Field Managements

The experimental plot were plowed by oxen three times and fine seed beds were prepared before planting. The seeds were sowed at spacing of 10 cm between plants on the experimental plot. All NPS fertilizer was applied in the row and mixed with soil at the time of planting.

Data Collection and Measurements

Crop Phenology and growth: Days to flowering, Days to maturity, Plant height (cm) and Number of primary branches per plant.

Yield and Yield Components: pod per plant, seed per pod, hundred seed weight, above ground biomass (kg ha^{-1}) and yield (kg ha^{-1})

Statistical Data Analysis: Analysis of variance was carried using General Linear Model of ANOVA using SAS software. Mean separation was carried out using Least Significance Difference (LSD) test at 5% probability level.

Results and Discussion

Crop Phenology and Growth

Days to Flowering and Physiological maturity

The analysis of variance over locations and years showed that 50% flower initiation and days to physiological maturity were not significantly affected by the main effect of inter row spacing and interaction effect but highly significantly (P<0.01) affected by location and sowing date. Bako location reached to 50% flower initiation and days to physiological maturity on average 48.52 and 87.80 days respectively. However Chawaka location reached to 50% flower initiation and days to physiological maturity on average 37.26 and 73.93 days. The difference may be due to temperature difference. The maturity increased as the temperature increased. Similarly, Thomas George *et al.* (1990) reported that days to flowering and physiological maturity are differed from location to location and maturity is delayed at the higher altitude compared to the lower altitude.

Early flowering (42.44 at Bako and 33.89 at Chawaka) was observed from late July sowing. That is, 10 and 5.33 days earlier than late June sowing; that flowered 52.44 at Bako and 39.22 at Chewaka) (Table 3). The Results revealed that late sown (Late July) flowered earlier than those of early sown (late june) which might be due to the fact that higher temperature reduced vegetative growth and enhanced flowering (Summer *et al.*, 1985). Days to Physiological maturity was also significantly (P<0.01) affected by sowing date. Late July sowing date was the earliest to mature (80.11 at Bako and 68.33 at Chawaka) (Table 3). This indicates that late sown (late July) matured about 12.50 and 11.11 days earlier than that of early sown (late June). Higher temperature increase rate of plant development (Entz and Fowler, 1991) and reduced length of the reproductive period (Angadi *et al.*, 2000). A. Ouji and M. Mouelhi (2017) stated that the delay of sowing decreases the number of days until flowering as well the number of days until maturity.

Plant Height (cm)

Plant height was highly significantly (P<0.01) affected by the main effect of sowing dates. The tallest plant height (35.08cm at Bako and 50.56cm at Chawaka) was recorded from late June sowing date and the shortest plant height was recorded (27.13cm at Bako and 37.93cm at Chawaka location) from late July sowing date (Table 3). The tallest plant height recorded was probably due to comparatively longer growing period along with the optimum environmental conditions. . This result is in line with Muzammal*et al.*, 2014 stated that shortest plant highest was obtained from late sowing.

Table 3. Main effects of sowing date and inter row spacing on Phenological and growth parameters at Bako and Chawaka location during 2018 and 2019 main cropping season

Treatments	Bako			Chawaka		
Sowing date	FD	MD	PH (cm)	FD	MD	PH (cm)
Late June	52.44a	92.61a	35.08a	39.22a	79.44a	50.56a
Early July	50.67b	90.67b	34.61a	38.67b	74.00b	43.76b
Late July	42.44c	80.11c	27.13b	33.89	68.33c	37.93c
LSD (0.05)	0.65	0.92	2.23	1.42	1.19	1.96
Inter row spacing						
20cm	48.44	87.67	33.26	37.00	73.67	43.98
30cm	48.44	87.94	32.14	37.67	74.00	42.11
40cm	48.67	87.77	31.41	37.11	74.11	46.16
LSD (0.05)	NS	NS	NS	NS	NS	NS
CV (%)	1.99	0.58	10.30	3.81	1.62	4.46

DF= days to flower initiation; DM= Days to physiological maturity; PH= plant height LSD = Least Significant Difference (P< 0.05); CV = Coefficient of Variation; NS =Non Significant

