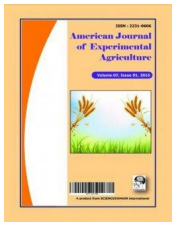

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Effect of Different Sowing Dates on Growth and Grain Yield of Chickpea (*Cicer arietinum* L.) Cultivars under Agro-environment of Taluka Dokri Sindh, Pakistan

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Authors' contributions

All authors contribute for designed the study, performed the statistical analysis and wrote the first draft of the manuscript. Author RQ carried out edited corrections and facilitated all e-mail correspondences. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The study was carried out to investigate the effect of different sowing dates on growth and grain yield of chickpea (*Cicer arietinum* L.) cultivars.
Study Design: A randomized complete block design (RCBD) in split plot arrangement was used.
Place and Duration of Study: Pulses Section, Rice Research Institute, Dokri, Sindh, Pakistan during Rabi season of 2012-13.
Methodology: Five sowing dates [S_1 = 15th October 2012, S_2 = 30th October 2012, S_3 = 15th

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November 2012, S_4 = 30th November 2012 and S_5 = 15th December 2012] in main plots and four cultivars [V_1 = DG-92, V_2 = Chhola, V_3 = DG-89 and V_4 = Sanyasi] in sub-plot.
Results: Sowing dates had significant difference ($P \leq 0.05$) on days to 50 % flowering, plant height, branches and pods per plant and 1000-seed weight while cultivars had on days to 50 % flowering and 1000-seed weight. Significant differences ($P \leq 0.05$) were observed among sowing dates and chickpea cultivars interaction for days to 90 % maturity and grain yield. The maximum days to 90 % maturity were observed for cultivar Sanyasi (169 days) when sown on 15th October while minimum for cultivar DG-92 (122 days) when sown on 15th December. Grain yield was maximized for DG-92 (3.3 Mg ha^{-1}) at sowing date of 15th November.
Conclusion: It is concluded that under agro-climatic conditions of Taluka Dokri, District Larkana, Province Sindh, Pakistan, cultivar DG-92 performed the best when sown on first fortnight of November.

Keywords: Sowing dates; cultivars; grain yield; chickpea.

1. INTRODUCTION

Chickpea is a conventional pulse crop of Pakistan and reasonable source of protein in human diet. It contains 21% protein, 61% carbohydrates and 2.2% oil [1]. It is not only the best source of protein but also a good food of high nutritive value ensuring substantial quantity of dietary fiber, vitamins C along with iron and minerals [2]. In Pakistan, chickpea is grown on an area of 975 thousands hectares with the total production of 475 thousand tons [3] and an average grain yield of 794 kg ha^{-1}, which is too low than its potential (1600 kg ha^{-1}). In Pakistan, chickpea is a broad-spectrum, reasonable and wide adaptability in all types of soil. It has ability to tolerate relatively high temperatures during the flowering and grain filling stage. Pulses have capability to fix the atmospheric nitrogen which has an important role in the profitability of farming systems by reducing cost of fertilizer application for both winter and summer cereal crops.

There are some limitations in chickpea production in which frost damage and disease are the two main limitations [4]. In sub-tropical region, the climate is temperate with winter rainfall, chickpea is conventionally seeded in spring; therefore, the crop faces high temperature and water stress towards maturity which resulted in low and variable yields. However, with new cultivars, winter seeding of chickpea in sub-tropical environments has recently been augmented, since winter sowing provides higher and more stable yield and growth [5]. To overcome the effect of cold temperature, adjustments in sowing date can be used as a strategy to increase chickpea production [6]. Time of sowing will depend on the interaction of environment and the available varietal germplasm [7]. The main reason of chickpea flower abortion has been shown when mean daily temperature of less than 15ºC [8]. Flower development is a crucial stage because fluctuation in environment affects it which ultimately influence on crop production. Start of flowering in chickpeas is dependent on photo-thermal reaction, which is the main determinant [9]. The optimum sowing date results in timely initiation of flowering by minimizing threats of cold temperatures which can retard the growth of chickpea plants [4]. Early sowing of chickpea can expose it to heavy rainfall which results in lodging, diseases occurrence, and moisture deficit during grain fill stage. Late sowing can effect on plant height which may reduce vegetative cover and water use efficiency and increase the incidence of insects [10]. Sowing time and cultivars are two important factors which can affect the growth and yield of chickpea [11]. The most vital step towards enhancing yield of chickpea is to ensure that the phenology of the crop is well in line to resources and constraints of the production environment [6].

