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Yield and Quality Response of Chickpea to Different Sowing Dates

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Authors' contributions

This work was carried out in collaboration with all authors. Authors MYA, PKB, SAS, SON and RRR designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors SAS and MYA managed the analyses of the study and the literature searches. Author PKB supervised the manuscript. Author SAS edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at the Agronomy research field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from November 2015 to June 2016 to observe the effect of sowing dates on yield and quality of chickpea. The study aimed at finding out yield and quality response of two varieties of chickpea (BARI Chola-5 and BARI Chola-9), at five different sowing dates viz. November 05, November 20, December 05, December 20 and January 04. The experiment was laid out in a split-plot design with three replications. The results of two varieties revealed significant variations in days to flowering, maturity, number of grains per plant, number of seeds per grain, the weight of 1000 seeds, grain yield, stover yield, biological yield and harvest index due to different sowing dates. Early and delayed sowings affected the chickpea yield and the

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quality of grain. Physiological responses of chickpea were also greatly influenced by different sowing dates that affect the proper growth and development of chickpea plants. In case of varieties, significant variation was observed in all parameters, here, BARI Chola-9 showed better performance than BARI Chola-5. BARI Chola-9 sown on November 20 produced maximum grain yield (2.40 t/ha) and the lowest grain yield (1.23 t/ha) was found in BARI Chola-5 sown on January 04. Irrespective of variety, early and delayed sowings showed lower performance on all parameters, significantly affected the yield and quality of chickpea.

Keywords: Chickpea; sowing dates; yield and quality.

1. INTRODUCTION

Chickpea (*Cicer arietinum* L.) belongs to the Fabaceae family. It is grown over 45 countries in all continents of the world. The larger area of its adaptation is the Indian sub-continent. Two-third of the world's production of chickpea comes from Indian sub-continent [1]. Chickpea plays an important role in the agro-economy and human health of Bangladesh. Also, it is an essential crop for both human consumption and animal feed due to the presence of 17-31% protein in seeds and biological activity of its protein ranging between 52-78%. It supplies about four times as much as protein, eight times as riboflavin and equal caloric value compared to rice. Moreover, it is known as the meat of poor man [2,3]. The yield of chickpea in Bangladesh is lower than the yield of other chickpea growing countries in the world. This is mainly due to the use of low yielding varieties as well as poor management practices. Chickpea primarily being a rabi season crop is losing its cultivable area every year due to an increase of cultivation of wheat, vegetables etc. On the other hand, cultivable land area is being decreased year after year to provide habitat to the additional population. So, we have limited scope to increase the production of chickpea in Bangladesh [4,5,6]. In this situation, we have only one way to increase chickpea production by means of using high yielding varieties, adjusting planting time and using improved technologies. A number of agronomic practices have been found to influence the yield of chickpea [7,8]. Sowing time had a marked effect on yield and quality of chickpea. Optimum sowing time provides more time for growth and development of plant which is favourable for higher yield whereas both early and late sowing hinder the growth and development with lowest yield potential [9,10,11]. The early sown crop grows luxuriantly followed by less number of pods and seeds production thus limits yield. Late sowing also results in lower yield, the growth is hampered and the seed development period is shortened [12,13]. To reduce the yield losses of chickpea, seeds should be sown as early as possible, but sometimes delayed sowing may help to escape from anthracnose epidemics and unfavourable planting condition [14,15]. So, proper sowing time, a non-monetary input can help to get a higher yield of chickpea. Optimum sowing time of chickpea varies from one cultivar to another and also from one region to another due to the variation of agro-ecological conditions [16,17].

With conceiving the above scheme in mind, the present research work was undertaken with a view to fulfilling the following objectives to identify the sustainable variety and optimum sowing time for chickpea cultivation having highest yield and quality.

2. MATERIALS AND METHODS

2.1 Geographical Location of the Experimental Plot

The experiment was conducted at the central farm of the Sher-e-Bangla Agricultural University, Dhaka during the period from November 2015 to June 2016. The site was 23.5°N and 90.2°E latitude and at an altitude of 8.2 m from the sea level. The soil of the experimental plot was non-calcareous, dark gray, high land belonging to the Modhupur Tract (AEZ No-28). The soil texture was silty clay. The experimental site was medium high land. The average maximum temperature during the period of the experiment was 31.82ºC, and the average minimum temperature was 28.14°C. The landscape comprises of level upland, closely or broadly dissected terraces associated with either shallow or broad, deep valleys.

