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Physiological characters and yield of chickpea (*Cicer arietinum* L.) as influenced by dates of sowing, varieties and irrigation regimes in vertisols of scarce rainfall zone of Andhra pradesh

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ABSTRACT
A field experiment was conducted at Regional Agricultural Research Station, Nandyal, Andhra Pradesh, India for three consecutive seasons from 2013 to 2015 to study physiological characters and yield of chickpea (Cicer arietinum L.) as influenced by dates of sowing, varieties and irrigation regimes in vertisols of scarce rainfall zone of Andhra Pradesh. The experiment was laid out in split split plot design having three dates of sowing i.e. 2nd FN of October, 1st FN of November and 1st FN of December as main plots, three irrigation regimes no irrigation, irrigation at 35 DAS, irrigation at 35 and 55 DAS as subplots and two varieties i.e. NBeG 3 and NBeG72 as sub-sub plots and replicated thrice. Significantly higher number of pods per plant (46.2), 100 seed weight (32.4) and seed yield (1833 kg/ha) were obtained with irrigation at 35&55 days in 2nd fortnight of October, whereas the lowest values were recorded under no irrigation conditions. This study has clearly indicated that partitioning efficiency will be maximum at 2nd fortnight of October and with advancing sowing dates i.e to November and December, partitioning efficiency was reduced due to receding soil moisture which affects Source and Sink partitioning. The desi chickpea variety of NBeG 3 significantly out-yielded the kabuli chickpea variety NBeG 72.
***Key words**: Chickpea, Date of sowing, Irrigation regimes, varieties.*

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INTRODUCTION

Chickpea is the most important pulse crop cultivated mainly under rainfed condition. It is a good source of protein in human diet and also a good food of high nutritive value ensuring substantial quantity of dietary fiber, vitamins C along with iron and minerals. Traditionally, chickpea is grown on marginal lands in semi arid regions on remnant monsoon preserved moisture (Maxted *et al.* 2008). In Andhra Pradesh, chickpea is the major pulse crop cultivated during rabi season with an area of 5.70 ha with a production of 5.49 m t having an average productivity of 341 kg ha^{-1}. In rainfed farming especially in vertisols, farmers harvest hardly 650 kg grains ha^{-1} whereas at research stations and extension farms maximum yield of 1500 kg ha^{-1} has been obtained in rainfed farming. This huge yield gap is due to timely preservation of moisture in monsoon season and proper weed control at research stations. In general in rainfed farming, has a general assumption that excessive moisture during vegetative phase of chickpea causes undesired vegetative growth which promotes lodging and reduces grain yield considerably. There are some limitations in chickpea production in which frost damage and disease are the two main limitations (whish *et al.* 2007). 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 (Pacuacci *et al.* 2006). Flower development is a crucial stage because fluctuation in environment affects it which ultimately influence on crop production. Flowering in chickpea is dependent on photothermal reaction, which is the main determinant (Basu *et al.*2009). 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 (Matthews *et al.*2011).The optimum sowing date results in timely initiation of flowering by minimizing threats of cold temperatures which can retard the growth of chickpea. To overcome the effect of cold temperature, adjustments in sowing date can be used as a strategy to increase chickpea production. Keeping this in view, the present study was undertaken to study physiological characters and yield of chickpea as influenced by dates of sowing, varieties and irrigation regimes in vertisols of scarce rainfall zone of Andhra Pradesh.

MATERIAL AND METHODS

A field study was carried out for three consecutive seasons from 2013 to 2015 on varieties at Regional Agriculture Research Station, Nandyal, Andhra Pradesh. The experiment was laid out in split split plot design having three dates of sowing i.e. 2nd FN of October (D_1), 1st FN of November (D_2) and 1st FN of December (D_3) as main plots, three irrigation regimes no irrigation (Io), irrigation at 35 DAS (I_1), irrigation at 35 and 55 DAS (I_2) as subplots and two varieties i.e. NBeG 3 (V_1) and NBeG72 (V_2) as sub-sub plots and replicated thrice. Phosphorus and Nitrogen were applied at the rate of 50 and 20 kg ha^{-1}, respectively. Nitrogen at the low rate was applied as a starter dose. However the fertilizers rates were adjusted according to the nutrient status of the soil after soil analysis. Pod borer and other insects and diseases were controlled with the suitable protective measures.

