



Effect of Row Spacing and Seed Rate on Ascochyta Blight Severity and Yield of Chickpea (*Cicer arietinum* L.) in Tunisia

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ABSTRACT

Background: In Tunisia, chickpea (*Cicer arietinum* L.) is the second major food legume. The development of chickpea production is facing several biotic constraints. Ascochyta blight (ABL) caused by *Ascochyta rabiei* (Pass.) Labr. is the most devastating disease and can cause complete yield losses under favorable conditions. In absence of chickpea variety totally resistance to ABL, some methods should be used to control and reduce this disease effects and help for its management. Therefore, this work was undertaken to evaluate the effect of row spacing and seed rate on ABL severity, growth and yield of chickpea.

Methods: A split-plot design with three replicates was adopted to carry out this study during 2018 and 2019 cropping seasons. 'Beja1' chickpea variety was sown at 40 and 60 cm row spacing and at three seed rates (80, 110 and 140 kg ha⁻¹). ABL severity was assessed visually on a 0-9 scale and agro morphological traits were measured. Analysis of variance was used to analyze the data. Correlations between agronomic traits, row spacing, seed rate and ABL severity were investigated.

Result: Results showed that most of the variation in disease severity was associated with seed rate ($r=0.61$). The highest ABL score severity was noted at 140 kg ha⁻¹ rate. Over both years, wide row spacing and low seed rate reduced ABL severity. Chickpea sown under narrow row spacing (40 cm) produced higher grain yield (1014 and 1099.7 kg ha⁻¹ for 2018 and 2019 cropping seasons, respectively). Grain yield was tending to decrease with increasing sowing rates but at a density higher than optimal, grain yields decrease. In this study, ABL disease severity reached a score of 3.7 and 4.3 in 2018 and 2019, respectively. These disease severities levels had little effect on yield.

Key words: Ascochyta blight, Chickpea, *Cicer arietinum* L, Row spacing, Seed rate, Yield.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the most important cool season food legumes grown globally with a cultivated area of 13.98 million ha area, production of about 13.73 million tons and productivity of 890 kg per ha (FAOSTAT, 2016). As a legume, chickpea enhances the soil fertility by fixing atmospheric nitrogen and serves as a valuable source of proteins (Gupta *et al.*, 2020), vitamins, essential amino acids and micronutrients to human food chain and serve an important component of global food (Jukanti *et al.*, 2012). The productivity of chickpea has been low than its potential yield. This is due to several abiotic and biotic stresses. Among biotic stresses, Ascochyta blight (ABL) caused by the fungus *Ascochyta rabiei* (Pass.) Labr. is an important and common disease of chickpea globally. This disease affects all above-ground parts of the plant and can cause complete yield losses under favorable conditions (Pande *et al.*, 2005). The development of integrated disease management is the key to success and increase chickpea production. In absence of chickpea variety totally resistance to ABL, some techniques have been used to control and reduce ABL disease effects, such as sowing pattern, row spacing and seed rate by identification of the optimum plant populations (Chang *et al.* 2007) and application of fungicide (Armstrong-Cho *et al.* 2008). Optimum row spacing and seed rate play an important role to increase the yield because thick plant population will not get proper light for photosynthesis and can be attacked by diseases. Fungicide

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application, crop rotation, use of resistant varieties, sowing date, row spacing and seeding rate are the main integrated disease management options as reported by Ahmed *et al.*, (2016). Regan *et al.* (2003) reported that recommended seed rates differ based on cultivar, seed size, location, soil moisture and climatic conditions such as rainfall and temperature. Beech and Leach, (1989) showed that the number of plants per unit area influences plant size, yield components and eventually the seed yield in chickpea. Furthermore, plant spacing in the field is also very important

to facilitate aeration and light penetration into plant canopy for optimizing rate of photosynthesis as confirmed by Ugwuoke *et al.*, (2021). Optimum spacing can ensure proper growth of the aerial and underground parts of the plant through efficient utilization of solar radiation, nutrients, water, land as well as air spaces and therefore contribute to the increase of chickpea yield as confirmed by Malik and Singh, (1996). Lopez-Bellido *et al.*, (2005) reported that plant density can affect canopy development, radiation interception, dry matter production and evaporation of water from the soil under the crop, weed competition, the development of fungal and viral diseases, podding and harvesting height and eventually, seed yield.

