Eco. Env. & Cons. 30 (May Suppl. Issue) : 2024; pp. (S146-S153)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2024.v30i03s.027

Effect of different varieties and spacings on growth and yield of cowpea (*Vigna unguiculata* L. Walp)

Dhanshree B. Jadhav

Department of Agronomy, Lovely Professional University, Phagwara, Punjab, India

(Received 10 September, 2023; Accepted 21 October, 2023)

ABSTRACT

The field investigation was conducted during *kharif* season of 2017 on "Effect of different varieties and spacings on growth and yield of cowpea (*Vigna unguiculata* L. Walp)". The field experiment was laid out in Factorial Randomized Block Design with three replications in which four spacings and two varieties were used. The results from experiments revealed that, the growth parameters such as number of functional leaves per plant (16.60) and total dry matter (21.23 g), the yield parameters viz. number of pods per plant (13.53), number of seeds per pod (14.06), seed yield (1332 kg ha^{-1}) and biological yield (4042 kg ha^{-1}), quality parameter like protein yield (308 kg ha^{-1}) were found significantly superior with wider spacing of 45 X 10 cm except plant height (63.60 cm) than the remained spacings and among the two different varieties the konkan safed recorded highest values than Konkan sadabahar. The interaction effect for all the growth, yield and quality parameters were found to be non significant during the course of investigation.

Key words: *Plant varieties, Spacing in crops, Vigna unguiculata*

Introduction

Pulses play a vital role in our lives. Pulses are the cheapest source of dietary proteins. The high content of protein in pulses makes the diet more nutritive for vegetarian when taken with other cooked food items. The pulses are second important constituent of Indian diet after cereals. They can be grown on all types of soils and climatic conditions. The pulses are also known for increasing productivity of soil through fixation of nitrogen from atmosphere, addition of biomass to soil and secretion of growth promoting substances. They play an important role in crop rotation, mixed and intercropping and help in maintaining soil fertility. Pulses are well suited in rainfed condition and require less farm resources. Pulses are generally not manured or require less manuring. Hence farmer prefers to grow them from economic point of view throughout the country. Pulses are helpful for checking the soil erosion as they have more leafy growth and close spacing. Majority of pulse crops are short durational, so that second crop may be taken on the same land in a year. They provide raw material to various industries e.g. *dal* industry, roasted grain industry, *papad* industry etc.

Cowpea is an important pulse crops for dryland agriculture, but low productivity. When promising genotypes with higher yield potential are identified, it is necessary to establish the appropriate agronomic manipulations for obtaining higher yield. A plant population is one such factor that has a direct influence on the yield level of any particular genotype. Spacing plays an important role in maintaining adequate plant population. Establishment of appropriate row spacing for maintaining the optimum

(Assistant Professor)

plant population per unit area is the most pre-requisite to obtain maximum yield for any field crops (Patel *et al.*, 2011).

Furthermore, varieties play an important role in crop production and the potential yield of variety within the genetic limit is determined by its environment. The release of high yielding varieties has contributed a great deal towards the improvement of cowpea yields. Hence, efforts are to be made to boost up the yield per hectare of cowpea by using appropriate spacing and varieties. Keeping in view, the present investigation was carried out to assess the plant spacing and variety for cowpea crop under subtropical climatic conditions of Maharashtra.

Materials and Methods

The present field experiment was conducted during *Kharif* season of 2017 at Agronomy section, College of Agriculture, Latur (Maharashtra). The field experiment was laid out in Factorial Randomized Block Design with three replications in which four spacings and two varieties were used

Climate

The meteorological data recorded at Meteorological observatory, Oilseed Research Station, Latur pertaining to the period of experimentation during 2017-18 are graphically presented in Fig 1a, 1b and 1c. The total precipitation received during crop growth period was 533 mm and distributed over 24

