EUROPEAN ACADEMIC RESEARCH
Vol. III, Issue 6/ September 2015

ISSN 2286-4822
www.euacademic.org

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

Variety and Sowing Time on the Growth and Yield of Chickpea *(Cicer arietinum* L.*)* in Southern Region of Bangladesh

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Abstract:

Experiment was conducted at the Field Laboratory of Agronomy Department, Patuakhali Science and Technology University, Patuakhali during the period from November 2012 to March 2013 to find out the effect of variety and sowing time on the yield performance of chickpea. The experiment was carried out with two varieties BARI Chola 2 and BARI Chola 4 three sowing time 10

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November, 20 November and 30 November. The experiment was laid out in RCBD design with four replications. Varietal effect was significantly influenced the morpho-physiological, yield and yield contributing characters of chickpea. The BARI Chola 4 at 90 days after sowing produced the highest plant height, branches per plant, canopy coverage and pods plant^{-1}, seeds pod^{-1}, TDM, 100-seed weight, seed yield, stover yield, biological yield and harvest index than BARI Chola 2. Sowing time significantly influenced all characteristics of the study. Sowing on 20 November produced highest plant height, branches, canopy coverage, TDM, 100-seed weight, seed yield, stover yield, biological yield and harvest index than 10 November. Interaction effect was also significantly influenced all characters where 20 November sowing BARI Chola 4 recorded the highest plant height (42.08 cm), branches per plant (27.45), canopy coverage (2891.94 cm^2), pods per plant (88.95), seed yield (2010.60 kg ha^{-1}), total dry matter per plant (8.94 g), stover yield (2515.80 kg ha^{-1}), biological yield, harvest index than other combinations. So, BARIChola 4 to be sown on 20 November for obtaining the higher yield of chickpea.

Key words: Chickpea, Variety, Sowing time and Yield

Introduction

Chickpea ***(****Cicerarietinum*L.*)* is the third most important food legume worldwide grown in 11 million ha with *9* million ton production. It is grown over *45* countries in all continent of the world. It is adapted to relatively cooler climates. The largest area of its adaptation is the Indian sub-continent. Two-thirds of world production of chickpea comes from Indian sub-continent. Among the pulse crops in Bangladesh, chickpea ranks third in terms of area contributing around 12% of total pulse production of the country (BBS, 2000). Chickpeas are a popular and profitable pulse crop obtains for the northern grains region. They are adapted to the heavier alkaline soil types of the region and are able to tolerate relatively high temperature during the flowering and grain filling period. They contribute to the

profitability of northern farming system through the ability to fix nitrogen for both winter and summer cereal crops. The two major constraints to chickpea production in the northern cropping region are disease and frost damage (Whish *et al.* 2007). In both cases, sowing date can be used as a strategy to influence yield through avoidance of cold temperatures during flowering and to reduce the effect of disease. The optimal time to sowing chickpea will depend on the interaction between the environment and the available varietal germplasm. Current chickpea varieties have excellent frost tolerance whilst in the vegetative stage, but conversely display one of the highest temperature thresholds for seed set among cool season (winter) pulse crops. Mean daily temperature of less than 15°C has been shown to cause flower abortion (Clarke & Siddique, 2010). The optimum sowing date results in flowering of chickpea when the risk of cold temperatures is low, and it is especially important to avoid frost during flowering, which can kill chickpea plants (Whish *et al.* 2007). Optimum sowing time can also be a compromise between maximising yield potential and minimising disease levels. The time of sowing a crop is a critical factor in determining the environmental conditions at planting, anthesis, pod-filling and drying. Therefore, sowing date can be important in determining the success of the crop and in maximizing seed yield (Dapaah *et al.* 2000). Earlier sowing can expose the crop to more rain events which can increase the risk of Ascochyta disease. It will also increase crop biomass, increasing the risk of Botrytis grey mold (BGM) and soil moisture deficit during grain filling. Later sowing can result in shorter plants (harvesting difficulties) and increased heliothis pressure, but may reduce vegetative water use and reduce the exposure to Ascochyta and Phytophthora infection events and lessen the risk of Botrytis grey mold (BGM) (Matthews & McCaffery, 2011). Chickpea is grown in Bangladesh as rainfedrabi crop on receding soil moisture. The amount of rainfall in this season is negligible, which cannot meet the

evapo-transpirational demand of the crop. So the crop suffers from soil moisture deficit at later stages. Water deficits reduce growth and yield (Castellanos *et al.* 1996; Anwar *et al.* 2003a; Thomas *et al.* 2004). Drought is the single most important factor threatening the food security of the peoples of the developing world and the single most important stress in legumes including chickpea. High sensitivity to drought at reproductive stage, particularly at flowering stage and at pod filling stage appears to cause significant loss in yield. The crop need water for their growth and development. The potential yield of chickpea is 4800 kg/ha (BARI, 1998) but the average yield in Bangladesh is only 732 kg/ha (BBS, 2000). The low yield of the crop is characterized by several biotic and abiotic factors. The mid-November is considered to be the optimum time for sowing in Bangladesh except in Barind Tract (Rashid *et al*. 1999). Though chickpea is considered as a drought tolerant crop, it suffers from soil moisture stress during the later period of crop growth. The problem aggravates further if sowing time is delayed beyond the optimum sowing time. Yield loss in chickpea can vary between 30% and 60% depending on variety, location and climatic conditions during sowing season. Similar losses have been reported from other warm winter site in India (Palled *et al*., 1985). Morphological, phenological characters associated with drought tolerance in chickpea are early maturity, early growth vigor, fast ground coverage, large seed size and root growth habit. These are earliness to escape from drought and desiccation avoidance through reduced transpiration loss and increased water uptake (Murshed, 2000). Proper understanding of this relationship could be vital for future yield improvement of chickpea in late sown areas of the country.

Keeping these is aimed the present experiment was taken with following objectives: i) To study the varietal differences growth, yield and yield attributes point of view. ii) To determine the optimum sowing time of comparable yield of

chickpea. iii) To assess the confirmed effect of variety and sowing time for maximum yield of chickpea.