2.2 Planting Materials

"BARI Chola-5" and "BARI Chola-9", high yielding varieties of chickpea developed by Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh were used as planting materials.

2.3 Experimental Design and Layout

The experimental treatments were laid out in a split-plot design with three replications. A total number of unit plots in the experiment were 2×5×3 = 30. The unit plot size was 3.2 m × 2.0 m. The plot to plot distance was 0.5 m and block to block 1.0 m having a provision for an irrigation channel.

2.4 Preparation of Experimental land for and Fertilizer Application

The land preparation was done as per treatment. After the establishment of seedlings, various intercultural operations were accomplished for better growth and development of chickpea plants. Proper intercultural operation facilities e.g. thinning, gap filling, weeding, mulching, irrigation and drainage were provided at the right times. The plots were fertilized with urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum, $ZnSO_4$ and boric acid at the rate of 50, 90, 40, 110, 7 and 12 kg/ha respectively. The whole amount of urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum, $ZnSO_4$ and boric acid were applied at the time of final land preparation.

2.5 Harvest Index

It denotes the ratio of economic yield (grain yield) to biological yield (grain yield + stover yield) and the harvest index was calculated with the following formula (Gardner *et al*., 1985).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (grain yield)}}{\text{Biological yield (grain yield+stover yield)}} \times 100$$

2.6 Collection of Data

The data of sowing date effects on chickpea to flowering, maturity, number of grains per plant, number of seeds per grain, weight of 1000 seeds, grain yield, stover yield, biological yield and harvest index were collected on the basis of five different sowing dates viz. November 05, November 20, December 05, December 20 and January 04.

2.7 Sampling and Statistical analysis of Data

For collecting data on different yield characters of chickpea, 5 plants were selected randomly and uprooted from each plot prior to harvesting. The seed and straw yields were recorded plot-wise on 14% approximate moisture basis as t/ha. All the data collected on different yield parameters were statistically analysed using STATISTIX-10 computer package program following the analysis of variance (ANOVA) technique. The mean differences were adjudged by least significant difference (LSD) test at 5% level of significance.

3. RESULTS

This research was carried out to find out the yield and quality of chickpea varieties as affected by different sowing dates. The data on yield attributes and quality parameters were recorded. The results have been presented and interpreted in different graphs and tables given under the following headings.

3.1 Effect of Sowing Date to Flowering and Maturity

Days to flowering and maturity showed a non-significant difference between two chickpea varieties in this study. To flowering and mature BARI Chola-9 required 67.20 days and 106.2 days respectively, where BARI Chola-5 required 66.86 days for flowering and 103.53 days for maturity.

Results revealed that delayed in sowing significantly affected the days to flowering and maturity. It was found that maturity date was decreased with late sowing date. Early sowing of November 05 required maximum days to flowering 75.50 days and maturity 119.67 days of chickpea. The minimum days to flowering 60.50 days and maturity 89.33 days were found for sowing on January 04. Delayed sowing reduced the time to flowering and maturity due to high temperature during the vegetative growth stage.

3.2 Effect of Sowing Date to the Number of Grains per Plant and Number of Seeds per Grain

A total number of grains per plant and seeds per grain of chickpea were differed due to its varietal effect. The highest number of grains per plant (21.37) and seeds per grain (1.19) were obtained from BARI Chola-9 where the lowest number of grains per plant (19.15) and seeds per grain (1.17) were obtained from BARI Chola-5.

The number of grains per plant and seeds per grain was significantly affected by several sowing dates. Delayed sowing gradually decreased the number of grains and seeds of chickpea. The maximum number of grains per plant (24.7) was found on November 05 and seeds per grain (1.38) was recorded from December 05. The lowest number of grains per plant (15.5) was recorded from January 04 and seeds per grain (1.1) was found from December 20. Higher temperature during grain filling stage might be the possible reason of a lower number of grains per plant and seeds per grain of chickpea with delayed sowing.