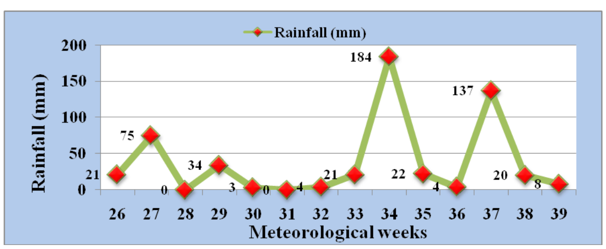

Fig. 1(a). Rainfall (mm) during crop growth period

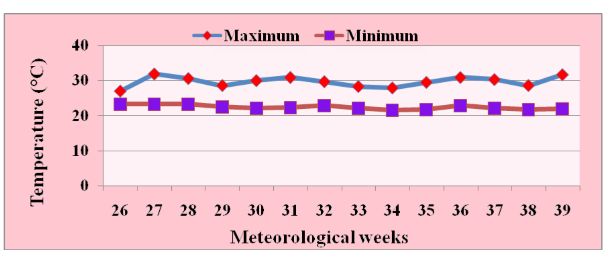

Fig. 1(b). Maximum and minimum temperature (°C) during crop growth period

days during the course of experimentation. The crop received moderate rainfall throughout the crop growth period. Temperature and mean relative humidity did not deviate much from the normal. So, the plant growth was not affected by these parameters throughout the crop duration.

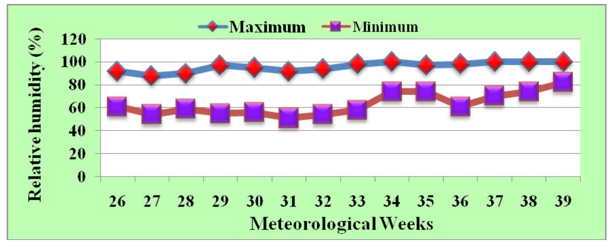

Fig. 1(c). Maximum and minimum relative humidity (%) during crop growth period

Growth attributes

Emergence count was taken on 15 days after sowing and final plant stand from each net plot was recorded before harvest. The plant height was measured from ground level to the base of last fully opened leaf and the mean plant height was worked out and expressed in cm. Total number of functional leaves (trifoliate leaves) borne on each randomly selected plant counted and recorded. The weight of dry matter is an index of productive capacity of the plants. Hence, one representative plant from each net plot was randomly uprooted. The roots of the plant uprooted for dry matter study were removed. After removal of roots, plant parts were sun dried in the first instance and oven dried at 65 ± 2° C temperature for 48 hours. The constant weight was recorded as total dry matter weight (g) per plant for each treatment.

Yield attributes

The number of pods plant^{-1} were counted and recorded from each plant. The number of seeds was counted from each plant and weight was recorded in gram. The plants were harvested and threshed then seeds were cleaned by winnowing and weight of seed was recorded in kg and expressed as seed yield kg ha^{-1}. The biological yield was recorded by following formula in kg. Biological yield = Seed yield + Straw yield.

Crude protein content

Nitrogen percentage was estimated by microkjeldahal method. Crude protein percentage of seed was estimated by multiplying the nitrogen percentage by 6.25.

Growth indices

Absolute growth rate (AGR)

The rate of increase in growth variables (W) at the time (t) is called as absolute growth rate (AGR). AGR of two growth variables *viz*. plant height and total dry matter were worked out by using following formula.

For height

$$AGR = \frac{H_2 - H_1}{t_2 - t_1} \text{ cm day}^{-1} \text{ plant}^{-1}$$

For dry matter

$$AGR = \frac{W_2 - W_1}{t_2 - t_1} \text{ g day}^{-1} \text{ plant}^{-1}$$

Where,

H_2 and H_1 as well as W_2 and W_1 refer to the plant height (cm) and total dry matter weight (g) of plant at time t_2 and t_1 respectively.