One method to enhance grain yield in chickpea would be to change the sowing time using existing cultivars which are resistant to biotic and abiotic disorders [12]. Winter sown chickpea produced higher seed yield than spring sown crop [13]. The maximum crop yield of winter crop has been recognized to the extended growing period and favorable climatic condition during winter and early spring [14]. Increased crop production, contributed by plant height, higher number of branches and pods per plant which was positively correlated with yield [15]. Optimum sowing time of chickpea vary from one cultivar to another and also from one region to another due to variation of agro-ecological conditions.

The present study was carried out to investigate the effect of different sowing dates on growth and

grain yield of chickpea cultivars under agro-environment of Dokri, Sindh, Pakistan.

2. MATERIALS AND METHODS

2.1 Study Site

The present study was performed at the experimental field of Pulses Section, Rice Research Institute, Dokri (68º 07´ E, 27º 25´ N), Sindh, during Rabi season, 2012-13.

2.2 Experimental Design and Cultural Practices

The experiment was set up as a randomized complete block design in split plot arrangement with three replications. Plot size was 9 m^2 (1.8 m x 5 m). Treatments were: five sowing dates, i.e. S_I = 15th October 2012, S_2 = 30th October 2012, S_3 =15th November 2012, S_4 = 30th November 2012 and S_5 = 15th December 2012 and four cultivars, i.e. V_I = DG-92, V_2 = Chhola, V_3 = DG-89 and V_4 = Sanyasi. Sowing dates were randomized in the main plots while cultivars were randomized in subplots. After the harvesting of paddy crop the land was prepared for chickpea sowing as Dubari crop by giving two dry ploughings with disc plough followed by clod crushing to achieve fine seed bed. Monthly temperatures and rainfall of region is presented in Fig. 1. The soil of the experimental field was clay loam in texture under mono-cropping system (Table 1). The sowing of chickpea cultivars was done by means of single coulter hand drill in lines. The recommended seed rate of 100 kg ha^{-1} was used for chickpea cultivars. Nitrogen and phosphorus fertilizers were applied at 40 kg N ha^{-1} and 75 kg P_2O_5 ha^{-1}, respectively. Full doses of fertilizers were applied at the time of sowing. The pesticide Karate (Lambda-cyhalothri 2.5 EC) was applied at the rate of 625 mL ha^{-1}. Buctril Super 60 EC (Bromoxynil + MCPA) @ 700 ml ha^{-1} and Topik 15WP (Clodinafop propargyl) at 250 g ha^{-1} were applied to control both dicot and monocot weeds.

2.3 Development and Agronomic Parameters of Chickpea

Development and agronomic parameters of chickpea, including days to 50% flowering, days to 90% maturity, plant height (cm), branches per plant, pods per plant, 1000-seed weight (g) and seed yield per hectare (Mg) were recorded. The whole above ground harvested material was kept in bundles separately and to be dried up, it was threshed with sticks and weighed for recording grain yield. The growth and yield components were determined on twenty randomly selected plants from each plot.

2.4 Statistical Analysis

Data collected was analyzed statistically by applying Fisher's analysis of variance technique. Least significant difference (LSD) test was employed at 5% probability level to test the significance of the treatments' means [16].

Table 1. Soil analysis of experimental site during 2012-13

Soil analysis	Value
Mechanical analysis	
Sand (%)	38
Silt (%)	24
Clay (%)	39
Textural classes	Clay loam
Chemical analysis	
Soil pH	8.3
EC (dS m^{-1})	7.70
Organic matter (%)	0.30
Available N (g kg^{-1})	0.16
Available P (mg kg^{-1})	6.3
Available K (mg kg^{-1})	163

3. RESULTS AND DISCUSSION

Number of days taken to 50% flowering and 90% maturity show the genetic nature of a cultivar i.e. early, mid or late-season. Sowing dates and cultivars had significant effects on growth of chickpea (Table 2 & Fig. 2). Data revealed that interaction of days to 50% flowering was non-significant (Table 2) and days taken to 90 % maturity were significant (Fig. 2). Chickpea sown on 15th October took comparatively more time (87.9 days) to bear 50% flowering (Table 2). Days taken to 50% flowering at 30th October (85.2 days) were statistically similarwith15th November (84.7 days), while 30th November and 15th December had the lowest number of days (78.4 and 78.2 days) to 50% flowering. Significant differences of days to 50% flowering were recorded in varieties which may be due to their genetic characters; however, maximum number of days to 50% flowering was recorded by cultivar Sanyasi (84.5 days), followed by cultivar Chhola (83.5 days) while minimum number of days to 50% flowering was recorded by cultivar DG-92 (81.9 days). Chickpea sown at 15th October significantly took more time (165.2 days) to complete 90% maturity, while the lowest number of days (122.1 days) to 90% maturity was recorded at 15th December that was statistically similar with 30th November (129.3