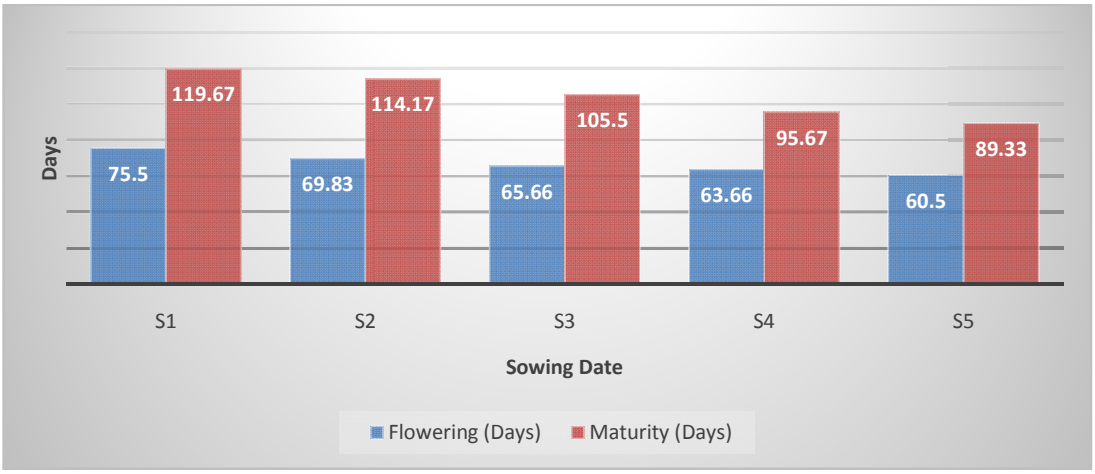

Fig. 1. Effect of sowing dates to flowering (LSD $_{(0.05)}$ 2.17) maturity duration (LSD $_{(0.05)}$ 3.89) of chickpea

S_1- November 05; S_2- November 20; S_3- December 05; S_4- December 20; S_5- January 04

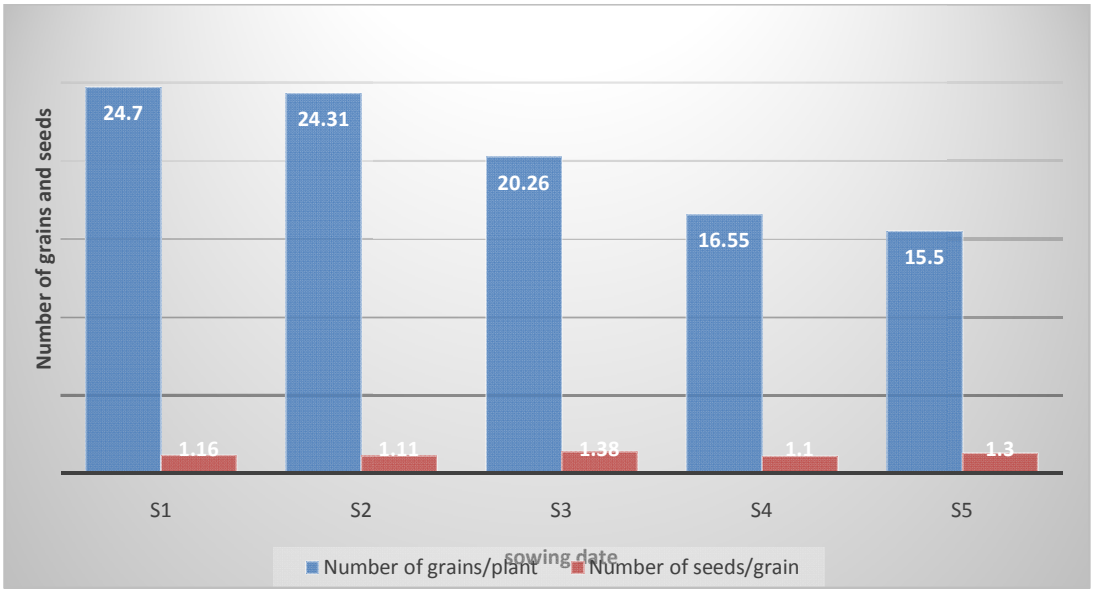

Fig. 2. Effect of sowing dates to number of grains per plant (LSD $_{(0.05)}$ 1.96) and seeds per grain (LSD $_{(0.05)}$ 0.19) of chickpea