Materials and Methods

The field experiment was conducted at the Field Laboratory of the Department of Agronomy, Patuakhali Science and Technology University, Patuakhali during the period of November 2012 to March 2013 to study on yield and yield contributing characters of chickpea varieties including three sowing times in coastal region of Bangladesh. Geographically, the research farm is located at $22^0 37'$ N latitude and $89^0 10'$ E longitudes. The maximum area is covered by Ganges Tidal Floodplains and falls under Agro Ecological Zone "AEZ 13" (UNDP and FAO, 1988). The area lies at 0.9 to 2.1 meter above mean sea level (Iftekhar & Islam, 2004). This region occupies a vast area of tidal floodplain land in the south–western part of Patuakhali district. The land type of the experiment field was low as because it was situated about 1.5 m above the sea level. The area is covered by tropical climate which is characterized by high temperature, high humidity, heavy precipitation during April to October and relatively low temperature and low rainfall with low humidity from October to February. The field of the experimental site belongs to the Ganges Tidal Floodplain (AEZ 13) which was characterized by non-calcareous Grey Floodplain soil with silty clay loam. The soil was mildly alkaline and non-saline. The soil was well drained and medium high. The soil was loam in texture and having soil P^H ranges from 5.50 to 6.50. Organic matter content was low (1.1%). The experiment consisted of two chickpea varieties and three sowing time and was laid out in a randomized complete block design with four replications. The size of each plot was 10 m^2 (4 × 2.5 m) where replication to replication distance was 1 m and plot to plot distance was 50 cm, respectively. Row to row distance was 40 cm and seed to seed distance was 10 cm,

respectively. So, the total plots were 24. Factor A: Variety (Two) BARI Chola 2 and BARI Chola 4. Factor B: Sowing time (Three) the seed were sown on three sowing dates. They were 10 November, 20 November and 30 November, 2012. Seed of the selected two chickpea varieties i.e. BARI Chola 2 and BARI Chola 4 were collected from Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur on 4th November, 2012. The land was finely tilt with power tiller during first week of November, 2012. The clods were broken and the land was leveled with tiller ladder. The weeds and stubble were removed. During final land preparation N, P and K at the rate of 40-50, 80-90 and 30-40 kg/ha were added respectively as Urea, TSP and MOP. Besides, well decomposed cow dung was also incorporated. Before sowing seeds were treated with Vitavax-200 @ 3 g/kg seed.Plots were laid out in the field following randomized complete block design on 9th November, 2012. Ails, drains and channels were made according to the layout. After germination of plants were thinned out in the early seedling stage at 15 days after sowing (DAS) to give uniform plant stand. Crops were infested with different species of weeds. So weeding of different plots was done at two times to keep the plots weed free. At 30 and 45 days after sowing first and second weeding were done to control weeds and to break the soil crust. The irrigation was done at different times during study. Irrigation water was applied at vegetative growth and pod formation stage. Proper drainage system was also developed for draining out excess water. Proper crop protection measures were taken during the entire course of crop production. The crop was infested by the pod borer at the flowering stage were successfully controlled by application of Ripcord 60EC @ 2ml/kg. The crop was harvested at their full maturity when all the plants and pods became turned into brown color. The harvested crop of each plot was bundled separately and tagged properly. Seeds and other plant parts were separated for collecting the data. Separated seeds, straw and other parts of

chickpea were also dried in sun and the plot wise data were recorded. Seed were separated from pods and weighed. Data was collected on different crop and yield contributing characters as follows: Plant height (cm), Total number of branch plant^{-1}, Total dry matter (g), Canopy coverage (cm^2), Number of pod plant^{-1}, Number of seeds pod^{-1}, Yield plant^{-1} (g), 100- seed weight (g), Stover yield (kg ha^{-1}), Biological yield (kg ha^{-1}), Seed yield (kg ha^{-1}), Harvest index (%). The recorded data for different parameters were compiled and tabulated in proper form for statistical analysis. Analysis of variance was done with the help of computer software package MSTAT-C program. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test (DMRT) at 5% level. (Gomez and Gomez, 1984).

Result and Discussion

A. Crop Characters

Plant height

Considerable varietal difference was observed in plant height. At different days after sowing (45, 60, 75 and 90 DAS) the maximum (25.73 cm, 35.78 cm, 37.15 cm and 38.54 cm respectively) plant height was obtained from BARI Chola 4 while the minimum (24.84 cm, 34.38 cm, 35.72 cm and 36.83 cm respectively) was recorded from BARI Chola 2 (Fig 1).

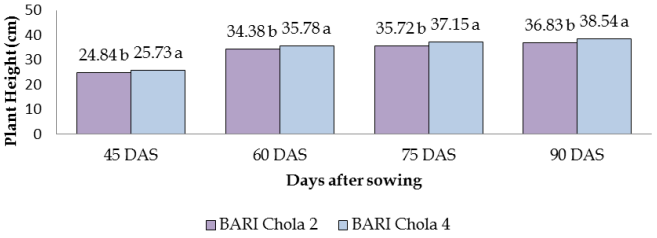

Fig. 1. Effect of variety on plant height at different days after sowing ($S_{\bar{x}}$ = 0.18, 0.26, 0.27, and 0.37 at 45, 60, 75 and 90 days after sowing respectively)

Variation among the varieties in respect of plant height appears due to genotypic variation. The results agreed with Kabir *et al*. (2009) who found highest plant height (32.30 cm) in BARI Chola 4 and lowest (30.90 cm) in BARI Chola 2. The tallest plants (27.09 cm, 37.26 cm, 38.88 cm and 40.69 cm, respectively) at different days after were observed in 20 November sowing which was statistically differed from other sowing times. On the other hand, 10 November obtained the shortest plant (23.67 cm, 32.67 cm, 34.15 cm and 35.14 cm) at 45, 60, 75 and 90 days, respectively which were statistically identical. These results revealed that time of sowing plays an important role for obtaining the higher growth where later sowing provides optimum growing conditions for obtaining the higher growth of chickpea plant. The cause of variation in plant height might be due to variation in sowing time (Fig 2).