Primary branch per plant

The main effect of inter row spacing was highly significantly (P<0.01) affect number of primary branches per plant. A greater number of branches were produced at wider space (40cm) than narrow space (20cm) at both locations. 20cm inter row spacing gave the lowest number of primary branches (1.34 at Bako and 2.00 at Chawaka).The highest primary branches (2.68 at Bako and 3.72 at Chawaka) were obtained from inter row spacing of 40cm (Table 4). Decreasing inter row spacing resulted in a decreased number of branches. The reverse is true. The decrease in number of branches per plant at higher plant population might be due to increased competition for growth resources like space, air, moisture, light and nutrients. This result was in line with El Naim *et al., (*2010) who reported that the number of branches per plant was increased as decreased plant population. The main effect of sowing date also had a significantly (P<0.01) affect primary branches. The lowest primary branches per plant (1.45 at Bako and 2.04 at Chawaka) were recorded from Late July sowing date (Table 4).

Pod per plant

The main effect of inter row spacing was significant (P<0.01) effect on pod per plant. Inter row spacing of 20 cm gave the lowest number of pod per plant (4.62 at Bako and 8.42 at chawaka). The highest pod per plant (7.89 and 11.89 at Bako and Chawaka respectively) was obtained from inter row spacing of 40cm (Table 4). As the space between rows increased, pods per plant also increased. The wider row spacing the lower competition between the plants and initiate the pod bearing per plant. The higher number of pods per plant recorded by wider row spacing may be due to lesser intra-specific competition for growth resources when compared to close spacing. Because the wider row spacing has lower plant population and more available growth resources. Also an increase in pods per plant in a wider row is because of an increase in branches that provided more pod bearing space on the plant. But, we cannot say increased number of pods per plant can increase yield per hectare; because total yield is determined by the yield harvested from individual plants and number of plants per hectare. Abdullah *et al.* (2007) reported that increased plant density decreased the number of pods per plant and as plant density decreased the number of pods per plant increased. In general, the total number of pods per plant was low in plots with the highest plant densities and high in plots containing lowest plant densities.

The main effect of sowing date also had significant (P<0.01) effect on pod per plant. Sowing date of Late July gave the lowest number of pod per plant (3.64 at Bako and 6.71 at Chawaka) and the highest pod per plant (8.93 at Bako and 13.13 Chawaka) was obtained from Early July (Table 4). This result could be due to the fact that in early sowing plants get more rainfall for a longer growing period that favored for more production of pods.

Seed per pod

The main effect of sowing date was a significant (P<0.01) effect on seed per pod. Seed per pod showed almost similar pattern as observed for pod per plant. The late sown plot seed per pod was lower than the early sown plot. Seed per pod is also significantly (P<0.01) affected by the main effect of inter row spacing. Row spacing of 20cm gave the lowest number of seeds per pod (2.57 at Bako and 4.79 at Chawaka) and the highest seed per pod (5.52 and 7.69 at Bako and Chawaka respectively) was obtained from 40cm (Table 4). The number of seeds per pod decreased progressively as the spacing between rows decreased at both locations. This indicates that the number of seeds per pod differed significantly within 20cm and 40cm rows. Competition of crops for light, moisture and nutrients due to smaller space in between rows could be the case for the lower seed number per pod. The finding similar to Mitiku and Getachew (2017) found that the number of seeds per pod of common bean had increased as row spacing increased and decreased as row spacing decreased.

Table 4. Main effects of sowing date and inter row spacing on primary branch per plant, pod per plant and seed per pod at Bako and Chawaka location during 2018 and 2019 main cropping season

Treatment Sowing date	Bako			Chawaka		
	PBPP	PPP	SPP	BPPP	PPP	SPP
Late June	2.05a	6.94b	5.52a	2.77b	11.00b	7.69a
Early July	2.64b	8.93a	5.61a	3.67a	13.13a	7.79a
Late July	1.45c	3.64c	2.57b	2.04c	6.71c	4.79b
LSD (0.05)	0.12	0.54	0.25	0.14	0.59	0.57
Inter row spacing						
20cm	1.34c	4.62c	4.25c	2.00c	8.42c	6.43b
30cm	2.11b	7.02b	4.56b	2.77b	10.53b	6.75ab
40cm	2.68a	7.89a	4.89a	3.72a	11.89a	7.18a
LSD (0.05)	0.12	0.54	0.25	0.14	0.58	0.59
CV (%)	8.84	12.40	8.19	5.26	5.70	8.53