In Tunisia, in absence of chickpea variety totally resistance to ABL, some methods should be used to control and reduce ABL disease effects and help for the disease management of chickpea. Therefore, this work was undertaken to evaluate the effect of row spacing and seed rate on ABL severity, growth and yield of 'Beja1' chickpea variety.

MATERIALS AND METHODS

Experimental procedure

A farmer's field experiment was conducted over 2017/18 and 2018/19 cropping seasons to study the effect of spacing row and seed rate on Ascochyta blight severity and yield of chickpea (*Cicer arietinum* L.). The area is located in Beldiya, Bousalem situated in Jendouba governorate which is located in the northwest of Tunisia. The annual mean maximum and minimum temperatures and the rainfall of the experimental site are shown in Table 1. Over both cropping seasons, seeds were planted on January 10th, 2018 and on January 13th, 2019 while, the harvest were carried out on June 14th, 2018 and June 16th, 2019. The fertilizer used at sowing was 100 kg ha⁻¹ of Di-Ammonium Phosphate. Hand weeding was applied. Beja1', the most common chickpea variety in Tunisia, was planted in a split-plot design with three replications. Main plot treatments consisted of two row spacing (40 and 60 cm). Sub-plot treatments were three seed rates (100, 140 and 200 kg ha⁻¹). Each row was 4 m long. Ascochyta blight severity (ABL) was assessed visually using 0-9 rating scale as described previously by Chongo *et al.*, (2004) as follow: 0 = no infection, 1 = 1-9% of foliage area affected per plot, 2 = 10-19%, 3 = 20-29%, 4 = 30-39%, 5 = 40-49%, 6 = 50-59%, 7 = 60-69%, 8 = 70-79% and 9 = ≥80% of the foliage area affected per plot. At full maturity, plant height, grain yield per ha (GYha⁻¹) and biological yield per ha (BYha⁻¹) were measured.

Data analysis

Data were subjected to analysis of variance to determine the significance of differences between treatments by using software package statistix 8.1. Least significance difference (LSD) test was applied for comparison of individual treatment means. Correlations between traits, row spacing,

seed rate and ABL severity were investigated using simple correlation coefficients.

RESULTS AND DISCUSSION

Impact of row spacing and seed rate on growth and yield of chickpea

Plant height

In 2017-18 cropping season, the analysis of variance of the plant height showed a significant difference of row spacing and seed rate (Table 2). Results showed that plant height increased with increasing seed rate and decreasing row spacing. Maximum plant height was recorded under 40 cm row spacing and 140 kg ha⁻¹ seed rate with 48.2 and 49.3 cm, respectively (Table 3). In 2018-19 cropping season, analysis of variance of the plant height showed a significant difference of seed rate. The row spacing effect was not significant. Maximum plant height was recorded under 140 kg ha⁻¹ seed rate (49.3 cm). Over both years, the interaction between row spacing and seed rate effect was not significant (Table 2). While, during 2017-18 and 2018-19 cropping seasons, the tallest plants were observed under 40 cm row spacing and 140 kg ha⁻¹ seed rate combination with 51.7 and 51.3 cm, respectively. Results indicated that besides genetic constitution, row spacing and seed rate also control growth behavior of chickpea plant. The current study revealed that plant height decreased with increased row spacing and decreased seed rate that probably due to plant competition for light. Plant height was affected by less light penetration in the crop canopy as well as increase in the competition for available nutrient which will affect plant branches. Increased plant height at increased seeding rates was mainly due to interplant competition leading to taller stems, as well as the production of fewer tillers as observed by Bhatta *et al.* (2017). Furthermore, in case of raise seeding rates, plants tend to be taller and develop longer internodes as confirmed by Maddonni *et al.* (2001).

Grain yield

Optimum plant population density in plant is an important factor to realize the potential yields as it directly affects plant growth and development (Saleem *et al.*, 2012). In 2017-18, different row spacing and seed rate had significant effects on grain yields. In 2018-19, analysis of variance of grain yield showed a significant difference of row spacing. Over both years, the interaction between row spacing and seeding rate effect was not significant (Table 2). The highest seed yield was registered under the narrowest row spacing (40 cm) with 1014 and 1099.7 kg ha⁻¹ in 2018 and 2019 cropping seasons, respectively. Grain yield was tending to increasing with increasing seed rates but at a density higher than optimal, grain yields decrease. Indeed, seed yield responded positively to an increase in seed rate up to about kg ha⁻¹. Results of Table 3 showed that the increase in seed rate from 80 to 110 kg ha⁻¹ increased grain yield from 868.5 to 1163.2 kg ha⁻¹ and from 974.7 to 1287.8 kg ha⁻¹ in 2017-18

Table 1: The climatic conditions (temperature and precipitation) of the two years at Beldiya region.