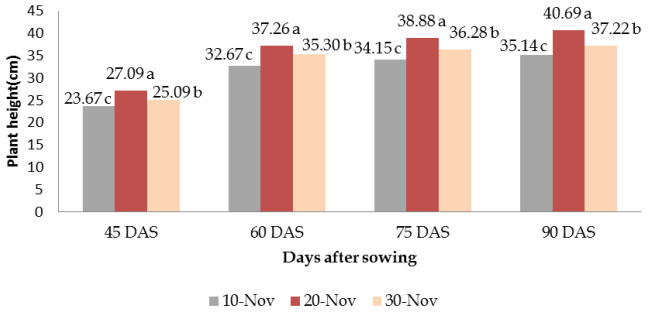

Fig. 2. Effect of sowing time on plant height at different days after sowing ($S_{\bar{x}}$ = 0.22, 0.32, 0.34 and 0.45 at 45, 60, 75 and 90 days after sowing respectively)

The results are in conformity with the results of Aziz *et al. (*1994) who noted reduced plant height with late sowing. Plant height varied significantly for the interaction effect of variety and sowing time at different days after sowing (DAS)**.** At 45 DAS the maximum (27.48 cm) plant height was obtained from the combination of BARI Chola 4 and 20 November sowing time which was statistically similar with the combination of BARI Chola 2 and 20 November sowing time (26.70 cm) while the

minimum (23.08 cm) was recorded from the combination of BARI Chola 2 and 10 November sowing time. The maximum (37.83 cm) plant height was recorded from the combination of BARI Chola 4 and 20 November sowing time which was statistically similar with the combination of BARI Chola 2 and 20 November sowing time (36.70 cm) and the minimum (31.65 cm) was found from the combination of BARI Chola 2 and 10 November sowing time at 60 DAS. At 75 DAS the maximum (39.78 cm) plant height was recorded from the combination of BARI Chola 4 and 20 November sowing time and the minimum (33.42 cm) plant height was observed in the combination of BARI Chola 2 and 10 November sowing time. At 90 DAS the maximum (42.08 cm) plant height was recorded from the combination of BARI Chola 4 and 20 November sowing time, while the minimum (34.47 cm) plant height observed in the combination of BARI Chola 2 and 10 November sowing (Table 1). The result showed that the plant height decreased when it was not sown in optimum time. The results are in conformity with the results obtain from Bahl, (1983) who found variable in plant heights of chickpea with treatments of sowing time x variety.

Table.1. Interaction effect of variety and sowing time on plant height at different days after sowing

Interactions	Plant height at different days after sowing			
	45 DAS	60 DAS	75 DAS	90 DAS
V_1 X S_1	23.08 d	31.65 e	33.42 e	34.47 d
V_1 X S_2	26.70 a	36.70 ab	37.97 b	39.30 b
V_1 X S_3	24.75 bc	34.80 cd	35.75 cd	36.70 c
V_2 X S_1	24.27 c	33.70 d	34.88 d	35.80 cd
V_2 X S_2	27.48 a	37.83 a	39.78 a	42.08 a
V_2 X S_3	25.42 b	35.80 bc	36.80 bc	37.75bc
$S_{\bar{x}}$	0.3078	0.4483	0.4738	0.6317
CV (%)	2.43%	2.56%	2.60%	3.35%

V_1= BARI Chola 2, V_2 = BARI Chola 4,
S_1 = 10 November, S_2 = 20 November, S_3 = 30 November

Number of branch

Varieties varied among themselves in case of number of branches per plant (Fig 3). The highest number of branches per plant (6.90, 17.40, 19.13 and 20.32) was observed in BARI Chola 4 and the lowest (6.00, 14.47, 16.05 and 17.05) was observed in BARI Chola 2 at different days (45, 60, 75 and 90 DAS). The results are in agreement with that of Sharma *et al.*(1988) and Dixit *et al.*(1993) who found that varietal differences in number of branches.

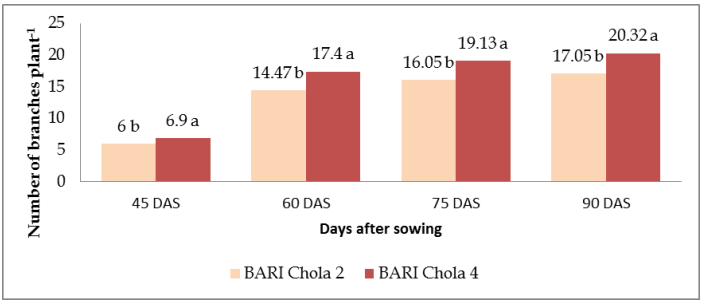

Fig. 3. Effect of variety on number of branch at different days after sowing ($S_{\bar{x}}$ = 0.21, 0.86, 0.86 and 0.72 at 45, 60, 75 and 90 days after sowing respectively)

Sowing time affect the number of branches significantly. The crop which was sown on 20 November showed the highest number of branches per plant (8.35, 21.13, 22.88 and 24.00 respectively) while 10 November showed the lowest (4.93, 11.30, 13.05 and 14.32) at different days after sowing (45, 60, 75 and 90 DAS) respectively (Fig 4).

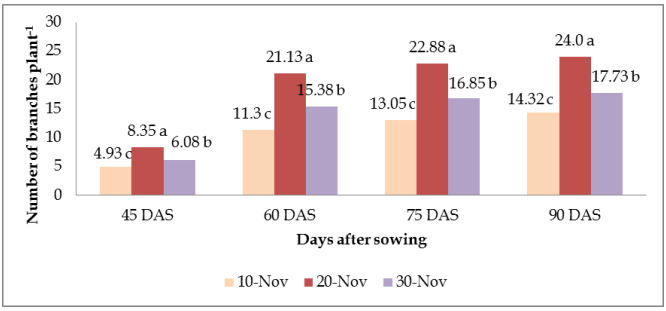

Fig. 4. Effect of sowing time on number of branch at different days after sowing ($S_{\bar{x}}$ = 0.26, 1.05, 1.06 and 0.88 at 45, 60, 75 and 90 days after sowing respectively)

The results are in agreement with that of Dixit *et al.*(1993) and Nawaz *et al.* (1995) who observed similar. Number of branches per plant affected due to the interaction between variety and sowing time. In present experiment the highest number of branches per plant (9.15, 23.55, 26.00 and 27.45) obtained from the combination of BARI Chola 4 and 20 November sowing time while the lowest (4.70, 10.10, 12.40 and 13.85) observed in the combination of BARI Chola 2 and 10 November sowing time at 45, 60, 75 and 90 DAS, respectively (Table 2). These results revealed that optimum time sown crop showed better performance to produce more branches than early and late sowing under irrigated condition. Similar results were also noted by Main *et al*. (2001) who reported that 20 November sowing performed better than early sowing.