Relative Growth rate (RGR)

Blackman (1919) pointed out that increase in dry matter of plant is a process of continuous compound interest, when the increments produced in any time interval are added to the capital for the growth in subsequent period. The rate of increment is called as relative growth rate (RGR). This is calculated by formula as given below and expressed in g g^{-1} day^{-1}

$$RGR = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{t_2 - t_1}$$

Whereas,

Log e – Natural Logarithms (2.3026) W_1 and W_2 are the weight of total dry matter at time t_1 and t_2 respectively.

Results and Discussion

A. Growth attributes

Emergence count and Final plant stand

The initial plant population and plant stand was not influenced significantly by different treatments. This indicated that the plant stand was uniform and variations on various parameters under study were due to the effect of treatments. However, the initial and final plant population was 73.74 and 64.53 arc values respectively (Table 1).

Plant height

Data showed in Table 1 stated that the significantly maximum height of plant was recorded by the closer spacing 30 X 10 cm (S_1). The increased plant height under narrow spacing (30 X 10 cm) might be due to higher competition for space and light resulting taller plants. Similar results were also recorded by Malami and samaila (2012), Rasul *et al*., (2012), Shaukat *et al*., (2012), Murade *et al*., (2014) and Joshi and Rahevar (2015). The variety Konkan Safed (V_1) recorded higher height of plant which was found significantly superior over Konkan Sadabahar (V_2). On the basis of phenotypic observation plant height showed positive relationship with maturity. Genotype with early maturity produce dwarf plants while genotype with late maturity showed highest plant height. This apparent variation might be attributed to the differences in the genotype which decide the biometric parameters, varies in each variety, or might be due to environmental fluctuation. This result are in agreement with the previous finding reported by Khan *et al*., (2010), Sutar *et al*., (2014), Ahmad *et al*., (2017) and Srinivas *et al*., (2017). The interaction effects in respect to plant height were found to be non-significant.

Number of functional leaves plant^{-1}

Data presented in Table 1 stated that the wider spacing (45 X 10 cm) produced significantly maximum number of functional leaves plant^{-1} (16.60) over narrow spacings. A wider plant spacing which intercepted more photosynthetically active radiation owing to better geometric situation that might be resulted in vigorous plant growth and more number of branches, leaves and leaf area than narrow spacing. The similar findings were given by Achakzai and Panizai (2007), Lone *et al*., (2009), Ndor *et al*., (2012), Murade *et al*., (2014), Amruta *et al*., (2015) and Tanya *et al*., (2015). Among the both of varieties, the Konkan Safed (V_1) was found to be superior with Konkan Sadabahar (V_2). This might be because of leaf senescence towards maturity of the crop. The results of the present study are in accordance with the finding of Sutar *et al*., (2014). The interaction between spacing and varieties were not found significant in respect of number of functional leaves per plant.

Dry matter plant^{-1}

Data in Table 1 stated that the maximum production

Table 1. Growth attributes of cowpea as influenced by different treatment.

Treatment	Emergence count (Arc. values)	Final plant stand (Arc. values)	Plant height (cm)	Number of functional leaves plant^{-1}	Dry matter plant^{-1} (g)
Spacing (S)					
S_1 – 30 X 10 cm	72.51	63.65	63.60	12.07	15.67
S_2 – 30 X 15 cm	73.35	64.18	59.89	13.10	17.70
S_3 – 37.5 X 10 cm	74.21	64.81	58.52	14.03	19.23
S_4 – 45 X 10 cm	74.89	65.50	54.43	16.60	21.23
SEm ±	0.59	0.45	1.75	0.48	0.59
CD at 5%	NS	NS	5.33	1.48	1.80
Varieties (V)					
V_1 – Konkan Safed	73.89	64.69	66.92	14.48	20.44
V_2 – Konkan Sadabahar	73.58	64.38	52.30	13.42	16.48
SEm ±	0.41	0.32	1.24	0.34	0.42
CD at 5%	NS	NS	3.77	1.04	1.27
Interaction (S X V)					
SEm ±	0.83	0.65	2.48	0.69	0.84
CD at 5%	NS	NS	NS	NS	NS
General mean	73.74	64.53	59.61	13.95	18.45

