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Chickpea Varieties and Time of Sowing Effects on Growth and Yield under North-East Monsoon Influenced in Andhra Pradesh, India

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ABSTRACT

Background: In Sri Potti Sriramulu Nellore district of Andhra Pradesh, India where North-East monsoon is predominant. During this season, chickpea crop sown during October to November 1st fortnight (FN) causing total crop loss due to high intensity rains in the changing climate scenario. In this context, there is a need for identification of suitable varieties of chickpea with ideal time of sowing for Sri Potti Sriramulu Nellore district under changing climatic situations to enhance the yields of chickpea.

Methods: Field experiment was carried out during *rabi* 2019-20 at Agricultural Research Station, Podalakur (14°22°N latitude, 79°44°E longitude and 43 m above mean sea-level), Sri Potti Sriramulu Nellore district andhra Pradesh to identify the suitable chickpea variety and optimum time of sowing. The field experiment was laid out in split plot design with 4 varieties of chickpea (V_1: Nandyala gram-49, V_2: Dheera, V_3: Nandyala Senaga-1 and V_4: JG-11) as main plot treatments and 3 time of sowings (D_1: November 2nd FN, D_2: December 1st FN, D_3: December 2nd FN) as sub plot treatments in three replications.

Result: Nandyala Senaga-1 and Dheera have taken more number days to 50% flowering and maturity. Crop sown on November 2nd FN took significantly more days (42.8) to bear 50% flowering and maturity, while the lowest number of days per 50% flowering and maturity was taken by December 2nd FN sown crop. Chickpea variety Nandyala Gram-49 recorded the highest grain yield (1491 kg ha^{-1}), which was statistically on par with Nandyal Senaga-1 (1465 kg ha^{-1}). The crop sown on November 2nd FN recorded significantly the highest grain yield (1462 kg ha^{-1}), but which was statistically on par with December 1st FN (1424 kg ha^{-1}) sown crop.

Key words: Chickpea, Date of sowing, Days to 50% flowering, Grain yield, Maturity, Varieties, Yield parameters.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the most important pulse crop of *rabi* season cultivated mainly in semiarid and warm temperate regions of the world. In India, chickpea cultivation is being restricted mainly to rainfed areas or cultivated under residual moisture. Globally, chickpea is grown in an area of 137 lakh ha with a production of 142.4 lakh tonnes and productivity of 1038 kg ha^{-1} (FAOSTAT, 2019). India contributes 70 per cent of total world chickpea production of 116.2 lakh tonnes cultivated under 112 lakh ha with productivity of 1036 kg ha^{-1} in 2020-21 (agricoop.nic.in). Andhra Pradesh produces 5.66 lakh tonnes in an area of 4.65 lakh ha with 1218 kg ha^{-1} productivity in 2020-21 (Angrau Bor, 2021).

Sri Potti Sriramulu Nellore district of Andhra Pradesh, India is mainly influenced by north-east monsoon and *rabi* is the main cropping season. A late or advancement of north east monsoon, high intensity rains may have devastating effects on agriculture in rainfed areas of Sri Potti Sriramulu Nellore district, even if the mean annual rainfall is normal. Climate change impact is a major concern for *rabi* crops like chickpea.

The performance of the crop mainly depended on the cultivar performance and the environmental area where it is growing. As far as a variety is considered its optimum time of sowing has a crucial role in fully utilizing the genetic potentiality as it provides the best possible growing conditions such as light, temperature, rainfall, humidity. It was reported that the main causes of yield component variability are genotypic (Sadhu and Mandal, 1989), genotype by environment interactions (Shrivastava *et al.*, 1990) and climatic variability in terms of temperature regime and moisture availability (Rheehrnen and Saxena, 1990; Pala and Mazid, 1992). Unlike other winter growing legumes, chickpea is very susceptible to low temperatures, especially at flowering (Srinivasan *et al.,* 1999; Nayyar *et al.,* 2005).

Selection of suitable varieties with optimum time of sowing plays an important role in improving the productivity of chickpea. Sowing time has a noticeable effect on the

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productivity as it decides the biotic and abiotic conditions to which various phenological stages of the plant subjected. Keeping this in view experiment was conducted to know the suitable variety and time of sowing of chickpea in Sri Potti Sriramulu Nellore district of Andhra Pradesh.