Table. 2. Interaction effect of variety and sowing time on number of branch at different days after sowing

Interactions	Number of branch at different days after sowing			
	45 DAS	60 DAS	75 DAS	90 DAS
V_1 x S_1	4.70 d	10.10 d	12.40 d	13.85 d
V_1 x S_2	7.55 b	18.70 b	19.75 b	20.55 b
V_1 x S_3	5.75 cd	14.60 bcd	16.00 bcd	16.75 bcd
V_2 x S_1	5.15 d	12.50 cd	13.70 cd	14.80 cd
V_2 x S_2	9.15 a	23.55 a	26.00 a	27.45 a
V_2 x S_3	6.40 c	16.15bc	17.70bc	18.70bc
$S_{\bar{x}}$	0.3691	1.487	1.493	1.239
CV (%)	11.45%	18.66%	16.98%	13.26%

V_1= BARI Chola 2, V_2 = BARI Chola 4

S_1 = 10 November, S_2 = 20 November, S_3 = 30 November

Canopy coverage

Between the varieties, the highest canopy coverage (1109.84 cm^2, 1968.42 cm^2, 2361.69 cm^2 and 2361.69 cm^2) was observed in BARI Chola 4 and the lowest (983.77 cm^2, 1687.90 cm^2, 2063.62 cm^2 and 2063.62 cm^2) was observed in BARI Chola 2 at different DAS (45, 60, 75 and 90 DAS, respectively) (Fig 5).

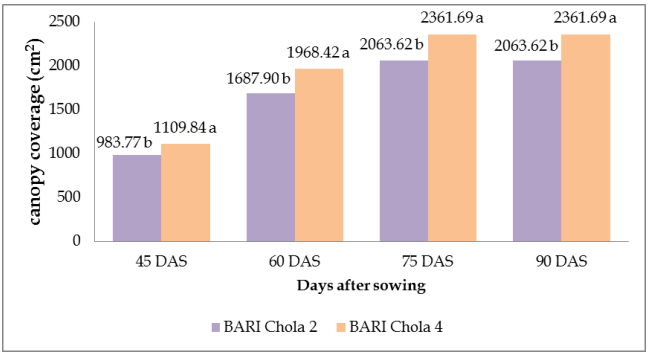

Fig. 5. Effect of variety on canopy coverage at different days after sowing ($S_{\bar{x}}$ = 47.37, 63.43, 50.88 and 50.88 at 45, 60, 75 and 90 days after sowing respectively)

This phenomenon can be explained by genotypic variation of the crop. Canopy coverage showed considerable variation due to variation in sowing time (Fig 6). The highest canopy coverage (1387.42 cm², 2244.75 cm², 2644.39 cm² and 2644.39 cm²) was observed in BARI Chola 4 and the lowest (726.40 cm², 1438.71 cm², 1769.61 cm² and 1769.61 cm²) was observed in BARI Chola 2 at different DAS (45, 60, 75 and 90 DAS, respectively).

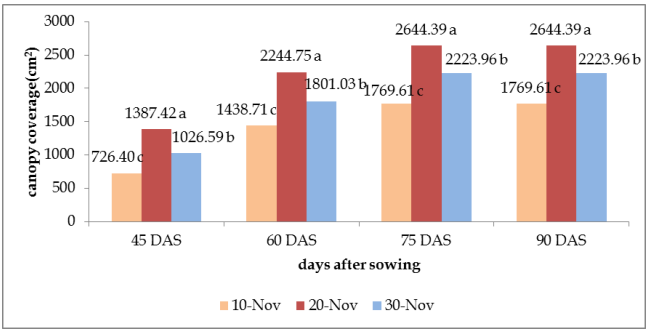

Fig. 6.Effect of sowing time on canopy coverage at different days after sowing ($S_{\bar{x}}$ = 58.62, 78.29, 63.31 and 62.33 at 45, 60, 75 and 90 days after sowing respectively)

It was reported earlier that chickpea variety with great canopy growth used more water rapidly until the soil profile is depleted and water deficit before flowering decreased canopy

development (Singh *et al.* 1986). Canopy coverage was significantly affected by interaction of variety and sowing time. Maximum canopy coverage (1516.83 cm^2, 2508.41 cm^2, 2891.34 cm^2 and 2891.34 cm^2) was found in BARI Chola 4 which was sown at 20 November. When, minimum canopy coverage (694.99 cm^2, 1354.28 cm^2, 1632.94 cm^2 and 1632.94 cm^2) was found in BARI Chola 2 which was sown at 10 November at 45, 60, 75 and 90 DAS, respectively (Table 3).

Table.3. Interaction effect of variety and sowing time on canopy coverage at different days after sowing

Interactions	Canopy coverage at different days after sowing			
	45 DAS	60 DAS	75 DAS	90 DAS
V_1 X S_1	694.99 e	1354.28 d	1632.94 d	1632.94 d
V_1 X S_2	1258.02 b	1981.08 b	2397.45 b	2397.45 b
V_1 X S_3	998.31 cd	1728.35 bc	2160.47 bc	2160.47 bc
V_2 X S_1	757.82 de	1523.14 cd	1906.29 c	1906.29 c
V_2 X S_2	1516.83 a	2508.41 a	2891.34 a	2891.34 a
V_2 X S_3	1054.88 bc	1873.71 b	2287.46 b	2287.46 b
$S_{\bar{x}}$	82.05	110.7	88.12	88.12
CV(%)	15.68%	12.11%	7.97%	7.97%

V_1= BARI Chola 2, V_2 = BARI Chola 4

S_1 = 10 November, S_2 = 20 November, S_3 = 30 November

Total dry matter production

Total dry matter (TDM) is the product of crop growth rate (CGR) and growth duration of plant (Takana, 1983). A significant variation was found due to the effect of chickpea varieties in respect of total dry matter (TDM) production (Fig. 7).