of dry matter plant^{-1} was observed (21.23 g) at harvest by adopting wider spacing 45 X 10 cm and it was observed significantly superior over rest of the spacings. Due to more number of branches, leaves and leaf area plant^{-1} which might have increased photosynthates produced and its accumulation at highest rate and quantity through the process of plant metabolism which ultimately reflected in dry matter production. The results of the present study were in conformity with those earlier recorded by Khan *et al*., (2010), Chaudhry *et al*. (2014), Murade *et al*. (2014), Joshi and Rahevar (2015) and Tanya *et al*., (2015). The variety Konkan Safed (V_1) recorded highest accumulation of dry matter plant^{-1} during growth stages of crop. The maximum total dry matter production plant^{-1} was 20.44 g. It was found significantly superior over Konkan Sadabahar (V_2). This is due to taller variety coupled with more number of branches and leaves plant^{-1}, as stated in preceding section might have contributed towards more dry matter accumulation. These results are in confirmation with those of Sutar *et al*. (2014) and Ahmad *et al*. (2017). Interaction due to different treatments of spacing and varieties did not reach to level of significance.

B. Yield and Quality

Number of pods plant^{-1}

Data presented in Table 2 showed that a significant result was found from number of pods plant^{-1}. The highest number of pods plant^{-1} were recorded (13.53) by following wider spacing 45 X 10 cm which was found significantly superior over remaining treatments. The wider spacing between rows intercepted more radiations for photosynthesis as well as less competition between plants for nutrients, proper vegetative, reproductive growth and development and thus consequently attained maximum number of pods plant^{-1}. Similar findings were reported by Patil *et al*. (1991), Achakzai and Panizai (2007), Patel *et al*. (2011), Ndor *et al*. (2012), Jakusko *et al*., (2013), Murade *et al*. (2014), Joshi and Rahevar (2015) and Kumar *et al*. (2016). Among both of the varieties the Konkan Safed (V_1) variety was found significantly superior over Konkn Sadabahar (V_2) in producing number of pods plant^{-1}. This improvement was mainly due to significantly higher photosynthetic efficiency which might have led to formation of more number of pods plant^{-1}. Similar report were made by Birari *et al*. (1993), Jakusko *et al*. (2013), Shilpa *et al*. (2015) and Sutar *et al*. (2014). There was no interaction effect found significant in respect of number of pods plant^{-1}.

Number of seeds pod^{-1}

Data represented in Table 2 shown that the maximum number of seeds pod^{-1} (14.06) was observed with wider spacing 45 X 10 cm which was found significantly superior over rest of the spacing (S_1, S_2 and S_3). It might be attributed due to reduced underground and over ground competition between crop plants with wider row spacing which perhaps increased the light interception in plant canopy, subsequently improved available soil moisture to the plants also nutrients and space for better development of crop resulted in more number of seeds. These results are in line with Patil *et al*. (1991), Singh and Sekhon (2006), Patel *et al*. (2011), Ndor *et al*. (2012), Jakusko *et al*. (2013), Chaudhry *et al*. (2014), Murade *et al*. (2014), Amruta *et al*. (2015), Joshi and Rahevar (2015) and Kumar *et al*. (2016). The higher number of seeds pod^{-1} (12.02) was recorded by Konkan Safed (V_1) which was significantly superior over Konkan Sadabahar (V_2). Larger pods produced maximum number of seeds pod^{-1} while shorter less. Moreover this variation might be due to different genotypes or due to environment. These findings are in accord with the previous results reported by Khan *et al*. (2010), Jakusko *et al*. (2013) and Sutar *et al*. (2014). Interactions was found non significant in number of seeds pod^{-1}.