MATERIALS AND METHODS

The experiment was conducted during *rabi*, 2019-20 at Agricultural Research Station, Podalakur (14°22°N latitude, 79°44°E longitude and 43 m above mean sea-level), Sri Potti Sriramulu Nellore district andhra Pradesh, India. The climatic conditions of southern zone are sub-tropical influenced by North-East monsoon. The soils are clay loam in texture, porous and grayish black having pH of 8.48, EC of 0.229 dSm^{-1}, organic carbon 0.3%, available nitrogen 201 kg ha^{-1}, available phosphorus 46 kg ha^{-1} and available potassium 225 kg ha^{-1}. The field experiment was laid out in Split plot design with 4 varieties of chickpea (V_1: Nandyala Gram-49, V_2: Dheera, V_3: Nandyala Senaga-1 and V_4: JG-11) as main plot treatments and 3 dates of sowing (D_1: November 2nd FN, D_2: December 1st FN, D_3: December 2nd FN) as sub plot treatments in three replications. Sowings were done as per treatments with spacing of 30 cm × 10 cm with the help of tyne by opening a shallow furrow at uniform depth of 5 cm. In treatments D_1, D_2 and D_3 sowing was carried out on 22.11.2019, 07.12.2019 and 19.12.2019, respectively. The recommended dose of fertilizer @ 20 kg N, 50 kg P_2O_5 and 40 kg S per hectare were applied as basal. Nitrogen, phosphorus and sulphur were applied in the form of urea, single super phosphate and sulphate, respectively. The crop was harvested on 07.03.2020 [106 days after sowing (DAS)], 17.03.2020 (101 DAS) and 26.03.2020 (98 DAS) in D_1, D_2 and D_3 treatments respectively.

Growth and agronomic parameters of chickpea, which includes days to 50% flowering, days to maturity, plant height (cm) at harvest, dry matter production per plant at harvest, pods per plant, 100 seed weight (g) and grain yield per hectare 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.

Data collected were 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 treatment means (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Weather

During the year 2019-20, 668.5 mm rainfall was received, which is 12.1% lesser than decennial mean (760.2 mm) (Fig 1). Last few years wide variation in rainfall both amount and intensity were noticed. During the cropping year (2019-20), higher rainfall was received in September (130.1 mm), October (224.3 mm) and November (130.6 mm) months with maximum rainfall during October (224.3 mm). The decennial mean revealed that higher rainfall was in October (132.9 mm), November (174.8 mm) and December (137.9 mm) months with maximum rainfall during November (174.8 mm) (Fig 1). During the cropping year (2019-20), 28.3% higher rainfall was received in maximum rainfall month (October) compared to decennial mean (November). This clearly indicated that climate change has influenced spatio-temporal variation in rainfall amount and intensity. Further analysis of rainfall data during cropping growing period (November to March) indicated that during the year 2019-20, 275.4 mm rainfall was received compared to 329.8 mm of decennial mean, which was 16.5% lesser. So, cropping year 2019-20 was a relatively dry year (Fig 2). Maximum rainfall was received during November followed by December.

Weather data analysis of sowing dates treatments revealed that average minimum temperature during cropping

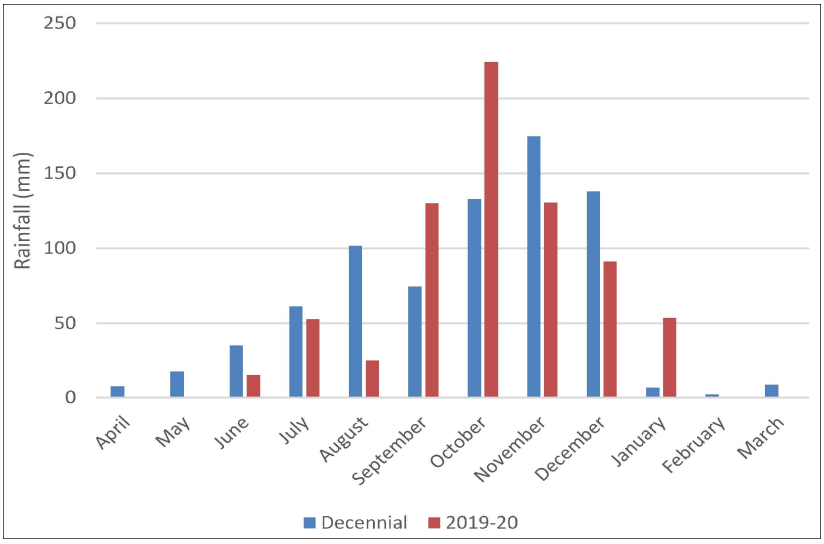


Fig 1: Rainfall (mm) during cropping year and decennial mean.

period was decreased with delay in sowing whereas average maximum temperature increased with delay in sowing (Table 1). The treatment November 2nd FN sowing recorded higher average minimum temperature whereas December 2nd FN sowing recorded higher average maximum temperature (Table 1). No particular trend was observed in relative humidity (RH). The total rainfall and rainy days during cropping period were decreased with delay in sowing (Table 1). Maximum rainfall of 154.0 mm with 12 rainy days were registered in November 2nd FN sowing and minimum rainfall of 59.0 mm with 6 rainy days were registered in December 2nd FN sowing (Table 1).