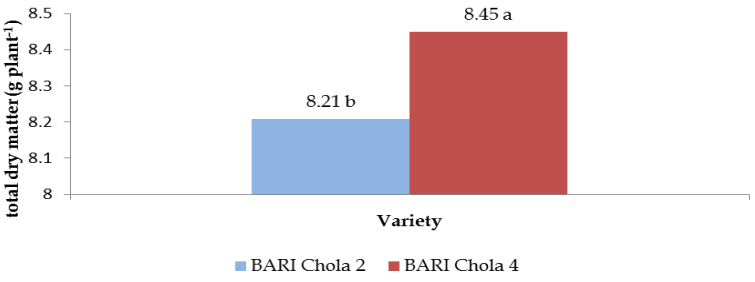

Fig.7.Effect of variety on total dry matter production ($S_{\bar{x}}$ =0.07)

BARI Chola 4 showed the highest TDM (8.45 g plant^{-1}) than BARI Chola 2 (8.21 g plant^{-1}). The results are in confirmative with (Kabir *et al.* 2009) who found that the variety BARI Chola 4 had tallest vegetative growth period and best in dry matter production compared to BARI Chola 2 and BARI Chola 6. The results revealed that total dry matter was significantly affected by sowing dates (Fig. 8).

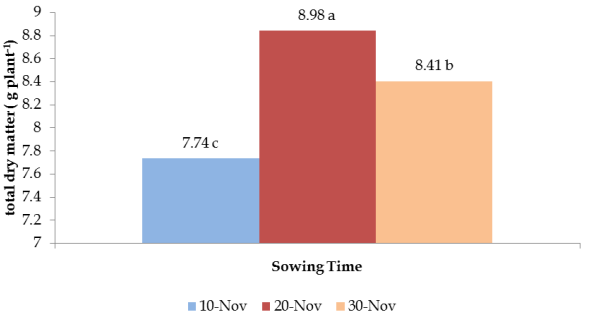

Fig.8. Effect of sowing time on total dry matter production ($S_{\bar{x}}$ =0.09)

Among the sowing time, the higher weight of total dry matter (8.84 g plant^{-1}) was found in 20 November sowing while 10 November sowing recorded the lowest total dry matter (7.74 g plant^{-1}). The result was in confirmation with the findings of (Biscoc and Gallge, 2005) who observed that early sowing significantly increased total dry matter production over late sowing. The interaction effect of variety and sowing time also showed significant difference in total dry matter production. Interaction effect of variety and sowing time was significantly influenced on the production to total dry matter production (Table 4). The TDM production had higher (8.98 g plant^{-1}) 20 November sowing of BARI Chola 4 under irrigation condition which was statistically identical with both the interaction effect of the same variety in early and late sowing (7.84 g and 8.53 g plant^{-1} respectively). Similarly, early sowing (10 November) of BARI Chola 2 recorded the lowest total dry matter (8.70 g plant^{-1}) which was also statistically similar in 20 and 30

November sowing of BARI Chola 2 (7.64 g and 8.29 g plant^{-1} respectively).

Table.4. Interaction effect of variety and sowing time on total dry matter production

Interactions	Total dry matter (g plant^{-1})
V_1 X S_1	7.64 d
V_1 X S_2	8.70ab
V_1 X S_3	8.29 c
V_2 X S_1	7.84 d
V_2 X S_2	8.98 a
V_2 X S_3	8.53bc
$S_{\bar{x}}$	0.1204
CV (%)	12.90%

V_1= BARI Chola 2, V_2 = BARI Chola 4S_1 = 10 November, S_2 = 20 November, S_3 = 30 November

B. Yield and yield contributing characters

Pods plant^{-1}

A considerable difference was observed in case of pods/plant between the two chickpea varieties under irrigated condition. The highest number of (62.57) pods/plant was found in BARI Chola 4. The lowest (50.12) pods were found in BARI Chola 2 (Table 5). However, BARI Chola 2 and BARI Chola 4 did differ from pods /plant. The variation in number of pods plant^{-1} was found due to the variation of branch production and also the genetic variations. Similar findings were also formed by Hussain*et al*., (2008) who studied on growth and yield response of two chickpea (*Cicerarietinum*L.) varieties. They also reported that the BARI Chola 4 gave better result as compare to BARI Chola 2 under irrigated condition. Similar findings were also found by Kabir and Sarkar, (2008) in chickpea. Considerable variation in number of pods/plant was found as the sowing time was early and the usual trend was the decrease in pod number with delay in sowing. The highest number of pods plant^{-1} (75.63) was obtained in case of sowing on 20 November. The lowest pods plant^{-1} (42.20) found in the plant that was sown in

10 November and statistically identical, with 30 November sowing. So, variation in sowing time beyond optimum was found to decrease the number of pods per plant and it was also reported earlier by Dixit *et al.,* (1993) and Siddique and sedgley, (1986). The reason might be explained by the fact that high moisture stress stages of crop growth in low temperature decrease in photosynthetic activity. It was also evident from earlier findings under this study that reproductive duration decreased as the sowing time was delayed beyond optimum (Table 7). There was a significant variation in terms of pods per plant due to interaction between variety and sowing time (Table 9). The highest number of pod plant^{-1} (88.95) was recorded from BARI Chola 4 along with 20 November sowing which was significantly higher over all other combinations. The lowest number of pods per plant (39.25) was observed in BARI Chola 2 sown on 10 November at per with V_2S_1, V_1S_3, $V2S_3$.

Seeds pod^{-1}

Difference existed in case of seeds per pod between the two chickpea varieties. The highest number of seeds per pod was found (1.35) in BARI Chola 4. The lowest number of seeds per pod was found (1.32) in BARI Chola 2 (Table 5). This difference might be due to different genetic potential of the varieties and in this regard BARI Chola 4 might be considered the best variety between the two varieties. This variation was found due to the variation of the varietal characteristics in this study. Variation in sowing time affects the number of seeds per pod appreciable (Table 7). The highest number of seeds per pod was found in (1.37) 20 November sowing. The lowest number of seeds per pod was found (1.310) in 10 November sowing. It was also evident that the number of seeds per pod decreases considerably after 20 November sowing. Results revealed that the number of seeds per pod varied due to the influence of different sowing time. The results are in agreement with that of Ageeb *et al*. (1976) also findings that the number of seeds per

pod was the component that was least affected by sowing dates. Interaction effect of variety and sowing time appeared significant (Table 9). The highest number of seeds per pod was found (1.41) in the combination of BARI Chola 4 and 20 November sowing. The lowest number of seeds per pod was found (1.30) in the combination of BARI Chola 2 and 30 November sowing.