PBPP= primary branch per plant; PPP= pod per plant; SPP= seed per pod; LSD = Least Significant Difference (P< 0.05); CV = Coefficient of Variation

Hundred seed weight (g)

Statistically significant differences were found for weight of hundred seeds due to sowing time. The lowest hundred seeds weight (2.78g at Bako and 3.53g at Chawaka) were recorded from Late July (Table 5). The highest hundred seed weight obtained from early sown (late June and early July) plot might be due to the long reproductive and grain filling period that significantly raised the hundred seed weight. These results are similar with Pedersen and Lauer (2004) in case of soybean the average seed weight from early sowing was higher than that from late sowing. Inter row spacing also had significantly (<0.01) affect hundred seed weight at both locations. The highest hundred seed weight was obtained from inter row spacing of 40cm and the lowest hundred seed weight was obtained from inter row spacing of 20cm (Table 5). This may be due to less competition between plants of lower populations on available resources such as water and light, increase the available assimilates per pod and result in increased seed weights. Similar result was reported by Stringi *et al.* (1988) hundred seed weight of faba bean decreased with increasing plant population.

Grain yield (kg ha^{-1})

Analysis of variance showed a significant (P<0.01) variation in grain yield due to the main effect of sowing date. The highest grain yield (827.78 kg ha^{-1} at Bako and 1081.07 kg ha^{-1} at Chawaka) were obtained from sowing date of Early July. The lowest grain yield was obtained from late July at both locations (Table 5). In late planting, the plant did not achieve its potential ability because light interception and crop simulates partitioning were severely affected and consequently lead to yield decline. In case of early planting then plants get more time for plant growth and development, so grain yield increased (Ahmed MS. *et al.* 2010) and (Calvino PA *et al.* 2003). The reduction of grain yield due to delay in sowing time can also be attributed to shorter growth period at the disposal of the late sown crop as the time taken by the crop to mature decreased with delay in sowing.

The main effect of inter row spacing had a highly significant (P<0.01) effect on grain yield. The highest yield (812.94 kg ha^{-1} at Bako and 910.18 kg ha^{-1} at Chawaka ha^{-1}) was obtained from 20cm inter row spacing and the lowest grain yield was obtained from 40cm inter row spacing (Table 4). When inter row spacing was increased the grain yield per plant also increased but the grain yield per area was decreased. The increase in the number of grain yields per plant with wider plant spacing could be due to less competition for nutrient and water. The reduction in yield per plant in high plant population 20cm inter row spacing may be plants may compete against each other, and the performance of individual plants becomes poor while, at low planting density, each individual plant performance was good due to low competition. This result is in collaborated with Nasser A. Al-Suhaibani *et al.* (2013) who reported higher grain yield per plant is obtained at low plant population of faba bean. Singh and Singh (2002) also indicated that the yield potential of an individual plant is fully exploited when sown at wider spacing. Mekonnen SA (2000) reported that the highest grain yield per plant was obtained from minimum plant population (150,000 plants ha^{-1}) and the lowest grain yield per plant was obtained from the highest plant population (350,000 plants ha^{-1}) of common bean.

In the narrow inter row spacing (20cm); number of pods per plant, seed per pod and hundred seed weight were low but the grain yield (kg ha^{-1}) was significantly higher. This might be higher plant stand at dense population contributes to high grain yield and effective light interception than sparse population. This indicated that plant population is the main factor for grain yield. Shad *et al.* (2010) stated that grain yield increased with increase in plant density. Similarly, Similarly, Aslam M *et al*. (1993) found that narrow inter-row spacing (30 cm) gave the highest grain yield as compared to wider spacing of 45 and 60 cm on soybean.