Days to 50% flowering

Number of days taken to 50% flowering was significantly influenced both by varieties and dates of sowing (Table 2). Among the four varieties, Nandyala Senaga-1 and Dheera recorded the highest and similar number of days to attain 50% flowering. JG-11 recorded the lowest number of days to reach 50% flowering, which might be due to their genetic nature (Rehman *et al.,* 2015). Chickpea sown on November 2nd FN took significantly more number of days (42.8) to bear 50% flowering, while the lowest number of days for 50% flowering was taken by December 2nd FN sown crop. This might be due to lower average maximum temperature in former and higher average maximum temperature in latter prevailed during crop growing period (Table 1). Aziz and Rahman (1996) also observed that number of days to flowering decreased with delay in sowing. This corroborates with the findings of Ganguly and Bhattacharya (2001), Kumar *et al.* (2006), Kiran and Chimmad (2015) and Thombre *et al.* (2019). Data revealed that interaction for days to 50% flowering was not significant (Table 2).

Table 1: Weather parameters during cropping period in different treatments.

Weather parameter	November 2nd FN	December 1st FN	December 2nd FN
Maximum temperature (°C)	33.9	34.4	34.7
Minimum temperature (°C)	22.8	22.3	22.3
Average RH (%)	71.5	73.0	71.5
Evaporation (mm)	413.7	418.4	433.1
Rainfall (mm)	154.0	87.4	59.0
Rainy days (Nos.)	12	9	6

Days to maturity

Days taken to maturity were significantly influenced by varieties (Table 2). The chickpea variety JG-11 took significantly lesser number of days to attain maturity followed by Nandyala Gram-49, Nandyal Senaga-1 and Dheera. This might be due to genetic nature of the varieties. Days taken to maturity were significantly curtailed with delay in sowing of chickpea (Table 2). More number of days was taken to maturity in case of crop sown in November 2nd FN and less number of days was taken to maturity in crop sown in December 2nd FN. This might be due to increase in average maximum temperature during crop growing period with delay in sowing and also moisture stress (Table 1). These results in corroboration with the findings of Ray Kripanidhi *et al*. (2017).

Plant height

Plant height was significantly influenced by varieties. Dheera which is released for mechanical sowing recorded significantly taller plants (58.4 cm) among the four varieties (Table 2). JG-11 recorded the shortest plants, but which was statistically on far with Nandyal Senaga-1 and Nandyal Gram-49. Variation in plant height among varieties might be genetic character. Plant height was not significantly influenced by dates of sowing and interaction between varieties and dates of sowing (Table 2).

Dry matter production per plant

Dry matter production per plant was significantly influenced by varieties. Among the four varieties tested, Nandyala

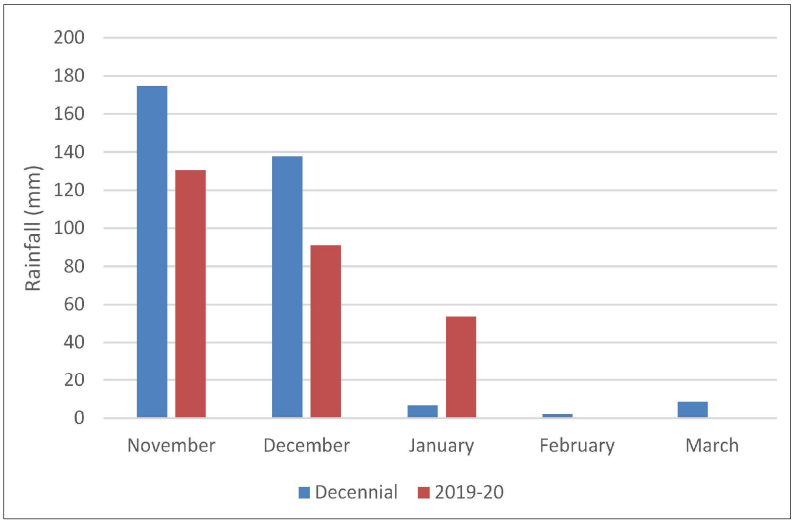


Fig 2: Rainfall (mm) during cropping season and decennial mean.

Gram-49 recorded the highest dry matter production per plant, but which was statistically on par with Nandyala Senaga-1. This might be genetic attribute of the varieties. The lowest dry matter production per plant was recorded with JG-11. This might be due to its short stature and small size leaves. Dates of sowing have significant influence on dry matter production per plant (Table 2). The highest and similar dry matter production per plant was recorded with November 2nd FN and December 1st FN sowings. Early sowing dates encountered more optimum environmental conditions and allowed the plant to accumulate more dry matter. According to Yadav *et al.* (1999) and Thombre *et al.* (2019) vegetative growth period is longer and continued into the reproductive stage under normal than late sowing. The lowest dry matter accumulation was recorded with December 2nd FN sowings (Table 2). Besides, growth period of the crop also decreased with each successive delay in sowing which was also reflected in reduced dry matter accumulation. Interaction between varieties and date of sowing didn't have any significant influence on the dry matter production per plant (Table 2).