Hundred seed weight (g)

Results showed a considerable variation in 100 seed weight among the varieties under irrigated condition. The BARI Chola 4 produced the heaviest seeds (13.89 g /100 seed), which was significant1y different over that of BARI Chola 2. BARI chola 2 produced the lightest seed (13.36 g /100 seed) (Table 5). This variation in 100 seed weight can be attributed to genetic makeup of the varieties. Kabir and Sarkar, (2008) found similar results in chickpea. They said that the variation in 100 seed weight of the varieties of chickpea might be due to their different genetic characteristics. Hundred seed weight was formed significantly variable due to sowing time variation (Table 7). The maximum 100 seed weight (14.09 g) was recorded from 20 November sowing followed by 30 November sowing (13.51 g). The minimum 100 seed weight (13.27g) was obtained from 10 November sowing which was at per with 20 November sowing. These results could be justified by the earlier findings of Singh *et al.*(1986) who reported that there was no effect of delayed sowing on 100 seed weight. The results are in agreement with that of Nanda *et al.* (1992) reported that under moisture deficit condition seed weight of chickpea increased. Nawaz *et al.*(1995) also reported 100-seed weight was not significantly influenced by the sowing time. Weight of 100 seed was significantly influenced by the interaction effect of chickpea varieties and different sowing time (Table 9). The highest weight of 100 seed (14.66 g) was obtained by the interaction effect of the variety BARI Chola 4 and 20 November which was

statistically identical with similar variety when sown 30 November (14.27g) and 10 November (13.80 g). Similarly, the lowest weight of 100 seed (12.75 g) was observed from the variety BARI Chola 2 in 10 November sowing which was statistically similar with the same variety in both 20 November and 30 November sowing (13.52 g and 12.76 g), respectively. Similar interaction effect was also observed by Kabir *et al.* (2009) who also found that the effect of sowing time and varieties of Chickpea under rainfed condition showed significant variation of 100 seed weight.

Seed yield plant $^{-1}$

The varieties differed significantly in respect of yield plant^{-1}. The highest seed yield (6.14 g plant^{-1}) was produced by BARI Chola 4 which was higher from that in BARI Chola 2 (5.74 g/plant) (Table 5). The seed yield per plant differed significantly in respect of sowing time. The yield per plant reduced gradually as effect of delayed sowing. The highest yield plant^{-1} (6.89 g) was found in 20 November sowing which is significantly higher over that in all other sowing dates. The lowest yield plant^{-1} (5.09 g) was observed in 10 November sowing (Table 7). Seed yield per plant of the studied chickpea varieties was found significant for the interaction effect (Table 9). The highest seed yield was in BARI Chola 4 sown 20 November (7.18 g) and the lowest observed BARI Chola 2 in 10 November sowing time (4.98 g). Similar effect was also found by Kabir *et al.*, (2009) in Chickpea varieties and different sowing time.

Seed yield (kg ha^{-1})

A significant varietal difference was observed in case of seed yield per hectare. BARIChola4 produced the highest seed yield (1719.41 kg/ha) (Table 6). The lowest seed yield (1606.38 kg/ha) was recorded in BARI Chola 2 under irrigated condition. The differences in yield between the varieties might be due to difference in genotypic potential. However Rashid *et al.* (1999)

reported seed yield of chickpea as 1300-1600kg/ha, 1900-2000 kg/ha from BARI Chola 2 and BARI Chola 4 respectively. A significant variation in seed yield was found due to variation in sowing time. The highest yield (1930.80 kg/ha) was recorded in 20 November sowing that was significantly higher over those in other sowing dates (Table 8). The lowest seed yield (1424.40 kg/ha) was recorded in 10 November sowing. Rashid *et al.*(1999) had significant maximum seed yield with 20 November sowing. Seed yield was significantly influenced by the interaction between variety and sowing time (Table 10). The highest grain yield (2010.60 kg/ha) was recorded in BARI chola4 in 20 November sowing and the lowest (1396.60 kg/ha) in BARI chola 2 in 10 November sowing. The second highest seed yield (1851.00 kg/ha) was obtained in BARI chola2 in 20 November sowing. However, BARI Chola 4 was found the best performer in respect of yield among the varieties. Bahl*et al.,* (1984) reported that sowing dates and genotypes interaction was highly significant for seed yield.

Stover yield (kg ha^{-1})

Stover yield showed significant variation due to the variety (Table 6) where significantly the higher yield of stover (2365.77 kg ha^{-1}) was found in BARI Chola 4 while BARI Chola 2 gave lower stover yield (2298.28 kg ha^{-1}). This result indicated that BARI Chola 4 produced the maximum branch and higher TDM than BARI Chola 2 which ultimately resulted in higher production of stover yield. Similarly, Hamdi *et al.* (2003) reported that significantly the highest stover yield was obtained in BARI Chola 4 than BARI Chola 2. Stover yield of chickpea was significantly affected due to the sowing time. The highest stover yield (2476.20 kg/ha) was recorded in 20 November sowing that was significantly higher over that in all other sowing dates (Table 8). The lowest stover yield (2166.15 kg/ha) was recorded in early November sowing. Stover yield data affected significantly by the interaction effect of sowing time

and variety (Table 10). Among the interaction effects, the highest stover yield (2515.8 kg ha^{-1}) was found in BARI Chola 4 sown on 20 November .On the other hand, the lowest stover yield (2138.5 kg ha^{-1}) was recorded from the BARI Chola 2 sown on 10 November.

Biological yield (kg ha^{-1})

Biological yield is a sum of seed yield and stover yield and it was statistically significant between two varieties (Table 6). Between two varieties, BARI Chola 4 gave higher biological yield (4085.17 kg ha^{-1}) than BARI Chola 2 (3904.67 kg ha^{-1}). Biological yield was also significantly influenced by the sowing time (Table). The 20 November sowing gave the higher biological yield (4407.00 kg ha^{-1}) due to the higher seed yield and stover yield. 10 November sowing gave lower biological yield (3590.55 kg ha^{-1}). Interaction effect of sowing time and variety showed significant difference regarding to biological yield (Table 10). Among the interactions, the highest biological yield (4526.4 kg ha^{-1}) was found in BARI Chola 4 along with 20 November On the other hand, the lowest biological yield (3535.10 kg ha^{-1}) was recorded from the BARI Chola 2 sown on 10 November.

