The effect of row and plant spacings on the growth and yield of chickpea (*Cicer arietinum* L.)

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Abstract

A field experiment was conducted in the Karaj area of Iran in 1996 to investigate the effect of row and plant spacings on the growth and yield of a new, semi-erect kabuli chickpea line, 12-60-31, in irrigated conditions. The effect of row and plant spacings on seed yield was not statistically significant, but the interaction was ($P < 0.05$). The effects of row spacings, plant spacings and their interaction on 100-seed weight and seed number in the pod and seed protein percentage were not significant ($P > 0.05$). The highest grain yields were observed for row spacings of 40 and 50 cm and plant spacings of 5 and 7.5 cm. The Harvest Index (HI) varied significantly for different row and plant spacings and their interactions ($P < 0.05$). The trends in relative growth rate and crop growth rate were similar across treatments. The net assimilation rate (NAR) was similar for the various row and plant spacings, although the overall NAR was less at higher densities. These results suggest that spacings of 40 ? 7.5 cm or 50 ? 5 cm would be suitable for semi-erect cultivars of chickpea under temperate conditions.

Key words

harvest index, growth-degree-days, leaf area index

Introduction

Chickpea (*Cicer arietinum* L.) is an important pulse crops of rainfed agriculture in West Asia and North Africa (1). The yield of each crop is determined by inter and intra plant competition for resources. Maximum yield will be obtained when environmental resources are used most effectively (2). Therefore, plant row spacing is an important crop management decision. Singh *et al* (3) reported row spacing of 45 cm increased rainfed chickpea yield compared to 30 and 50 cm spacings, while Parihar (1) indicated that row spacings had no significant effect on seed yield under irrigated conditions. Analysis of crop growth and development can provide insight into differences between treatment inputs that affect yield (4). There are few reports on physiological aspects of chickpea growth and more research is waranted.

Materials and Methods

The response of a semi-erect kabuli chickpea line 12-60-31to inter and intra row spacings under irrigated conditions was conducted in Karaj, Iran (35?N and 51?E and elevation 1321m). There were 3 replicates in a strip-plot or split block design with 3 plant spacings (5, 7.5 and 10 cm) as the horizontal factor and 4 row spacings (30, 40, 50 and 60 cm) as the vertical factor. Sampling was carried out every 10 days in order to analyse the growth pattern from one month after sowing. For each plot the first row on each side and 30 cm from each end were considered buffers and samples were taken from the next rows and the centre 0.5 m^2 of each plot was used for final harvest. Total dry weight, leaf dry weight, leaf area index, 100-seed weight, the percentage of seed protein and grain yield per m^2 were measured. The growth indices were analysed based on growth degree day (GDD). Crop growth rate (CGR) was calculated using Watson's (5) formula, CGR = NAR *LAI. Data were analysed using STATGRAPHICS, MSTATC and QUATROPRO and treatments compared using the Duncan’s multiple range test.

Results and Discussion

Dry matter accumulation followed a sigmoid pattern with a decrease at the end due mostly to falling leaflets (Fig. 1). Similar patterns were observed for plant and row spacings, although plant spacing of 5 cm and row spacing of 30 cm showed a consistently higher accumulation over other spacings. The trends in leaf area index (LAI) versus accumulative GDD had a normal distribution and maximum LAI of 2 was observed with row spacing of 30 cm and plant spacing of 5 cm. The maximum LAI for chickpea obtained in ICRISAT was 2 (2). Low LAI could be mentioned as a reason for low grain yield in chickpea. Relative growth rate decreased linearly during the growth period and it became negative at harvest time. The trends were similar for each of the treatments. The net assimilation rate (NAR) was similar for all spacings, being nearly constant until 1200GDD and then decreasing to negative after 1600GDD. However, NAR declined more quickly in higher densities than that in lower plant densities. CGR increased initially then reached a maximum 0.6 $gm^{-2}gdd^{-1}$ at 1200 GDD, decreasing to negative after 1600 GDD. Katyar (6) reported a maximum of 72.5 $gm^{-2}wk^{-1}$ for CGR at the reproductive stage.

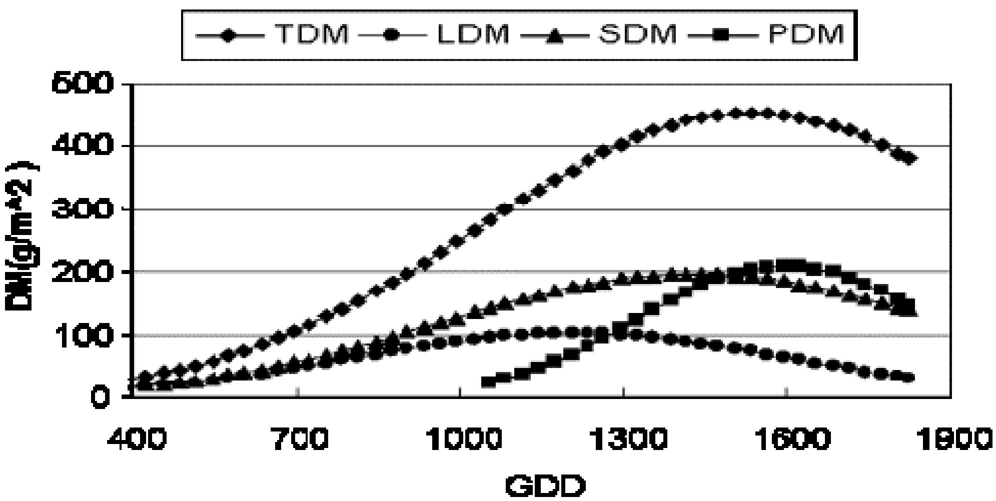

Fig. 1: The pattern of accumulation and distribution of dry matter upon growth degree day (GDD). TDM, LDM, SDM, and PDM represent total dry matter, leaf dry matter, stem dry matter and pod dry matter, respectively.

Grain yield did not vary significantly with different plant and row spacing. However, the interaction between plant and row spacings on grain yield was significant ($P < 0.05$) (Table 1). A possible reason for this is that plant density is determined by both row and plant spacings, and this experiment showed moderate densities, i.e. 40 ? 7.5 cm and 50 ? 5 cm, are the best for lines with similar growth pattern in similar climates. The number of pods per m^2 had the highest correlation with the seed yield ($r^2 = 0.66$). Therefore, by increasing the number of pods per m^2 which can be achieved through plant breeding and cropping management (e.g. by using appropriate planting spacings), grain yield can be expected to improve. The effect of the treatments on 100-seed weight and the number of seed in pod and the percentage of seed protein were not significant. It was concluded these plant traits are determined more by genetic factors than by environmental factors. Similar results have been reported in India and Syria (7).The Harvest Index (HI) varied significantly for different row and plant spacings and their interactions ($P < 0.05$). HI increased as plant and row spacings increased. The reason for that is in lower densities the number of pod per m^2 and the number of seed per pod decreased.

Conclusion

This study demonstrated that plant density affects the grain yield of chickpea. The densities of 40 ? 7.5 cm and 50 ? 5 cm are recommended for semi-erect cultivars of Kabuli chickpea in temperate areas.

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