Year	Precipitation (mm)		T Min (°C)		Max (°C)	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
September	36.8	50.4	16.27	19.4	31.8	32.73
October	38.9	140.6	12.48	14.65	26.26	25.87
November	190	92.8	7.6	8.83	19.53	20
December	34.2	75.5	5.35	6.39	15.48	17.97
January	60.7	172.6	6.35	5.06	18.19	14.39
February	62.9	48.4	4.82	5.14	14.96	15.68
March	79.2	47.6	7	7.19	19.45	29.46
April	26.4	49.4	8.9	9.47	24.03	22.07
May	36.8	192.4	12.77	11.74	26.87	24.52
June	62	0	16.8	17.6	32.07	36.37
Sum/Average*	627.9	869.7	9.84	10.55	22.87	22.90

*Sums for precipitation; average values for the rest.

Table 2: Analysis of variance with F values of plant height (PH), grain yield (GY), biological yield (BY) and Ascochyta blight severity (ABL) over 2017-18 and 2018-19 cropping seasons.

Year	Source of variation	PH	GY	BY	ABL
2017-18	Row spacing (RS)	23.08*	103.5**	68.38*	1.00
	Seeding rate (SR)	29.71**	10.91**	6.18*	5.64*
	RS × SR	1.42	0.91	0.37	0.18
2018-19	Row spacing (RS)	8.67	23.91*	17.48	1.00
	Seeding rate (SR)	25.96**	3.07	2.78	4.75*
	RS × SR	1.75	0.58	0.60	0.25

Table 3: Means of plant height (PH) and grain yield (GY) under different row spacing and seeding rate over 2017-18 and 2018-19 cropping seasons.

Year	Row spacing (cm)	Plant height (PH)				Grain yield per ha (GY/ha)			
		Seed rates (kg ha ⁻¹)				Seed rates (kg ha ⁻¹)			
		80	110	140	Means	80	110	140	Means
2017-18	40 (cm)	45	48	51.7	48.2a	921.7	1343	777.3	1014a
	60 (cm)	42.7	45	47	44.9b	815.3	983.3	626	808.2b
	Means	43.8a	46.5b	49.3c	-	868.5b	1163.2a	701.7a	-
2018-19	40 (cm)	45.3	47	51.3	47.9a	1231.7	1336.3	731	1099.7a
	60 (cm)	43a	45.7	47.3	45.3a	717.7	1239.3	676	877.7b
	Means	44.2a	46.3b	49.3c	-	974.7ab	1287.8b	703.5a	-

and 2018-19 cropping season, respectively. Under 140 kg ha⁻¹ seed rate, grain yield decreases significantly. The Influence of row spacing × seed rate interaction on seed yield was not significant. However, the highest seed yield (1343 kg ha⁻¹) was observed at 40 cm row spacing combined with 110 kg ha⁻¹ seed rate treatment. Therefore, to achieve the highest yield from chickpea, determining a suitable row spacing and seeding rate is too important for production. Biçer, (2014) reported that high plant density may lead to competition among plants and increase risk of disease and lodging of the crop, resulting in reduced grain yield. As plant density per unit area increased there is more plant to plant competition as a result there was low seed yield as reported by Kissi and Tamiru (2016). An optimum plant density

ensures proper growth of plant through efficient utilization of solar radiation, nutrients, land as well as air spaces and water as reported by Malek *et al.* (2012).

