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ISSN: 0974-4908
Res. Environ. Life Sci.
9(9) 1087-1089 (2016)

Yield and yield attributes of plant geometry of Gram (*Cicer arietinum* L.) under rainfed condition in Uttar Pradesh

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(Received: December 10, 2015; Revised received: June 9, 2016; Accepted: June 15, 2016)

Abstract: An experiment was carried out in relation to various plants spacing of chickpea with variety (Avarodhi) under rainfed condition. The crop of chickpea was grown with ten plant spacing viz. T_1 (30 X 15 cm), T_2 (30 X 20 cm), T_3 (30 X 25 cm), T_4 (40 X 15 cm), T_5 (40 X 20 cm), T_6 (40 X 25 cm), T_7 (45 X 15 cm), T_8 (45 X 20 cm), T_9 (45 X 25 cm) and T_{10} (50 X 30 cm) in three replications with randomized block design -. The soil of experimental plot was sandy loam in texture, poor in organic carbon and medium available phosphorous and available potash with soil pH 7.5. The sowing of chickpea was done on October 5, 2009-10 and October 8, 2010-11. The crop was fertilized with uniform dose of 20 kg N ha^{-1}, 40 kg each P_2O_5 and K_2O ha^{-1} respectively. The crop received 143.4 mm rains during 2009-10 and 65.5 mm during 2010-11. The result showd that yield attributing character like pods/plant, number of seed/pod, 100-seed weight/plant were higher under wider spacing *i.e*. 50x30 cm. However, seed yield was maximum (21.00 & 19.30 q ha^{-1}) with the spacing of 45x20 cm during two year of the experimentation.

Key words : Chick pea, Yield, Plant geometry and Rainfed

Introduction

One of the main reasons of low yield of Chickpea (*Cicer arietinum* L.) is improper population. Too low and high plant population beyond a certain limit often adversely affects the crop yield. Number of plants per unit area influences plant size, yield components and ultimately the seed yield (Beech and Leach, 1989). Moreover, plant spacing in the field is also very important to facilitate aeration and light penetration in to plant canopy for optimizing rate of photosynthesis. There is very little information available on the relative contribution of various plant spacing towards yield and yield components. Panwar *et al*. (1980) and Singh *et al*. (1994) reported row spacing of 45 cm increased chickpea yield compared to 30 and 50 cm spacing while Parihar (1996) indicated that row spacing had no significant effect on seed yield. Chickpea is one of the most important crops as it ranks first in area & production is total pulses. It is the most important crop of rabi season which occupies an area of 8.26 million ha in the country with an annual production of 6.20 million tons @ 7.51 q ha^{-1} in our state if U.P. it is grown an area of 8.49 Lakh ha with annual production of 5-5.25 Lakh tons. With an average productivity 8.35 q ha^{-1}. Thus, there is an urgent need to increase the production of pulses to meet the increasing demand by manipulating the production technologies appropriately. chickpea is the most important pulse crop of India. The yield of chickpea is limited by a number of factors such as agronomic, pathogenic, entomological, genetic and their interaction with environment. Among the different agronomic practices limiting the yield, choice of a suitable geometry and population for a particular genotype is one of the important factors. Adaptation of proper planting geometry to a particular genotype will go a long way in making efficient use of limited growth resources and thus to stabilize yield.

Materials and Methods

The field experiment was conduct during Rabi 2009-10 and 2010-11 on the field at Soil Conservation and Water Management farm. Chandra Shekhar Azad University of Agriculture & Technology of Kanpur. The location represents the agro climatic condition of central plain zone of U.P. between $26^0$27'N - $26^0$58'N latitude and $79^0$31' E - $80^0$31' E longitude and at an elevation of 125.9 m from mean sea level. The soil of experimental plot was sandy loam texture having 0.47 % organic carbon, 272 kg ha^{-1} available nitrogen, 12.6 kg ha^{-1} available phosphorous, 160 kg ha^{-1} available potassium, pH 7.6 and EC 0.37 dS m^{-1}. The entire quantity of recommended dose of fertilizer for Pigeonpea (20:40:40::N: P_2O_5: K_2O kg ha^{-1}) was applied as basal dose at the time of sowing. The chickpea variety "Avrodhi" was tested in ten spacing treatments viz. 30x15(T_1), 30x20 cm (T_2), 30x25 cm (T_3), 40x15 cm (T_4), 40x20 cm (T_5), 40x25 cm (T_6), 45x15 cm (T_7), 45x20 cm (T_8), 45x25 cm (T_9), 50x30 cm (T_{10}). The experiment was laid out in tree replications of the randomized block design. Five plants were tagged at random in net plot area for recording various yield components like number of pods per plant, number of seeds per pod, weight per plant (g), 100-seed weight (g), seed yield (kg ha^{-1}) was computed by threshing pods from net plot, cleaned and the seeds weight was recorded. From this seed yield per hectare was computed.