Table 4. Main effects of sowing date and inter row spacing on hundred seed weight (g) and grain yield (kg^{-1})at Bako and Chawaka location during 2018 and 2019 main cropping season

Treatment	**Bako**		**Chewaka**	
Sowing date	HSW (g)	GY (kg^{-1})	HSW(g)	GY(kg^{-1})
Late June	3.91a	767.96b	4.64a	857.14b
Early July	3.90a	827.78a	4.70a	1081.07a
Late July	2.78b	337.22c	3.53b	322.22c
LSD (0.05)	0.20	40.27	0.35	44.29
Inter row spacing				
20cm	3.46b	812.94a	4.30	910.18a
30cm	3.36b	701.44b	4.10	816.11b
40cm	3.76a	418.58c	4.47	534.1c
LSD (0.05)	0.20	40.28	NS	44.29
CV (%)	8.53	9.29	8.14	5.88

HSW= hundred seed weight; GY= grain yield; LSD = Least Significant Difference ($P < 0.05$); CV = Coefficient of Variation

Conclusion

Inter row spacing and sowing date is the most important agronomic factor influencing the yield of mung bean. Plant population was positively correlated with yield per unit area but negatively correlated with yield per plant. Certain yield components, such as seeds per plant, pods per plant, and branches per plant, increased in a similar manner when the inter row spacing increased; but it decreased as inter row spacing decreased. At late sowing branches per plant, pod per plant seed per pod and grain yield was decreased but it is increased at early sowing. It concluded that mung bean should be sown Early to avoid the effect of high temperature on flowering and pod setting at late in the season and sown at inter row spacing of 20cm gave maximum grain yield per unit area. Therefore mung bean is sown at inter row spacing of 20cm and early July are the appropriate spacing and time for mung bean production in the study area and similar agro ecology.

Acknowledgments

I thank Oromia Agricultural Research Institute for funding the research work and Bako Agricultural research center for facilitating research work. I would also like to acknowledge all pulse team staff members of Bako Agricultural Research Center for their assistance in planting and recording of data during the research work.

References

A. Ouji and M. Mouelhi 2017.Influence of Sowing Dates on Yield and yield Components of Lentil under Semi-arid Region of Tunisia. *Journal of new sciences, Agriculture and Biotechnology,* 38(2), 2077-2082

Abdullah, T., Rahmianna, A.A., Hardaningsih, S. and Rozi, F. 2007. Increasing groundnut yield on dry land Alfisols in Indonesia. *Journal of Semi-Arid Tropics Agricultural Research,* 5(1): 84 - 96.

Ahmed MS, Alam MM, Hasanuzzaman M. 2010. Growth of different *Glycine max* L. Merril varieties as affected by sowing dates. *Middle East Journal of Science Research*. 5:388-391.

Angadi, S. V., H. W. Cutforth, P. R Miller, B. G. McConkey, Entz M. H. S. A. Brandt and K.M. Volkmar. 2000. Response of three brassica species to high temperature stress during reproductive growth. *Canadian Journal of Plant Science*. 80: 693-701.

Aslam M, Khan NA, Mirza MS, Naeemullah 1993. Effect of different row and plant spacing on soybean yield and its components. *Pakistan Journal of Agricultural sciences* 14: 143-148.

Central Statics Agency 2019. The federal democratic republic of Ethiopia central statistical agency, Agricultural sample survey. Volume I, Report on area and production of major crops (private peasant holdings, meher season), Addis Ababa, Ethiopia.

El-Noemani AA, El-Zeiny HA, El-Gindy AM, Sahhar EA, El-Shawadfy MA. Performance of some bean (*Phaseolus vulgaris* L.) varieties under diferent irrigation systems and regimes. Aust J Basic Appl Sci. 2010;4:6185–96

Entz, M. H. and D. B. Fowler. 1991. Agronomic performance of winter versus spring wheat. *Agronomy journal*. 83: 527-532.

FanuelLaekemariam and WalelignWorku. 2013. Growth, Light Interception, Radiation Use Efficiency and Productivity of Mungbean [*Vigna radiata* (L.) Wilczek] (Fabaceae) Cultivars As Influenced By Sowing Date. *Ethiop Journal of Biological Science* 12(2): 117-133.