Biological yield

Data given in Table 2 showed that, in 2018, row spacing and seed rate affected significantly the biological yield. Table 4 showed that changing the row spacing had shining influences on biological yield per hectare, where it was increased from 2121.3 to 2791.8 kg ha⁻¹ by decreasing row spacing from 60 to 40 cm. Different seed rates had also significant differences in biological yields per hectare. Maximum biological yield was recorded at 110 kg ha⁻¹ seed rate. In 2019, row spacing and seed rate didn't affect

significantly the biological yield. Over 2017-18 and 2018-19, row spacing \times seeding rate interaction on biological yields was not significant. While, the 40 cm row spacing and 110 kg ha⁻¹ seed rate treatment was found to be the best for chickpea production in terms of biological yield per hectare (Table 4). This combination produced the highest biological yields 3518 and 3392.3 kg ha⁻¹ in 2017-18 and 2018-19, respectively. Optimum plant population density is an important factor to realize the potential yield as it directly affects plant growth and development. When plants are widely spaced, biological yield tend to increase linearly with increase in plant density due to no or minimum competition between the adjoining plants. In this study, biological yield was achieved through more plants with increasing plant population density. Ramroodi *et al.* (2008) showed that appropriate plant density is an important parameter affecting the yield of crops. Optimum plant density is important considering the point that too much reduced plant density may reduce total yield due to reduced number of plants per unit area. The increase in plant density increased dry matter accumulation per unit area because of higher leaf area index and greater absorption of solar radiation.

Impact of row spacing and seeding rate on Ascochyta blight severity

The analysis of variance of Ascochyta blight severity showed a significant effect of seed rate in 2017-18 and 2018-19 cropping seasons. Over both years, the effect of row spacing and row spacing \times seed rate interaction were not significant (Table 2). Results of Table 4 showed that the increase in seed rate from 80, 110 and 140 kg ha⁻¹ increased Ascochyta blight severity. Ascochyta blight severity score was lower at 80 kg ha⁻¹ seeding rate (mean score 1.7 and mean score 2.3 in 2017-18 and 2018-19, respectively), compared to the highest severity of Ascochyta blight (mean score 3.7 and mean score 4) that was scored at 140 kg ha⁻¹ seed rate. Reduced plant population density could be one tool in a program to manage Ascochyta blight of chickpea. Decreasing disease severity level of chickpea observed with 80 kg ha⁻¹ seed rate could be due to proper aeration resulting in decreased humidity level suitable for fungus growth and decreasing plant population also limits the transmission of rust pathogen to the next plant as confirmed by Mengesha

and Tesfaye, (2015). Higher plant density may lead to severe competition between plants and increase risk of disease and lodging of the crop, resulting in reduced grain yield as confirmed by Liaqat *et al.* (2019). In Tunisia, Ascochyta blight disease is among the major constraint to yield improvement and adoption of the crop by farmers which cause complete yield loss. So, disease management strategies are necessary to offer farmers high chickpea yields. Since only chickpeas are susceptible to *Aschochyta rabiei*, cultural practices such as optimum seed rate and row spacing are able to control this disease as confirmed by Kimurto *et al.* (2013). So, choice of optimum row spacing and seeding rate could be among the disease management strategies and are essential for diseases control and therefore provide higher chickpea yields.

Correlation among disease severity and yield and related traits

The objective of this study was to evaluate the effect of row spacing and seed rate on yield and disease development. Information on nature and magnitude of association among disease severity and yield and related traits could be helpful for the achievement of the highest yield and determining the suitable row spacing and seed rate to decrease diseases severity and therefore increase chickpea production. Based on the coefficients of correlation computed for the relationships between the disease and yield parameters, Ascochyta blight severity was strongly ($p \leq 0.01$) and positively correlated with seed rate ($r=0.61$) and plant height ($r=0.59$) (Table 5). It is known that plant diseases reduce crop yields compared to yields that could be expected in the absence of disease. In this study, ABL severity was not correlated with grain and biological yields. Consequently, ABL attacks hadn't a negative impact on yields. This is agreeing with McGrath, (2004) results who reported that small amounts of ABL disease have little or no effect on yield and the disease may not be worth controlling. Biological yield was negatively correlated with row spacing ($r= -0.33$). Furthermore, plant height was positively correlated with seed rate ($r= 0.75$) and negatively correlated with row spacing ($r= -0.51$). It is usually not sufficient to determine whether a disease is present or absent. The critical information required is the amount of disease that is present. Disease often has

Table 4: Means of biological yield (BY) and Ascochyta blight severity (ABL) under different row spacing and seeding rate over 2017-18 and 2018-19 cropping seasons.