Seed yield

Data presented in Table 2 shown that the wider spacing 45 X 10 cm produced maximum seed yield (1332 kg ha$^{-1)}$ which was significantly superior over closer spacings (S_1, S_2 and S_3). The remaining spacing was found on par with each other. This was mainly due to more number of branches plant^{-1} and rapid vigorous vegetative growth of crop plants. Similar results were discussed by Kabir and Sarkar (2008), Chaudhry *et al*. (2014), Nayak *et al*. (2014) and Jagadale *et al*., 2017. The maximum seed yield (1221 kg ha^{-1}) was produced by Konkan Safed (V_1) and found significantly superior over Konkan Sadabahar (V_2). The peculiarity of genotypes is of great importance when we evaluate or develop genotypes for stability. However variation in yield was noted, which may be attributed to climatic diversity and genetic makeup of genotypes. The results resemble the finding of Sutar *et al*. (2014) and Srinivas *et al*. (2017). Seed yield was not significantly influenced by interaction.

Biological yield

Data tabulated in Table 2 showed that the higher biological yield were received from wider spacing 45 X 10 cm (4042 kg ha^{-1}) and recorded significantly superior than closer spacing except 30 X 10 cm. The spacing 30 X 10 cm was found at par with 45 X 10 cm for biological yield. Increase in vegetative growth in wider spacing might be due to less competition for space, light, CO_2, moisture and mutual shading effect due to reduced plant density per unit area which ultimately leading to higher biological yield. These results are according to the findings as reported by Singh and Sekhon (2006) and Khan *et al*. (2010). Among the two varieties the maximum biological yield (3962 kg ha^{-1}) were found from Konkan Safed which was observed significantly superior than Konkan Sadabahar. This might be due to higher growth and development of leaves and branches. The present results are in consonance with

Table 2. Yield and quality of cowpea as influenced by different treatment

Treatment	Number of pods plant^{-1}	No. seeds pod^{-1}	Seed yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Protein content (%)	Protein yield (kg ha^{-1})
Spacing (S)						
S_1 – 30 X 10 cm	8.37	8.88	968	3874	22.35	215
S_2 – 30 X 15 cm	9.53	10.93	1033	3525	22.60	234
S_3 – 37.5 X 10 cm	11.37	12.44	1196	3503	22.76	272
S_4 – 45 X 10 cm	13.53	14.06	1332	4042	23.02	308
SEm ±	0.39	0.38	40.64	101.03	1.05	13.83
CD at 5%	1.20	1.15	123.27	306.41	NS	41.97
Varieties (V)						
V_1 – Konkan Safed	11.50	12.02	1221	3962	22.96	281
V_2 – Konkan Sadabahar	9.90	11.14	1044	3511	22.41	233
SEm ±	0.28	0.27	28.74	71.44	0.74	9.78
CD at 5%	0.85	0.81	87.16	216.66	NS	29.67
Interaction (S X V)						
SEm ±	0.56	0.53	57.48	142.88	1.49	19.57
CD at 5%	NS	NS	NS	NS	NS	NS
General mean	10.70	11.58	1132	3736	22.68	257

those of Sutar *et al*. (2014). Interaction was not evident in biological yield of cowpea crop.

Protein content

Data presented in Table 2 confirmed that the higher protein content (23.02 %) was observed with wider spacing 45 X 10 cm. The protein content in cowpea seed did not differ significantly due to various spacing. The protein content was not influenced significantly due to varieties. However maximum protein content was recorded by Konkan Safed (22.96 %). Interaction between spacing and varieties was not found significant in protein content.

Protein yield

Data noted in Table 2 showed that The maximum protein yield (308 kg ha^{-1}) was obtained with wider spacing 45 X 10 cm. This treatment was found significantly superior over rest of the spacings. Significantly increased in grain and straw yield with wider spacing also improves the protein content and protein yield. Similar results of investigation are in coinciding with Lone *et al*. (2009) and Joshi and Rahevar (2015). The higher protein yield (281 kg ha^{-1}) was produced by Konkan Safed and which was significantly superior over Konkan Sadabahar. Variations may be due to climatic condition or genetic contribution of tested genotype among varieties. Similarly variation in protein content and protein yield in different varieties was also noticed by Sutar *et al*. (2014). None of the interaction was reach to the level of significance in protein yield.