Results and Discussion

Plant stand and mortality : Final plant stand ('000 plant/ha) significantly differ because of different plant geometry. Highest plant stand observed 213.00 and 212.70 DAS at 30X15 cm spacing when the compared 161.10 and 160.90, 144.25 and 144.25 and lowest 66.10 and 66.00 DAS at 50X30 cm, respectively during

Table-1: Effect of plant geometry on growth characters of chickpea

Treatments	Final plant stand ('000 plants/ha)		Mortality (%)		Plant height (cm)		Primary branches/plant		Secondary branches/plant		Days to maturity	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
T_1 (30x15 cm)	213.00	212.70	4.36	5.04	45.66	44.54	5.66	5.25	8.23	7.21	150.46	149.95
T_2 (30x20 cm)	161.10	160.90	3.10	3.56	45.16	44.25	6.00	5.35	8.66	7.33	150.86	150.30
T_3 (30x25 cm)	130.00	129.60	2.70	3.10	44.33	44.00	6.33	6.10	9.66	7.80	150.53	150.00
T_4 (40x15 cm)	161.70	161.20	2.82	3.15	44.23	43.90	6.56	6.00	10.33	9.65	150.90	150.40
T_5 (40x20 cm)	121.90	121.50	2.69	2.98	44.00	42.86	6.66	6.23	11.00	10.32	150.60	150.00
T_6 (40x25 cm)	97.90	97.40	2.49	2.90	43.50	42.10	7.00	6.45	11.23	10.50	150.60	150.10
T_7 (45x15 cm)	144.25	144.10	2.76	3.01	43.33	41.75	7.09	6.60	11.26	10.60	150.23	149.36
T_8 (45x20 cm)	108.91	108.84	2.24	2.90	43.16	41.25	7.33	7.00	11.29	10.65	149.90	149.10
T_9 (45x25 cm)	87.00	86.76	1.80	2.05	39.50	38.15	7.66	7.30	11.33	10.90	151.10	150.60
T_{10} (50x30 cm)	66.10	66.00	1.04	1.25	39.16	37.85	7.82	7.50	11.66	11.00	150.46	149.90
SE (d)±	10.972	10.566	0.441	0.458	0.843	0.753	0.460	0.458	0.432	0.515	0.993	1.025
CD at 5%	23.059	22.055	0.923	1.112	1.779	1.547	0.965	0.824	0.915	0.956	NS	NS

Table-2: Effect of plant geometry on yield and yield attributing characters of chickpea

Treatments	Number of pods/ plants		Number of seeds/plant		Weight of per plant		100-seed weight/plant		Seed yield (q ha^{-1})		Stover yield (q ha^{-1})	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
T_1 (30x15 cm)	83.33	80.25	2.16	2.13	15.07	14.59	19.08	19.62	12.60	11.00	21.80	20.10
T_2 (30x20 cm)	104.00	100.65	2.16	2.15	28.91	26.68	19.79	19.55	13.60	12.20	23.00	22.00
T_3 (30x25 cm)	113.00	110.10	2.00	1.98	29.53	27.55	19.93	19.68	16.30	14.80	28.00	27.58
T_4 (40x15 cm)	105.00	102.50	1.83	1.70	30.00	29.15	20.20	19.84	13.90	12.35	24.10	23.10
T_5 (40x20 cm)	117.00	113.65	1.83	1.75	33.16	31.23	20.33	20.05	17.20	15.40	30.05	29.60
T_6 (40x25 cm)	125.33	120.56	2.10	2.01	35.95	34.10	20.36	20.23	20.80	18.40	35.20	34.20
T_7 (45x15 cm)	116.00	112.32	2.16	2.16	38.14	36.56	20.42	20.33	16.00	14.10	27.00	26.90
T_8 (45x20 cm)	121.66	118.20	2.09	2.08	38.58	36.73	20.51	20.42	21.00	19.30	35.00	34.70
T_9 (45x25 cm)	132.66	128.36	2.03	2.00	38.74	37.00	20.60	20.56	20.00	18.60	33.20	32.20
T_{10} (50x30 cm)	151.66	145.28	2.33	2.33	39.61	38.54	20.73	20.66	13.20	11.70	23.20	21.20
SE (d)±	8.621	7.569	0.025	0.025	1.839	1.954	0.909	0.951	0.890	0.735	1.481	1.358
CD at 5%	18.115	16.585	0.161	0.160	3.869	3.759	NS	NS	1.871	1.584	3.110	2.598