S_1- November 05; S_2- November 20; S_3- December 05; S_4- December 20; S_5- January 04

Table 1. Effect of variety on flowering duration and maturity duration of chickpea at different DAS

Variety	Flowering duration (days)	Maturity duration (days)	Grains per plant	Seeds per grain
BARI Chola-5	66.86	103.53	19.15 b	1.19
BARI Chola-9	67.20	106.20	21.37 a	1.17
LSD $_{(0.05)}$	NS	NS	1.42	NS
CV (%)	3.14	8.19	4.46	8.94

NS: Non-significant

3.3 Effect of Sowing Date to 1000 Seeds Weight

Statistically significant differences were found for a weight of 1000 seeds of chickpea due to varietal effect. The highest weight of 1000 seeds (222.50 g) was recorded from BARI Chola-9 whereas the lowest weight of 1000 seeds (121.27 g) was observed from BARI Chola-5.

A weight of 1000 seeds of chickpea was differed non-significantly due to several sowing times. Results showed that the maximum weight of 1000 seeds (178.17g) was recorded from November 20 whereas the minimum weight of 1000 seeds (166.00 g) was found from January 04. The 1000 seeds weight was probably decreased due to delay in sowing because the chickpea plants may not have got sufficient time to increase the seed size sufficiently because of longer photoperiod and higher temperature.

3.4 Effect of Sowing Date to Grain Yield, Stover Yield and Biological Yield of Chickpea

Findings revealed that a varietal effect of chickpea in respect of grain yield, stover yield and biological yield were significant. The highest grain yield (2.09 t/ha), stover yield (4.39 t/ha) and biological yield (6.48 t/ha) were found by BARI Chola-9, where BARI Chola-5 produced the lowest seed yield (1.67 t/ha), stover yield (3.58 t/ha) and biological yield (5.25 t/ha).

Grain yield, stover yield and biological yield of chickpea were varied significantly due to sowing date. It was observed that grain yield, stover yield and biological yield of chickpea were gradually decreased with the delay in sowing. The highest grain yield (2.18 t/ha), stover yield (4.57 t/ha) and biological yield (6.75 t/ha) were observed from November 20 and the lowest grain yield (1.53 t/ha), stover yield (3.43 t/ha) and biological yield (4.95 t/ha) were found in January 04. Lower grain yield of chickpea for delayed sown might be due to the shorter grain filling period as a result of higher temperatures at grain filling stage.

3.5 Effect of Sowing Date to Harvest index

Significantly variation was observed for harvest index between the two varieties of chickpea. The highest harvest index (32.30%) was exerted by BARI Chola-9, where BARI Chola-5 produced the lowest harvest index (31.51%).

The time of sowing significantly influenced harvest index of chickpea. The highest harvest index (32.64%) was observed on December 05. The lowest harvest index (30.66%) was found on January 04. Early sowing of chickpea produced higher harvest index due to more number of grains per plant.

Table 2. Effect of variety on 1000 seeds weight (g), grain yield (t/ha), stover yield (t/ha), biological yield (t/ha) and harvest index of chickpea

Variety	1000 seeds weight (g)	Grain yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
BARI Chola-5	121.27 b	1.67 b	3.58 b	5.25 b	31.51 b
BARI Chola-9	222.50 a	2.09 a	4.39 a	6.48 a	32.30 a
LSD $_{(0.05)}$	6.69	0.04	0.15	0.19	0.29
CV (%)	2.56	2.38	1.31	2.04	0.59