Year	Row spacing	Biological yields per ha (BY/ha)				Ascochyta blight severity (ABL score)			
		Seed rates (kg ha ⁻¹)				Seed rates (kg ha ⁻¹)			
		80	110	140	Means	80	110	140	Means
2017-18	40 (cm)	2626	3518	2229.7	2791.2a	1.7	2.3	3.7	2.6a
	60 (cm)	2108.7	2543.3	1710.3	2120.8b	1.7	1.7	3.7	2.3a
	Means	2367.3ab	3030.7a	1970b	-	1.7a	2a	3.7b	-
2018-19	40 (cm)	3052	3392.3	1989.3	2811.2a	2.3	3	4.3	3.2a
	60 (cm)	1923.3	3240	2010.7	2391.3a	2.3	3	3.7	3a
	Means	2487.7ab	3316.2b	2000a	-	2.3a	3ab	4b	-

Table 5: Coefficients of correlation between ABL severity, plant height (PH), Grain yield (GY), biological yield (BY), row spacing and seeding rate.

	ABL	BY	SR	RS	PH	GY
ABL	1					
BY	-0.21	1				
SR	0.61**	-0.22	1			
RS	-0.09	-0.33*	-	1		
PH	0.59**	-0.08	0.75**	-0.51**	1	
GY	-0.22	0.98**	-0.26	-0.31	-0.11	1

to exceed a certain threshold before it reduces the yield of a crop. In other study, on chickpea, Chang *et al.*, (2007) reported that wide row spacing and low seed rate reduced Ascochyta blight severity and increased seed yield per plant.

CONCLUSION

Two levels of rows spacing (40 and 60 cm) and three levels of seed rates (80, 110 and 140 kg ha⁻¹) were tried to study the impact of row spacing and seed rate on Ascochyta blight severity, growth and yield of 'Beja1' chickpea variety. Among row spacing, the lowest disease severity level was recorded on plots planted with 40 row spacing. Different types of seed rate could significantly affect yield and related traits of chickpea. The maximum grain yield was obtained from plot planted under with 40 cm row spacing and 110 kg ha⁻¹ seed rate. While, the minimum value of yield was achieved by plot planted under 60 cm row spacing and 140 kg ha⁻¹ seed rate. Furthermore, Grain yield was tending to increasing with increasing seed rates but at a density higher than optimal, grain yields decrease. In this study, ABL attacks have little or no effect on chickpea yields because the small amounts of disease. However, plant population could reduce the Ascochyta blight severity. So, decreasing density could be one tool to manage Ascochyta blight of chickpea. The choice of row and seed rate should be considered as important components of integrate pest management in chickpea. It's considered as method to reduce Ascochyta blight pressure wherever possible. Since this research is done in one location, research works should be carried out for confirmation in different location in the future.