2009-10 and 2010-11. Data on plant mortality clearly recorded that higher plant mortality (4.36 & 5.04 %) was observed under narrow plant geometry (30X15 cm) followed by 3.10 and 3.56 % at 30X20 cm spacing. While minimum plant mortality (1.04 & 1.25 %) was recorded in wider spacing of 50X30 cm during 2009-10 and 2010-11, respectively (Table - 1). Similar findings of Singh *et al.* (2003).

Plant height : It is obvious that the plant height (cm) was influenced significantly with plant geometry at all stages of crop growth. In spacing of T_1 (30x15 cm) had produced being 45.66 and 44.54 cm taller plant as compared to other treatment at all stages of crop growth while treatment T_{10} (50x30cm) attained minimum plant height 39.16 and 37.85 cm of chickpea, respectively during both years of 2009-10 and 2010-11 Dhakad *et al.* (2005).

Primary branches/plant : Number of primary branches per plant was recorded at successive stages of crop growth at 30, 60, 90 and 120 DAS. Primary branches significantly higher under T_{10} treatment and maximum branches 7.82 and 7.50 per plant were recorded at 120 DAS while minimum branches per plant 5.66 and 5.25 per plant observed under T_1 treatment, respectively during both the years 2009-10 and 2010-11.

Secondary branches/plant : The data on number of secondary branches per plant showed that the numbers of secondary branches per plant were significantly affected by plant geometry. Maximum secondary branches recorded under treatment T_{10} viz. 11.66 and 11.00 at maturity stage as well as minimum 8.23 and 7.21 in T_1 treatment, respectively during both years of investigation of 2009-10 and 2010-11.

Days to maturity : Days of maturity measured at successive stage. It is clear from the Table-1 variety "Avrodhi" was matured in around 150 days after sowing then the early maturity time in T_8 treatment (45x20 cm) at 149.90 and 149.10 days and late maturity in T_9 treatment in 151.10 and 150.60 days. There was no significant difference on maturity of chickpea by any spacing/plant geometry treatment, respectively during 2009-10 and 2010-11.

Yield attributing characters -

Number of Pods/plant : Number of pods per plant summarized in Table-2 whereas the number of pods per plant should that significantly higher pods per plant (151.66 and 145.28) showed recorded under T_{10} (50X30 cm) treatment followed by 132.66 and 128.36 in T_9 (45X25 cm) and 125.33 and 120.56 and low pods per plant (83.33 and 80.25) in T_1 treatment, respectively during course of investigation of 2009-10 and 2010-11. Higher number of pods $plant^{-1}$ in 45 cm apart single rows might be due to proper adjustment of plants in the field which facilitated more aeration, greater light interception and more photosynthetic activity. Tripathi and Kumar (1998) and Prasad and Singh (2004), have also reported that

sowing of chickpea by regular sowing has given higher number of pods per plant in wider plant geometry/spacing.

Number of seeds/pod : Data on number of seeds per pod higher seed per pod in T_{10} treatment (2.33 and 2.33) as well as followed by 2.16 and 2.16, 2.16 and 2.15 and 2.16 and 2.13 in T_7, T_2 and T_1, respectively. Lower seeds per pod in T_4, and T_5 treatment (1.83 and 1.70 & 1.75), respectively during 2009-10 and 2010-11. Tripathi and Kumar (1998) and Prasad and Singh (2004), have also reported that sowing of chickpea by regular sowing has given higher number of seed per pod in wider plant geometry/spacing. The lowest number of seeds per pod might be due to relatively closer plants within row, which might have resulted in greater competition for light, space and nutrients.