Harvest index (%)

In this study, the highest harvest index was found in BARI Chola 4 (41.89%). The lowest harvest index (40.96%) was found in BARI Chola 2 (Table 6). The harvest index was reduced as sowing time found beyond optimum time. Nawaz *et al.,* (1995) found the similar results. The highest harvest index was found in case of 20 November sowing (43.81%) and the lowest harvest index was in 10 November. The seed sown were November so, variation in temperature is important. The results are in agreement with that of Islam *et al.* (1987) who found that the similar results (Table 8). Harvest index (HI) varied significantly due to interaction effect between variety and sowing time

(Table 10). The highest harvest index (44.48%) was recorded from the combination of BARI Chola4 and 20 November sowing. It was statistically similar to the combination of BARI Chola 2 and 20 November sowing (43.14%). The harvest index was decreased as the sowing time variesirrespective to varieties. The lowest harvest index (39.38%) was of course recorded from BARI Chola 2 sown on 10 November sowing time.The results are in agreement with that of Bahl *et al.* (1984) who observed that the harvest index varied significantly with combination of sowing dates and varieties.

Table.5. Yield and yield contributing characters of chickpea as affected by variety

Variety	Pods plant^{-1}	Seeds pod^{-1}	100 seed weight (g)	Seed yield plant^{-1} (g)
V_1	50.12 b	1.32 b	13.36 b	5.74 b
V_2	62.57 a	1.35 a	13.89 a	6.14 a
$S_{\bar{x}}$	3.068	0.0084	0.333	0.081
CV (%)	18.86%	2.18%	8.47%	4.74%

V_1= BARI Chola 2, V_2 = BARI Chola 4

Table.6. Yield and harvest index of chickpea as affected by variety

Variety	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
V_1	1606.38 b	2298.28 b	3904.67 b	40.96 b
V_2	1719.41 a	2365.77 a	4085.17 a	41.89 a
$S_{\bar{x}}$	68.392919	19.5256	26.1357	0.4660
CV (%)	4.73%	12.90%	12.27%	13.90%

V_1= BARI Chola 2, V_2 = BARI Chola 4

Table.7.Yield and yield contributing characters of chickpea as affected by sowing time

Sowing Time	Pods plant^{-1}	Seeds pod^{-1}	100-seed weight (g)	seed yield plant^{-1} (g)
S_1	42.20 b	1.31 b	13.27 b	5.09 c
S_2	75.63 a	1.37 a	14.09 a	6.89 a
S_3	51.20 b	1.32 b	13.51 ab	5.83 b
$S_{\bar{x}}$	3.757	0.0104	0.2037	0.09937
CV(%)	18.86%	2.18%	8.47%	4.74%

S_1 = 10 November, S_2 = 20 November, S_3 = 30 November

Table.8. Yields and harvest index of chickpea as affected by sowing

Sowing Time	Seed yield (kg ha$^{-1)}$	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
S_1	1424.40 c	2166.15 c	3590.55 c	39.52 b
S_2	1930.80 a	2476.20 a	4407.00 a	43.81 a
S_3	1633.40 b	2353.73 b	3987.21 b	40.95 b
$S_{\bar{x}}$	27.83	23.91	32.01	0.5707
CV (%)	4.73%	12.90%	12.27%	13.90%

S_1 = 10 November, S_2 = 20 November, S_3 = 30 November

Table. 9. Interaction effect of variety and sowing time on yield attributes of chickpea

Interactions	Pod plant^{-1}	Seeds pod^{-1}	100-seed weight (g)	Seed yield (g plant^{-1})
V_1 X S_1	39.25 c	1.32 b	12.75 c	4.98 e
V_1 X S_2	62.30 b	1.34 b	13.52 bc	6.61 b
V_1 X S_3	48.80 bc	1.30 b	12.76 c	5.613 d
V_2 X S_1	45.15 bc	1.30 b	13.80 ab	5.18 e
V_2 XS_2	88.95 a	1.41 a	14.66 a	7.18 a
V_2 XS_3	53.60 bc	1.33 b	14.27 ab	6.05 c
$S_{\bar{x}}$	5.314	0.0147	0.2881	0.1405
CV (%)	18.86%	2.18%	8.47%	4.74%

V_1= BARI Chola 2, V_2 = BARI Chola 4, S_1 = 10 November, S_2 = 20 November, S_3 = 30 November

Table.10 .Interaction effect of variety and sowing time on seed yields and harvest index of chickpea

Interactions	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
V_1 X S_1	1396.60 e	2138.50 d	3535.10 e	39.38 c
V_1 X S_2	1851.00 b	2436.60 ab	4287.60 b	43.14 ab
V_1 X S_3	1571.55 d	2319.75 c	3891.30 d	40.37 c
V_2 X S_1	1452.20 e	2193.80 d	3646.00 e	39.67 c
V_2 X S_2	2010.60 a	2515.80 a	4526.40 a	44.48 a
V_2 X S_3	1695.43 c	2387.70 bc	4083.12 c	41.53 bc
$S_{\bar{x}}$	39.36	33.82	45.27	0.8072
CV (%)	4.73%	12.90%	12.27%	13.90%

V_1= BARI Chola 2, V_2 = BARI Chola 4S_1= 10 November, S_2 = 20 November, S_3 = 30 November

REFERENCE

Ageeb, O. A. A. and A.T. Ayoub. 1976. Effect of sowing date arid soil type on plant survival and grain yield of chickpeas (*Cicerarietinum*L.) J. Agric. Sci. Camb. 88:521-527.

Anwar, M.R., B.A. McKenzieand G.D. Hill.2003b. The effect of irrigation and sowing date on crop yield and yield components of Kabuli chickpea (Cicer arietinumL.)in a cool-temperate sub humid climate. J. Agric. Sci.141, 259-271

Anwar, M. R., B. A. McKenzie and G.D. Hill. 2003a. Phenology and growth response to irrigation and sowing date of Kabuli chickpea (*Cicerarietinum*L.) in a cool-temperateclimate. J. Agril. Sci.141, 273-284.

Aziz, M. A. and M. M. Rahman. 1994. Effect of date of sowing on yield and yield components of Kabuli gram **(***CicerarietinumL.***)** Indian J. Agric. Sci. 64(9): 624 –6.