C. Growth indices

Absolute growth rate (AGR) for plant height

Data in Table 3 noted that the highest absolute growth rate for plant height was observed with closer spacing (30 x 10 cm) and counted as 0.416 (cm day^{-1} plant^{-1}) at 61 DAS to harvest respectively. The higher values of AGR were recorded with Konkan Safed (V_1) over Konkan Sadabahar (V_2).

Absolute growth rate (AGR) for dry matter

Data in Table 3 stated that the AGR for dry matter attained its higher values with spacing 30 X 15 cm (0.088 g day^{-1} plant^{-1}) at 76 DAS to harvest. The AGR for dry matter counted its maximum values with Konkan Safed (V_1).

Relative growth rate (RGR) for dry matter

Data in Table 3 shown the highest value of RGR was recorded in between 76 DAS to harvest the RGR was (0.005 g g^{-1} day^{-1}) with 30 X 15 cm. The RGR with its highest values was obtained with Konkan Safed (V_1).

Simple correlation

Data on simple correlation (r) between biological yield (kg ha^{-1}) as depended variable (Y) and plant height (cm), number of trifoliate functional leaves, dry matter plant^{-1} (g), number of pods plant^{-1}, no. of seeds per pod, protein content (%), protein yield (kg ha^{-1}) and seed yield (kg ha^{-1}) as independent variable (Xn) were established and resultant data are predicted in Table 4.

Data presented in Table 22 revealed that negative correlation was observed between plant height and number of functional leaves plant^{-1} (-0.3272), number of pods plant^{-1} (-0.2672), number of seed pod^{-1} (-0.3858), protein yield (-0.1064) and seed yield (-0.1295). The positive and highly significant correlation were observed between seed yield plant^{-1} and

Table 3. Growth indices of cowpea as influenced by different treatment

Treatment	Absolute growth rate (AGR) for plant height (cm day^{-1} plant^{-1})	Absolute growth rate (AGR) for dry matter (g day^{-1} plant^{-1})	Relative growth rate (RGR) for dry matter (g g^{-1} day^{-1}
Spacing (S)			
S_1 – 30 X 10 cm	0.416	0.044	0.002
S_2 – 30 X 15 cm	0.410	0.088	0.005
S_3 – 37.5 X 10 cm	0.392	0.055	0.002
S_4 – 45 X 10 cm	0.403	0.048	0.002
Varieties (V)			
V_1 – Konkan Safed	0.476	0.118	0.006
V_2 – Konkan Sadabahar	0.291	0.000	0.000
General mean	0.398	0.059	0.003

Table 4. Simple correlation (r) of seed yield plant^{-1} with growth, yield and quality attributes.

Particulars	Plant height (cm)	No. of functional leaves	Dry matter production (g)	No. of pods per plant	No. of seeds per pod	Protein content (%)	Protein yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Biological yield (kg ha^{-1})
Plant height (cm)	1								
No. of functional leaves	-0.3272	1							
Dry matter production (g)	0.0397	0.9040**	1						
No. of pods per plant	-0.2672	0.9842**	0.9402**	1					
No. of seeds per pod	-0.3858	0.9556**	0.9034**	0.9750**	1				
Protein content (%)	0.1099	0.8796**	0.9970**	0.9146**	0.8689**	1			
Protein yield (kg ha^{-1})	-0.1064	0.9549**	0.9765**	0.9861**	0.9421**	0.9610**	1		
Seed yield (kg ha^{-1})	-0.1295	0.9555**	0.9676**	0.9885**	0.9448**	0.9496**	0.9991**	1	
Biological yield (kg ha^{-1})	0.3582	0.4938	0.4828	0.4377	0.2407	0.5182	0.4963	0.4859	1

* Significance at 5 per cent: 0.7067
** Significance at 1 per cent: 0.8343

number of trifoliate functional leaves plant^{-1}, dry matter plant^{-1} (g), number of pods plant^{-1}, no. of seeds per pod, protein content (%), protein yield (kg ha^{-1}).