days). Significant differences were recorded in cultivars; maximum number of days to 90% maturity was recorded by cultivar Sanyasi (145.5 days) followed by cultivar Chhola (143.2 days) while minimum number of days to 90% maturity was recorded by cultivar DG-89 (142 days) (Fig. 2). The interaction of sowing dates and cultivars (Fig. 2) envisaged that cultivar Sanyasi when sown on 15th October took maximum (169.0 days) number of days to maturity, followed by cultivars Chhola and DG-89 (167.7 and 163.3 days) and significantly lower in case of cultivar DG-92 under 15th December (120.7 days).

Sowing dates and cultivars had significant effects on yield parameters of chickpea (Table 2 & Fig. 3). Significantly higher plant height (53 cm) was recorded at 15th November and lower plant height (43.4 cm and 41.6 cm) at 30th October and 15th December sowing dates respectively. Number of branches per plant (4.8) at 15th October was significantly higher over other sowing dates. Significantly maximum (46.8) number of pods per plant was recorded at 15th October and minimum (40.3 and 40.7) was at 30th October and 15th December respectively. Sowing at 15th November produced significantly higher 1000-seed weight (224.8 g) while lower 1000-seed weight (209.7 g) was recorded at sowing date of 15th December (Table 2). Chickpea seed yield per hectare (Fig. 3) was significantly higher (2.3 Mg ha^{-1}) in 15th November while lower chickpea yield per hectare was recorded (1.4 g $plot^{-1}$ and 1.1 Mg ha^{-1}) in 30th November and 15th December.

Cultivars had non-significant effect on plant height, number of branches per plant and pods per plant (Table 2). Significantly higher 1000-seed weight was recorded at DG-89 (263.9 g) that was 14, 21 and 34% greater as compared to in DG-92(226.7 g), Chhola (207.1 g) and Sanyasi (172 g) respectively. Chickpea seed yield per hectare was significantly higher in DG-92 (2.2 Mg ha^{-1}) and lower was recorded in Sanyasi (1.1 Mg ha^{-1}) (Fig. 3). In 2012-13 growing season, sowing dates and cultivars interaction significantly influenced the chickpea seed yield per hectare except plant height, number of branches and pods per plant and 1000-seed weight (Table-2). However, cultivar DG-89 at 15th November of sowing date and cultivar DG-92 at 15th October sowing data produced significantly higher growth and yield of chickpea as compared to other cultivar and sowing dates.