RESULTS AND DISCUSSION

Growth parameters

Plant height differ significantly due to different treatments. Higher plant height (51.3 cm) was observed in sowing during 2nd FN of October and at par with 1st FN of November (50.9 cm). Delay in planting consistently decreased plant height in both the chickpea varieties, and also long statured plants were noted in early planting .The results are in line with Khalid Nawab *et al*. 2015, that delay in planting decreased plant height in chickpea variety Karak-I and attained long stature plants at early planting while, short stature plants were noted in KC-98.

Table 1. Influence of dates of sowing under different dates and irrigation schedules on growth and yield parameters in desi and kabuli chickpea varieties

Treatments	Plant height (cm)	Days to 50% flowering	Days to maturity	Leaf area index	Pods per plant	100 seed weight (gm)	Seed yield Kg/ha	Harvest index
Dates of sowing								
D_1- 2nd FN October	51.3	60.2	100.2	0.796	45.5	29.2	1833	0.328
D_2- 1st FN November	50.9	51.8	88.3	0.687	39.8	27.4	1600	0.304
D_3- 1st FN December	41.1	48.1	83.0	0.561	32.6	26.3	953	0.224
S.Em±	3.1	1.6	2.4	0.009	1.59	0.81	48	0.032
CD (p=0.05)	9.5	4.1	7.2	0.037	4.1	2.8	172.1	NS
Irrigation regimes								
I_0-Rainfed	45.1	52.4	89.1	0.616	32.4	22.9	1190	0.264
I_1-Irrigation at 35 DAS	50.2	53.5	90.2	0.676	39.4	27.8	1406	0.286
1_2-Irrigation at 35 & 55 DAS	47.8	54.1	92.3	0.753	46.2	32.1	1792	0.305
S.Em±	1.8	0.9	5.1	0.010	1.21	0.9	61	0.029
CD (p=0.05)	NS	NS	NS	0.034	2.8	3.2	192	NS
Varieties								
V_1 –NBeG 3	44.2	52.4	88.2	0.716	43.1	22.8	1592	0.308
V_2 – NBeG 72	51.3	54.2	92.8	0.646	35.5	32.4	1332	0.262
S.Em±	3.2	1.5	1.2	0.008	2.1	0.7	32	0.025
CD (p=0.05)	N.S.	NS	4.1	0.028	5.9	2.4	110.1	NS

Chickpea sown during 2nd FN of October took comparatively more time (60.2 days) to bear 50 percent flowering (Table 1) while 1st FN of November and 1st FN of December had the lowest number of days (51.8 and 48.1 days) to 50% flowering, however, maximum number of days to 50% flowering was recorded by variety NBeG 72 (54.2 days). Chickpea sown at 2nd FN of October significantly took more time (100.2 days) to complete maturity, while the lowest number of days (83 days) to maturity was recorded at 1st FN of December (Table 1). Significant differences were recorded in varieties i.e maximum number of days to maturity was recorded by variety NBeG72 (92.8 days) while in NBeG 3 (88.2 days).

Leaf area index recorded significantly higher values in 2nd FN of October (0.796) along with irrigation at 35 and 55 DAS (0.753) and among the varieties NBeG3 (0.716) have recorded higher values compared to NBeG72 (0.646). Planting dates and irrigation schedules significantly influenced pods per plant. Maximum (45.5) number of pods per plant was recorded at 2nd FN of October and minimum (39.8 and 32.6) was at 1st FN of November and 1st FN of December. Irrigation at 35 and 55 DAS recorded higher pod per plant (46.2) than no irrigation and irrigation at 35 DAS. Bakhsh *et al*, (2007) noted that on average basis 48% increase in number of pods per plant was recorded due to irrigation. Similarly El-Waraky and Koliey, (2000) investigated that Irrigation at branching and pod development stages resulted with the highest number of pods per plant. Significantly 100 seed weight recorded at 2nd FN of October (29.2g) that was greater than 1st FN of November (27.4g) and 1st FN of December (26.3g). Seed yield was greatly influenced by different dates of sowing and irrigation schedules. Effect of sowing dates and irrigation schedules were significant on grain yield and the findings are in coherent with Bakhsh *et al*, (2007) in which they noted that yield and most of the yield components were improved with the application of irrigation. The higher seed yield of 1833 kg ha^{-1} was recorded in 2nd FN of October followed by1st FN of November(1600 kg ha^{-1}) and 1st FN of December (953 kg ha^{-1}).The higher yields in 2nd FN of October is attributed to lower maximum temperature coupled with higher relative humidity compared with other dates of sowing. Similar higher grain yield of chickpea from 2nd FN of October sown crop from different agro-climatic conditions are reported by Mansur *et al.*(2010).

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