Itefa, D. 2016.General Characteristics and Genetic Improvement Status of Mung bean (*Vigna radiata* L.) in Ethiopia. *International Journal of Agriculture Innovations and Research,* 5(2), 2319-1473.

Malik, M.A., M.F. Saleem, A. Asghar and R.A.F. Ishaq, 2006. Effect of sowing dates and planting patterns on growth and yield of mungbean (*Vigna radiate* L.). *Journal of Agricultural Research* 44: 139-146.

Mekonnen SA (2012) Irrigation frequency and plant density affect phenology and crop growth of haricot bean (*Phaseolus vulgaris* L.). *African Journal of Plant Science and Biotechnology* 6: 34-39

Mitiku, W., Getachew, M., 2017. Effects of common bean varieties and densities intercropped with rice on the performance of associated components in kaffa and benchimaji zones, southwestern Ethiopia. *Global Journal of Science Frontier Research.* 17 (3), 29–41, 1.

MuzammalRehman, Tasneem Khaliq, Ashfaq Ahmad, Syed AftabWajid, Fahd Rasul, Jamshad Hussain and Saddam Hussain 2014. Effect of planting time and cultivar on soybean performance in semi-arid Punjab, Pakistan Academia Journal of Agricultural Research 2(5): 134-138

Nasser A. Al-Suhaibani, Salah El-Hendawy and Urs Schmidhalter . 2013. Influence of varied plant density on growth, yield and economic return of drip irrigated Faba bean (Vicia faba L.). *Turkish Journal of Field Crops,* 18, 185–197.

Patel, D.B., K.R. Purphit and R.R. Shah, 1992. Physiological analysis of yield variation in Mungbean. *Journal of Agronomy Crop Science.* 168: 128-132.

Pedersen P, Lauer JG 2004. Response of soybean yield components to management system and planting date. *Agronomy of Journal*. 96:1372-1381

Sarkar A.R., H. Kabir, M. Begum and A. Salam, 2004. Yield performance of mungbean as affected by planting date, variety and plant density. *Journal of agronomy* 3: 18-24.

Shad, K., Khalil, A., Wahab, A., Rehman, F. M., Wahab, S., Khan, A., Amin, R. (2010). Density and planting date influence phenological development assimilate partitioning and dry matter production of faba bean. *Pakistan Journal of Botany, 42,* 3831–3838.

Singh, N. P., & Singh, R. A. (2002). Scientific crop production. Delhi: Press Graphics.

Stringi, L., G.S. Amato and L. Gristina, 1988. The effect of plant density on faba bean in semi–arid Mediterranean conditions. *Italian journal of agronomy* 22: 293–301

Summer, F., R. J., E.H. Roberts, W. Erskine and R. H. Killis. 1985. Effects of temperature and photoperiod and flowering in lentils (*Lens culinaris* Medic.). *Annals* of *Botany journal*. 56(5): 659-671.

Thomas George, Duane P. Bartholomew and Paul W. Singleton 1990. Effect of temperature and maturity group on phenology of field grown nodulating and non nodulating soybean. *Isolines .journal of B1otronics* 19: 49-59.

Wanns M.N. J., D. H. Denes and R.J. Barcen. 1986. Effects of planting density and design on pod yield of bush snap bean (*Phaseolus vulgaris* L.). *Canadian Journal of Plant Science*, 66: 669-675

Access this Article in Online

Website:
www.ijarbs.com

Subject:
Agricultural Sciences

Quick Response Code

DOI:10.22192/ijarbs.2021.08.06.018

How to cite this article:
Teshome Gutu and Alemayehu Dabasa. (2021). The Influence of Sowing Date and Inter-row Spacing on Growth, Yield and Yield Components of Mung Bean (*Vigna radiate* L.) in western Oromia, Ethiopia.. Int. J. Adv. Res. Biol. Sci. 8(6): 156-164.
DOI: http://dx.doi.org/10.22192/ijarbs.2021.08.06.018