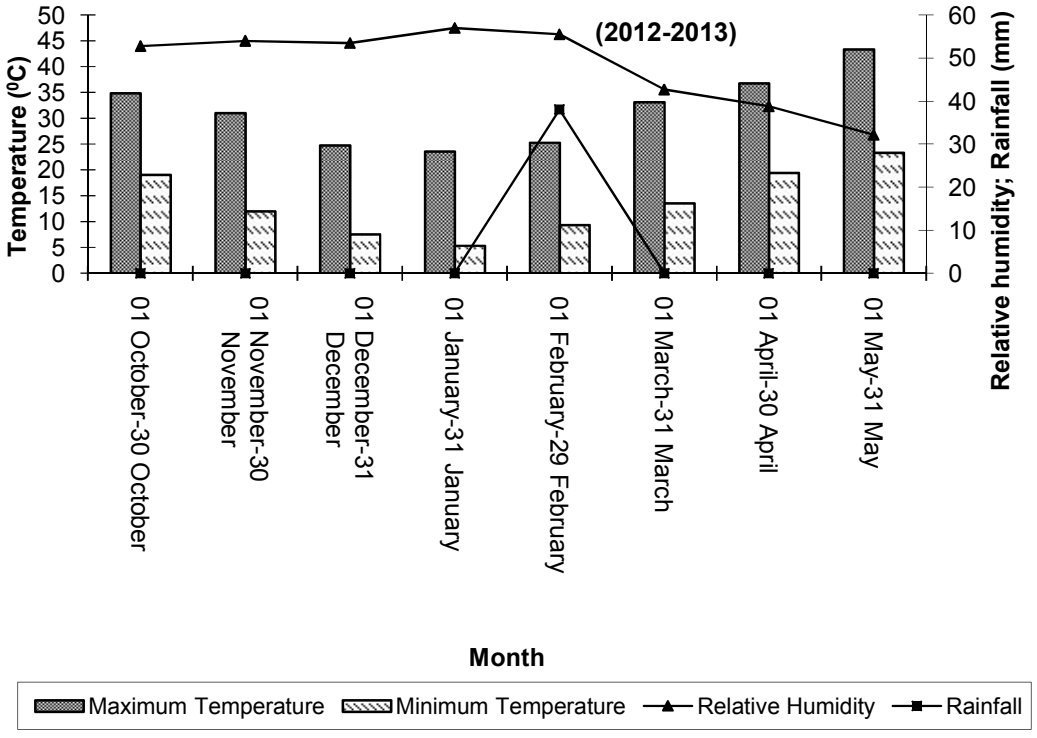

Fig. 1. Meteorological data recorded at Rice Research Institute, Dokri, during Rabi season, 2012-13

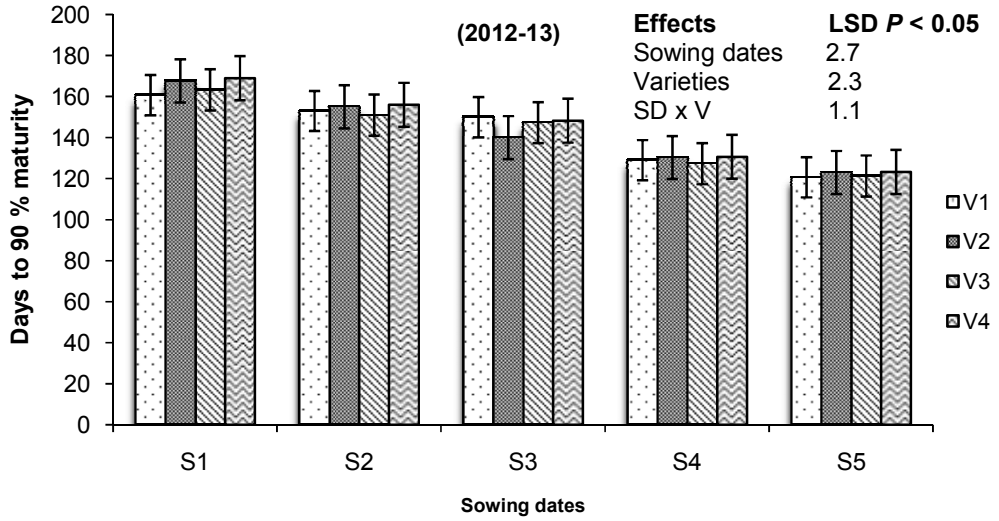

Fig. 2. Sowing dates and varieties effects on days to 90% maturity of chickpea (data over 2012-13)

(S_l= 15th October 2012, S_2 = 30th October 2012, S_3 =15th November 2012, S_4 = 30th November 2012 and S_5 =15th December 2012. V_l = DG-92, V_2 = Chhola, V_3 = DG-89 and V_4 = Sanyasi)

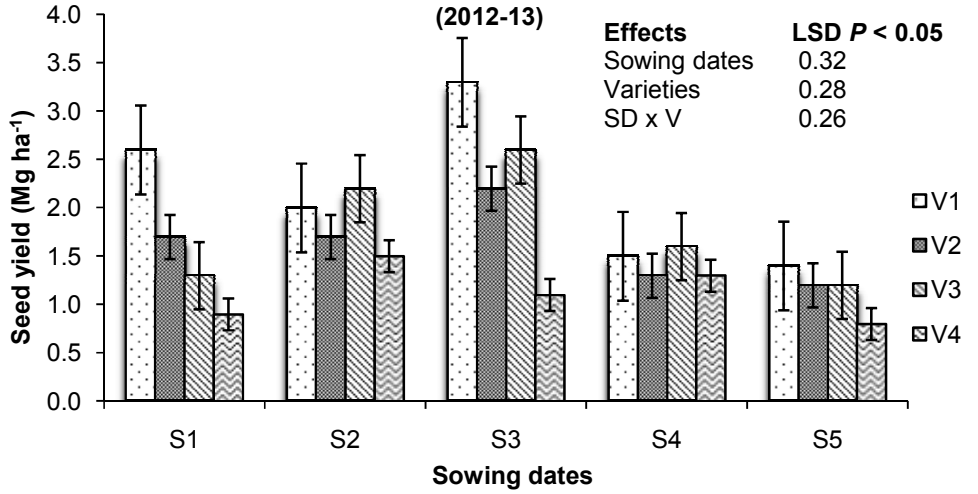

Fig. 3. Sowing dates and varieties effects seed yield (Mg ha^{-1}) of chickpea (data over 2012-13)