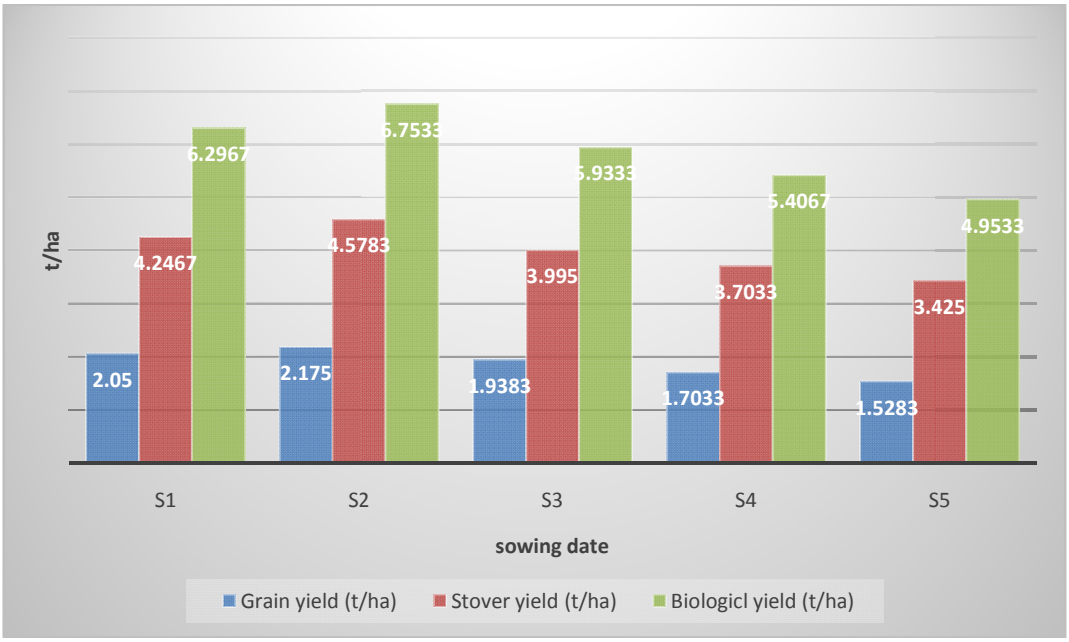

Fig. 3. Effect of sowing dates to grain yield (LSD $_{(0.05)}$ 0.03), stover yield (LSD $_{(0.05)}$ 0.07) and biological yield (LSD $_{(0.05)}$ 0.09) of chickpea

S_1- November 05; S_2- November 20; S_3- December 05; S_4- December 20; S_5- January 04

4. DISCUSSION

Maximum yield in November 20 sowing was a result of a favourable climatic condition which provided the suitable vegetative and reproductive growth stages for chickpea plant. November 20 sowing increased seeds weight and seed yield of chickpea compared to early and late sowing and this result was due to the moderate temperature regime during the grain filling stages [18]. Chickpea sown on 20th November produced highest grain yield. The lower number of 1000-seed weight and seed yield in early and late sowing dates was due to the encounter of flowering and fertilisation stages with high and low temperatures respectively [19]. The higher yields given by the 20th November sown chickpea, as compared to others sowing dates seem to be the result of better grain yield of a favourable growth period. Under the low temperate, frost could be harmful to sowing, because it usually occurs during the early stages of vegetative growth [20]. The results of two varieties revealed, BARI Chola-9 sown on 20th November showed better performance than BARI Chola-5 sown on 04th January in days to flowering, maturity, number of grains per plant, number of seeds per grain, weight of 1000 seeds, grain yield, stover yield, biological yield and harvest index.

The demand of chickpea is being increased in Bangladesh day by day. But the yield and quality of chickpea is very low due to its traditional agronomical practices [21]. Besides, lack of high yielding varieties, very early and delayed sowing dates are also responsible factors to yield loss. Cropping patterns of chickpea are being changed due to a drastic change of climate [22]. The breeders should work more on the evaluation of high yielding varieties of chickpea. The growers are also advised to plant high yielding varieties on optimum sowing date with proper cultivation practices and thus the yield and quality of chickpea may be increased.

5. CONCLUSION

A general trend was observed that early and delayed in sowing dates decreased the average yield and quality of chickpea. BARI Chola-9 showed better performance than BARI Chola-5. Both early and delay sowing affected the chickpea plant growth, yield and grain quality. Maximum results were found in case of sowing date November 20 than others, where the minimum results were observed by January 04. Interaction of variety and sowing date significantly affected the grain yield. BARI Chola-9 sown on November 20 produced maximum grain yield where BARI Chola-5 sown on January

04 produced minimum grain yield. Further research should be conducted on other agro-ecological zones of Bangladesh with varying sowing dates.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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