Number of pods per plant

Number of pods per plant was not significantly influenced by varieties (Table 2). These results are in corroboration with the findings of Rahman *et al.* (2015). Time of sowing has a significant influence on number of pods per plant. Among the three different dates of sowings crop sown on November 2nd FN recorded significantly higher number of pods per plant. The increased number of pods per plant might be due to higher dry matter production per plant and the favourable weather conditions especially rainfall distribution during the early stages of crop growth. Interaction between varieties and date of sowing didn't have any significant influence on the number of pods per plant (Table 2).

100 grain weight

In chickpea, 100 grain weight was significantly influenced both by varieties and date of sowing (Table 2). Among the four varieties, Nandyala Gram-49 recorded the highest 100 grain weight (22.5 g), which was statistically on par with Nandyala Senaga-1 (22.4 g) and Dheera (21.2 g). The variety JG-11 recorded the lowest 100 grain weight. Among the three dates of sowing, crop was sown in November 2nd FN and December 1st FN recorded higher and similar 100 grain weight (22.1 g). This might be due to optimum moisture availability during the grain filling stage at these sowing times. These results are in conformity with Kumar *et al.* (2003), Shelke *et al.* (2015) and Thombre *et al.* (2019). Interaction between varieties and date of sowing didn't have any significant influence on the 100-grain weight (Table 2).

Grain yield

Grain yield was significantly influenced by varieties and dates of sowing (Table 2). The highest grain yield (1491 kg ha^{-1}) was recorded with Nandyala Gram-49, which was statistically on par with Nandyal Senaga-1 (1465 kg ha^{-1}). The higher yield with Nandyala Gram-49 might be due to higher dry matter production per plant, number of pods per plant and 100 grain weight (Table 2). Chaitanya and Chandrika (2006) also reported similar findings. The lowest grain yield (1236 kg ha^{-1}) was recorded with JG-11, but which was statistically on far with Dheera (1264 kg ha^{-1}) (Table 2). Among the three dates of sowing, crop was sown in November 2nd FN recorded significantly the highest grain yield (1462 kg ha^{-1}), but which was statistically on par with December 1st FN (1424 kg ha^{-1}) sown crop. This might be due to higher dry matter production per plant, number of pods per plant and 100 grain weight (Table 2). Delayed sowings beyond December 1st FN recorded lower grain yield might be due to moisture stress during grain filling stage. The total rainfall and number of rainy days decreased and average maximum temperature increased with delayed sowing (Table 1). The interaction effect did not have any significant influence on the grain yield of chickpea (Table 2).

Table 2: Growth and yield parameters influenced by varieties and time of sowings in chickpea.

Treatment	Days to 50% flowering	Days to maturity	Plant height (cm) at harvest	Dry matter production per plant (g) at harvest	No. of pods $plant^{-1}$	100 grain weight (g)	Grain yield (kg ha^{-1})
Varieties							
Nandyala Gram-49	42.2	98.4	40.4	17.41	27.2	22.5	1491
Dheera	43.3	100.8	58.4	16.98	24.9	21.2	1264
Nandyala Senaga-1	43.3	99.8	40.1	17.23	24.2	22.4	1465
JG-11	36.1	87.7	38.9	13.92	21.7	19.6	1236
S.E (m)±	0.17	0.51	1.48	0.19	4.59	0.48	42.7
CD (0.05)	0.61	1.81	5.2	0.68	N.S.	1.7	151
Time of sowings							
November 2nd FN	42.8	100.4	45.0	16.88	30.5	22.1	1462
December 1st FN	41.8	97.2	45.6	16.28	21.8	22.1	1424
December 2nd FN	39.1	92.4	42.8	15.99	21.2	20.1	1206
S.E (m)±	0.27	0.48	1.05	0.15	2.24	0.47	36.3
CD (0.05)	0.80	1.45	N.S.	0.47	6.8	1.4	110
Interaction	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

CONCLUSION

From the present investigation, it could be concluded that chickpea variety Nandyala Gram-49 and Nandyal Senaga-1 were the best varieties to get higher yields. Further, sowing of chickpea from November 2nd FN to December 1st FN was found optimum time for higher yield under North-East monsoon influenced Andhra Pradesh, India.

Conflict of interest

There is no conflict of interest among all the authors.

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