REFERENCES

- Ahmed, S., Abang, M.M. and Maalouf, F. (2016). Integrated management of Ascochyta blight (*Didymella fabae*) on faba bean under Mediterranean conditions. *Crop Protection*. 81: 65-69.
- Armstrong-Cho C., Wolf T., Chongo, G., Gan, Y., Hogg, T., Lafond, G., Johnson, E., Banniza, S. (2008). The effect of carrier volume on ascochyta blight (*Ascochyta rabiei*) control in chickpea. *Crop Protection*. 27(6): 1020-1030.
- Beec, D.F., Leach, G.J. (1989). Effect of plant density and row spacing on the yield of chickpea (cv. Tyson) grown on the Darling Downs, south-western Queensland. *Aust. J. Expt. Agric.* 29: 241-246.
- Bhatta, L.R., Subedi, R., Joshi, P., Gurung, S.B. (2017). Effect of crop establishment methods and varieties on tillering habit, growth rate and yield of finger-millet. *Agri. Res. and Tech.* 11(5): 1-2.
- Bicer, B.T. (2014). Some agronomic studies in chickpea (*Cicer arietinum* L.) and lentil (*Lens culinaris* Medik). *Turkish J. of Agricultural and Natural Sciences*. 1(1): 42-51.
- Chang, K.F., Ahmed, H.U., Hwang, S.F., Gossen, B.D., Howard, R.J., Warkentin, T.D., Strelkov, S.E., Blade S.F. (2007). Impact of cultivar, row spacing and seeding rate on ascochyta blight severity and yield of chickpea. *Can. J. Plant Sci.* 87: 395-403.
- Chongo, G., Gossen, B.D., Buchwaldt, L., Adhikari, T., Rimmer, S.R. (2004). Genetic diversity of *Ascochyta rabiei* in Canada. *Plant Dis.* 88: 4-10.
- FAOSTAT (2016). <http://faostat.fao.org/faostat/>.
- Gupta, R., Acharjee, S., Sarmah, B.K., (2020). Assessment of seed protein quality of a transgenic chickpea event expressing Cry2Aa protein. *Legume Research*. In press.
- Jukanti, A.K., Gaur, P.M., Gowda, C.L., Chibbar, R.N. (2012). Nutritional quality and health benefits of chickpea (*Cicer arietinum* L.): A review. *British Journal of Nutrition*. 108: 11-26.
- Kimurto, P.K., Towett, B.K., Mulwa, R.S., Njogu, N., Jeptanui, L.J., Rao, G.N., Silim, S., Kaloki, P., Korir, P., Macharia, J.K. (2013). Evaluation of chickpea genotypes for resistance to Ascochyta blight (*Ascochyta rabiei*) disease in the dry highlands of Kenya. *Phytopathol. Mediterr.* 52: 212-221.
- Kissi, W., Tamiru, M. (2016). Effect of sowing method and seed rate on the growth, yield and yield components of faba bean (*Vicia faba* L.) under highland conditions of Bale, Southeastern Ethiopia. *Research Journal of Agriculture and Environmental Management*. 5(3): 86-94.
- Liaqat, S., Muhammad, Y., Syed, M., Ali, S., Muhammad, N., Ahmad, A., Asif, A., Jing, W., Muhammad, W.R., Shamsur, R., Weixun, W., Riaz, M.K., Adil, A., Aamir, R., Galal, B.A., Hongqi, S., Haiyang, J., Chuanxi, M. (2019). Improving lodging resistance: Using wheat and rice as classical examples. *Int. J. Mol. Sci.* 20(17): 2-39.
- Lopez-Bellido, F.J., Lopez-Bellido, L., Lopez-Bellido, R.J. (2005). Competition, growth and yield of faba bean (*Vicia faba* L.). *Eur. J. Agron.* 23: 359-378.
- Maddonni, G.A., María, O.E., Cirilo, A.G. (2001). Plant population density, row spacing and hybrid effects on maize canopy architecture and light attenuation. *Field Crops Research*. 71(3): 183-193.
- Malek, M.A., Shafiquzzaman, M., Rahman, M.S., Ismail, M.R., Mondal, M.M.A. (2012). Standardization of soybean row spacing based on morpho physiological characters. *Legume Research*. 35: 138-143.
- Malik, B.P.S., Singh, R.C. (1996). The influence of seeding rate and weed control in small seeded lentils (*Lens culinaris*). *Weed Sci.* 45(2): 296-300.
- McGrath, M.T. (2004). What are Fungicides? The Plant Health Instructor. DOI: 10.1094/PHI-I-2004-0825-01.
- Mengesha, W., Tesfaye, A. (2015). Effect of spacing in incidence and severity of garlic rust [*Puccinia allii* (Rudolphi)] and bulb yield and related traits of garlic at eastern Ethiopia. *J. Plant Pathol. Microbiol.* 6: 314.

- Pande, S., Siddique, K.H.M., Kishore, G.K., Baaya, B., Gaur, P.M., Gowda, C.L.L., Bretag, T.W., Crouch, J.H. (2005). Ascochyta blight of chickpea (*Cicer arietinum* L.): A review of biology, pathogen cycle and disease management. Aust. J. Agric. Res. 56: 317-332.
- Ramroodi, M., Galavi, M., Nakhzari, M.A. (2008). Evaluation of yield and yield components of some lentil genotypes at different sowing dates. Res. J. Agric. 8(2): 45-56.
- Regan, K.L., Siddique, K.H.M., Martin, L.D. (2003). Response of *kabuli* chickpea (*Cicer arietinum* L.) to sowing rate in Mediterranean-type environments of south-western Australia. Australian Journal of Experimental Agriculture 43: 87-97.
- Saleem, A., Muhammad, A.Z., Habib, I.J., Ansar, M., Asghar, A., Rashid, S., Noor S. (2012). Effect of seeding rate on lentil (*Lens culinaris* Medik) seed yield under rainfed conditions. Pakistan J. Agric. Res. 25(3): 181-185.
- Ugwuoke, C.U., Asogwa, A.A., Okwo, C.R., Onu, F.M., Eze, G.E. and Onah, F.C. (2021). Effects of planting distance and seed rate on the growth and yield of Egusi Melon (*Citrullus colocynthis*). Legume Research. 44: 328-333.