(S_l= 15th October 2012, S_2 = 30th October 2012, S_3 =15th November 2012, S_4 = 30th November 2012 and S_5 =15th December 2012. V_l = DG-92, V_2 = Chhola, V_3 = DG-89 and V_4 = Sanyasi)

The current study revealed that the interaction of different sowing dates and chickpea cultivars had significant effect on days to 90% maturity and seed yield per hectare while non-significant effect on days to 50% flowering, plant height, number of branches and pods per plant and 1000-seed weight. The variability in sowing dates and chickpea genotypes for yield and yield components also had been reported by other researchers [17,13,18]. Sowing dates had significant effect on days to flowering and maturity. Moreover, higher numbers of days taken to 50% flowering and 90% maturity in early autumn sown was due to the matching crop phenology with the availability of optimum temperature and moisture regimes and prolong growth period [19]. After a long delay at the seedling emergence stage due to low temperature at 15th December sowing while 15th November sown crops quickly started to develop

Table 2. Sowing dates and varieties effects on days to 50% flowering, plant height, branches per plant, pods per plant and 1000-seed weight of chick pea (data of 2012-13 growing season)

Treatments / Parameters	Days to 50% flowering	Plant height (cm)	Branches per plant	Pods per plant	1000-seed weight (g)
Sowing dates					
S_1 = 15th Oct. 2012	87.9a	49.6b	4.8a	46.8a	217.2c
S_2 = 30th Oct. 2012	85.2b	43.4c	3.1b	40.3b	222.0b
S_3 = 15th Nov. 2012	84.7b	53.0a	3.6b	46.1a	224.8a
S_4 = 30th Nov. 2012	78.4c	49.1b	3.1b	46.3a	213.6d
S_5 = 15th Dec. 2012	78.2c	41.6c	2.6b	40.7b	209.7e
LSD *P* < 0.05	2.51	2.10	1.12	2.72	2.41
Varieties					
V_1 = DG-92	81.9bc	49.6	3.6	44.3	226.7b
V_2 = Chhola	83.5ab	48.1	3.5	39.5	207.1c
V_3 = DG-89	82.0b	49.7	3.3	49.3	263.9a
V_4 = Sanyasi	84.5a	42.0	3.3	43.1	172.0d
LSD *P*<0.05	3.20	NS	NS	NS	2.11
Inter-action	NS	NS	NS	NS	NS

Any two means not sharing a letter in common differ significantly at 5 % probability level. NS = non-significant

a larger crop cover and grain yield in promising temperature and availability of soil moisture and longer growth duration [19]. However, delay in sowing resulted in adverse effect of climate which, resulted in poor crop stand and short time to complete their life cycle, specifically after 15th November [14]. The result showed that different sowing dates and chickpea cultivars had individually significant effect on yield and yield component [17].

Maximum yield in the mid-autumn sowing was as a result of favorable climatic condition which supported the vegetative and reproductive growth stages [20]. Mid-autumn sowing increased seeds weight and seed yield of chickpea compared than early and late sowing and this result was due to the moderate temperature regime during the seed filling stage. Chickpea sown on 15th November produced highest grain yield [19]. The lower number of 1000-seed weight and seed yield in early and late autumn sowing dates was due to encounter of flowering and fertilization stages with high and low temperatures respectively [18]. Overall the higher yields given by the 15th November sown chickpea, as compared with the 15th October and 15th December sown crop seem to be the result of better grain yield occurring as the result of a favorable growth period [21]. Under the low temperate, frost could be harmful for late-autumn sowing, because it usually occurs during the early stages of vegetative growth. Early spring sowing usually allows a crop to escape frost danger, unless there is a late frost. Autumn-sown chickpea may face water shortages in the later part of the crop's growth. We observed that the higher yield of 15th November related with favorable environmental conditions which can be lost due to unfavorable environmental conditions [22].

4. CONCLUSION

The current study confirms previous results showing that mid-autumn sowing improves the productivity of chickpea as compared with very early and late autumn sowing. Nonetheless, we observed that in very early autumn sowing date (October 15) resulted to plant lodging and flowering was encountered with low temperature which resulted low yield. In late autumn sowing date (December 15) resulted lower growth and yield of crop due to frost damage. After going through the results in detail, it was concluded that under climatic conditions of Taluka Dokri, District Larkana varieties DG-92 found best suitable when sown in the first fortnight of November.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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