Conclusion

At the outset of our detailed field experiment, it can conclude that, the growth attributing characters like plant height, number of functional leaves plant^{-1}, dry matter plant^{-1} (g), yield parameters such as number of pods, seeds per plant, seed and biological yield were influenced significantly with wider spacing 45 X 10 cm and the variety V_2 – Konkan Sadabahar. Hence it has been showed that Konkan Sadabahar variety of cowpea could be sown at 45 X 10 cm to obtain a higher yield of cowpea in subtropical climate of Maharashtra.

Conflict of interest: None

References

Achakzai, A.K.K. and Panizai, K. 2007. Effect of row spacing on growth, yield and yield components of mungbean. *Sarhad J. Agril.* 23(1): 5-10.

Ahmad, A., Tomar, G.S., Taunk, S.K. and Verma, N. 2017. Evaluation of new cultivars of fodder cowpea in terms of growth attributes and seed yield as influenced by various doses and varieties. *Int. J. Curr. Micro. App. Sci.* 6(10): 937-944.

Amruta, N., Maruthi, J. B., Sarika, G. and Deepika, C. 2015. Effect of integrated nutrient management and spacing on growth and yield parameters of black gram cv. LBG-625 (Rasmi). *Int. Quarterly J. Life Sci.* 10(1): 193-198.

Birari, D.S., Birari, S.P. and Jamadagni, B.M. 1993. Stability analysis of promising genotypes of cowpea (*Vigna unguiculata*) *I. J. Agril. Sci.* 63(2): 103-106.

Chaudhry, S., Verma, V.K., Singh, V., Pyare, R. and Kumar, A. 2014. Dwarf field pea (*Pisum sativum* L.) as influenced by new varieties and row spacings. *Asian J. Bio. Sci.* 9(1): 101-103.

Jagdale, A.R., Bahure, G.K., Mirza, I.A.B., Mirche, S.H. and Ghungarde, S.R. 2017. Effect of plant geometry and fertilizer levels on yield and economics of cowpea (*Vigna unguiculata* L. Walp). *Int. J. Curr. Micro bio. Appli. Sci.* 6(5): 1518-1522.

Jakusko, B.B., Anasunda, U.I. and Mustapha, A.B. 2013. Effect of inter-row spacing on some selected Cowpea (*Vigna unguiculata* L. Walp) varieties in Yola, Adamawa State, Nigeria *IOSR J of Agric. And Vet. Sci.* (IOSR- JAVS)e- ISSN : 2319-2380, p- ISSN : 2319 - 2372. 2(3): 30-35.

Joshi, S.K. and Rahevar, H. 2015. Effect of dates of sowing, row spacing and varieties on growth and yield attributes of *rabi* Indian bean (*Dolichos Lablab* L.). *I. J. Agril. Res.* 49(1): 59-64.

Kabir, M.H. and Sarkar, M.A.R. 2008. Seed yield of mungbean as affected by variety and plant spacing in *Kharif*-I season. *J. Bangladesh Agril. Uni.* 6(2): 239-244.

Khan, A.,Bari, A., Khan, S., Shah, N.H. and Zada, I. 2010. Performance of cowpea genotype at higher altitude of NWFP. *Pak. J. Bot.* 42(4): 2291-2296.

Khan, E.A., Aslam, M., Hajikhalil, A., Hi, Maytullah, Khan, M.A. and Hussain, A. 2010. Effect of row spacing and seeding rates on growth, yield and yield components of chickpea. *Sarhad J. Agric.* 26(2).

Kumar, Sarvesh, Kumar, Jitendra, Katiyar, A., Katiyar, S.C., Rajput, P.K. and Kumar, A. 2016. Effect of plant geometry on growth, yield and water use efficiency of gram (*Cicer arientinum* L.) under water stress condition in U. P. *Agriways.* 4(1): 56-61.