Weight of plant (g) : Plant weight per plant (g) summarized in Table-2 whereas the resulted data on plant weight per plant that significantly higher plant weight per plant in T_{10} treatment 50x30 cm (39.61and 38.54g) followed by 38.74 and 37.00 in treatment T_9 (45X25 cm) and lowest plant weight per plant in T_1 treatment (15.07 and 14.59g), respectively during course of investigation of 2009-10 and 2010-11. The higher weight per plant was confirmed by the findings reported by Rathi and Kumar (2002), and Rathore and Patel (1991).

100-seed weight : Hundred seed weight of gram of tabulated under main effect of treatment in the Table-2 indicate that data significantly not differ by the plant geometry. The maximum 100-seed weight (20.73 and 20.66 g) in T_{10} (50X30 cm) treatment and minimum 100-seed weight (19.08 and 19.62 g) in T_1 (30X15 cm) treatment, respectively during years of 2009-10 and 2010-11. Lower number of plants per unit area at lower seed rate had more nutrients availability and greater partition to seed as compared to higher seed rate which resulted in more plump and bold seeds. Lowest density produced healthy individual seeds by receiving maximum sunlight for the process of photosynthesis. The lowest 100 seed weight in this treatment might be due to relatively closer plants within row which might have resulted in greater competition for light, space and nutrients and ultimately less assimilation of photosynthates.

Seed yield : It was clear from data that statistically higher seed yield (q ha^{-1}) was obtained in plant geometry T_8 (45 X 20 cm) treatment during 2009-10 and 2010-11 (Table - 2). It was higher probably due to better yield attributes and growth characters. Yield is a resultant of plant population per unit area into seed yield per plant. Seed yield per plant was maximum (21.00 q ha^{1} and 19.30q ha^{-1}) in plant geometry of T_8 treatment (45 X 20 cm) during 2009-10 and 2010-11 respectively. Highest biological yield (56.00 q ha^{1} and 54.00 q ha^{1}) in T_8 (45X20 cm) treatment during 2009-10 and 2010-11, respectively. The biological yield was also higher in wider spacing in 45X20 cm (T_8) treatment. The higher yield in wider spacing was confirmed by findings of Prasad and Singh (2004) and Prasad *et al.* (2007) in chickpea. The availability of more space to the upper portion of plant creates convenience for more interception of light up to lower horizon of plant. For longer period in day which provide chance in two ways fertility, by increasing photosynthetic activities for longer period on large plant biomass and secondly due to reduction in the competition for light and air which is ultimately responsible for early senescence of leaves under close canopy condition. The findings are also supported by Tripathi and Kumar (1998) and Khan *et al*. (2001).

Stover yield : Stover yield of chickpea in tabulated under effect of treatment in the Table-2 indicated that data significantly differ among the treatment. The maximum stover yield (35.20 q ha^{-1} in T6 (40X25 cm) and 34.70 q ha^{-1} in T_6 (45X20 cm) treatment when the compared to other treatments and minimum stover yield (21.80 and 20.10 q ha^{-1}) recorded in T_1 treatment (30x15 cm). These were 38% and 42.07% highest than T_1 treatment, respectively during course of investigation of 2009-10 and 2010-11. It might be concluded that 45 cm single row spacing is optimum for maximum light interception and aeration and eventually the stover yield which might be attributed to optimum space per plant that resulted in efficient light interception and photosynthetic activity. Barary *et al*. (2002) also reported increased stover yield with 45 cm row spacing. Through over viewing all discussions, it is accomplished that 50X30 cm plant geometry in chickpea crop affected positively different agronomic parameters like number of pods/plant, number of seeds/pod and 100 seed weight which ultimately contributed to increased biological yield, grain yield in 45X20 cm treatment and stover yields concluded that T6 and T8 treatment of planting geometry for efficient light interception and photosynthetic activity and same is proposed to the farmers for better yield in chickpea under given environmental conditions, respectively during 2009-10 and 2010-11.

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