BARI (Bangladesh Agricultural Research Institute). 1998. Annual Report (1998- 99), BARI, Joydebpur, Gazipur, Bangladesh. P.151-152.

Bahl, P. N. 1983.Performance of tall chickpea genotypes under normal and late sown conditions. Intl. Chickpea Newsletter. Vol-8: 8-9.

Bahl, P. N., K. P. Singh, S. Dixit and D. Singh.1984. Evaluation of tall chickpea genotypes for normal and late sowings. Indian J. Agric. Sci. 54(2**):** 110-3.

BBS(Bangladesh Bureau of Statistics). 2000. Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, Dhaka. Bangladesh.

Biscoc, P. V and J. N. Gallge.2005. Physiological analysis of cereal yield Production of dry matter. Agric. Prog. 53: 34.

Castellanos, J.Z.,J.J. Pena-CabrialesandJ.A. Acosta-Gallegos. 1996. ^{15}N- Determineddinitrogen fixation capacity of

common bean (Phaseolus vulgaris) cultivarsunder water stress. J. Agril. Sci.126: 327-333.

Clarke, H. and K.H.M. Siddique. 2010.Growth and Development in the Chickpea Book (eds. S. Loss, N. Brandon & K.H.M. Siddique), Agriculture Western Australia.

Dapaah, H.K., B.A. McKenzieand G.D. Hill. 2000. Influence of sowing date and irrigation on the growth and yield of faba beans (Phaseolus vulgaris L.) in a subhumid temperate environment. J.Agril. Sci.134, 33-43.

Dixit, J. P., N. K. Som and K. N. Narndeo. 1993. Moisture-use pattern and yield of chickpea (*Cicerarietinum* L.) in relation to planting date, variety and irrigation. Indian J. Agron. 38(4): 573-577**.**

Dixit, J. P., 0. P. Dubey and N. P.Soni. 1993. Effect of sowing date and irrigation on yield and nutrient uptake by chickpea (*Cicerarietinum* L.)cultivars under Tawa Command area. Indian J. Agron. 38 (2): 227-231.

Dixit, J. P., P.V.A. Pillai and K.N. Namdeo. 1993. Response of chickpea (*Cicerarietinum*L.) to planting date and irrigation schedule. Indian J. Agron. 38(1): 121- 123.

Gomez, K. A. and A. A. Gomez.1984. Statistical Procedures for Agricultural Research. 2nd ed. John Wiley and Sons, New York. p. 680.

Hamdi, A., A.A. El–Gharaib, S.A. Shafey, and M.A.M. lbrahim. 2003.Direct and indirect relationships among chickpea characters. Egyptian J. Agric. Res., 81(1): 139–150.

Iftekhar, M. S. and M. R.Islam. 2004. Managing mangroves in Bangladesh: A strategy analysis, Journal of Coastal Conservation 10, pp.139-146.

Islam, M. S. and M. B Solh. 1987. Growth arid yield performance of winter and spring sown four cultivars of chickpea (*Cicerarietinum*L.)Bangladesh. J. Bot. 16(2):117-124.

Kabir, A. H. M. F., M. N. Bari, M. A. Karim,K.Abdul,A. Qazi and, J. U.Ahmed. 2009. Effect of sowing time and cultivars on the growth and yield of chickpea underrainfed condition. Bangladesh J. Agril. Res. 34(2): 335-342.

Kabir, M.H., M.A.R. Sarkar, M. Begum and M.A. Salam. 2008. Yield performance of chickpea as affected by planting date, variety and plant density. J. Agron., 3(1): 18-24.

Main, M.A.K., M.A.Matin, M.A. Aziz and M.N. Islam. 2001. Some aspects of agronomic management for higher yield of chickpea at barind tract. Annual Bangladesh Botanical Conference 2001 of Bangladesh Botanical Society. P. 58.

Matthews, P. and D. McCaffery. 2011. "Winter crop variety sowing guide 2011" NSWDPI Management Guide.

Murshed, M. J.2000. Root growth and productivity of some selected chickpea genotypes under irrigated and non-irrigated conditions. MS. Thesis, BSMRAU, Gazipur, Bangladesh.

Nanda, R. and A. D. Saini. 1992. Effect of restricted soil moisture on yield its attributes in Chickpea. India. J. Plant physio. 35: 16-24.

Nawaz. M., A. Hussain, F.M. Chaudhry, M. Maqsood and M. Azarn.1995.Effect of sowing date and plant population on seed yield components of chickpea (*Cicerarietinum*L.) J.Agric. Res.33: 317-320.

Rashid, M. M., M. A. Wahhab, M. S. Amin, M. A. Quayyum and M. S. Alam. 1999. (Eds). KrishiProjuktiHatboi, (Hand book on Agro-technology), Bangladesh Agricultural Research Institute, Gazipur, Bangladesh. pp. 75-85.

Sharma, M. L.; Y. S. Chauhan, G. S. Bharadwaj and R. K. Sharma. 1988. Relative Performance of chickpea varieties to sowing dates. Indian J. Agron. 33(4):452-452.

Siddique, K. H. M. and R. H. Sedgley.1986. Chickpea (*Cicerarietinum*L.) a potential grain legume for south-western Australia: seasonal growth and yield. Aust. J.Agric. Res. 37: 245-61.

Singh, K. P., C. S. Tyagi, V.P. Singh and B.D. Chowdhary. 1986. Interactions between genotypes and sowing dates for yield and its components in chickpea. Indian,J. Agric. Sci. 56(4): 224-22.

Takana, A.1983. Physiological aspect of productivity. In: Potential of field crop under different environment. IRRI, Los Banos, Philipincs.pp.61-69.

Thomas, M.J., S.Fukaiand M.B. Peoples. 2004.The Effect of timing and severity of water deficit on growth, development, yield accumulation and nitrogen fixation of mungbean. Field Crops Res.86: 67-80.

UNDP (United Nations Development Programme) and FAO (Food and Agriculture Organization). 1988. Agro-ecological zone in Bangladesh. Identification of Agro-ecological zone project. United Nations Dev. Progr. & Food and Agric. org. pp. 156-189.

Whish, J.P.M., P. Castor and P.S. Carberry. 2007". Managing production constraints to the reliability of chickpea within marginal areas of the northerngrains region of Australia." J. Agril. Res. 58: 396-405.