Lone, B.A., Hasan, B., Ansar, S. and Khanday, B.A. 2009. Effect of seed rate, row spacing and fertility levels on growth and nutrient uptake of soyabean (*Glycine max* L.) under temperate conditions. *J. Agril. Bio. Sci.* Vol.4, 3.

Malami, B.S. and Samaila, M. 2012. Effect of inter and intra row spacing on growth characteristics and fodder yield of cowpea (*Vigna unguiculata* L. Walp. Var. Kanannado) in the semi arid north-western Nigeria. *Nigerian J. Basic Appli. Sci.* 20(2): 125-129.

Murade, N.B., Patil, D.B., Jagtap, H.D. and More, S.M. 2014. Effect of spacing and fertilizer levels on growth and yield of urdbean. *Int. Quarterly J. Life Sci.* 9(4): 1545-1547.

Nayak, S., Chavan, D.A. and Waghmare, Y.M. 2014. Effect of different spacings on growth and yield of black gram (*Vigna mungo* L. *Hepper*) varieties. *Int. Convection Centre. Agrotechno.* 2:4.

Ndor, E., Dauda, N.S., Abimuku, E.O., Azagaku, D.E. and Anzaku, H. 2012. Effect of phosphorus fertilizer and spacing on growth, nodulation count and yield of cowpea (*Vigna unguiculata* L. *Walp*) in southern Guinea savanna Agroecological zone, Nigeria. *Assian J. Agril. Sci.* 4(4): 254-257.

Patel, B.V., Parmar, B.R., Parmar, S.B. and Patel, S.R. 2011. Effect of different spacings and varieties on yield parameter of cowpea (*Vigna unguiculata* L. Walp). *The Asian J. Horti.* 6(1): 56-65.

Patil, N.K., Kamannavar, P.Y. and Biradar, D P. 1991. Performance of cowpea varieties at two interrow spacings. *J. Maha. Agril. Uni.* 16(1): 112-113.

Rasul, F., Cheema, M.A., Sattar, M.F., Saleem and Wahid, M.A. 2012. Evaluating the performance of three mungbean varieties grown under varying inter-row spacing. *J. Ani. Plant Sci.* 22(4): 1030-1035.

Shaukat, S.A., Ahmad, Z., Choudry, Y.A. and Shaukat, S.K. 2012. Effect of different sowing dates and row spacing on the growth, seed yield and quality of off season pea (*Pisum sativum* L. cv. Climax) under temperature condition of Rawalkot Azad Jammu and Kashmir. *Scientific J. Agril*. 1(5): 117-125.

Shilpa, H.D., Wali, S.Y., Halli, H.M. and Amruta, T.G. 2015. Response of cowpea (*Vigna unguiculata*) genotypes to different levels of phosphorus during summer under northern dry zone of Karnataka. *I. J. of tech. Res. And Appli.* 2320-8163. 3(5): 224-226.

Singh, Guriqbal and Sekhon, H. S. 2006. Effect of row spacing and seed rate on the growth and grain yield of *desi* Chickpea (*Cicer arientinum*). *I. J. Agril.Sci.* 76(6): 375-376.

Sutar, V.K., Chavan, L.S. and Game, V.N. 2014. Response of cowpea (*Vigna unguiculata* L.) varieties to different sowing dates and effect on yield, quality and soil fertility. *J.I. Soci. Coastal Agril. Res.* 32(1): 16-20.

Srinivas, J., Kale, V.S. and Nagre, P.K. 2017. Evaluation of different cowpea varieties and genotypes. *Int. J. Pure App. Biosci.* 5(3): 329-334.

Tanya, Daniel, S. and Kumar, M. 2015. Comparative study on effect of spacing on the growth and yield of different varieties of black gram (*Vigna radiata* L.) under subabul (*Leucaena leucophala*) based agrosilviculture system. *Int. J. Adv. Res.* 3(6): 1190-1196.