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Effect of sowing dates and irrigation levels on growth, yield, and water productivity of Dhaincha

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Abstract
A field experiment was conducted at Water Technology Centre, College Farm, College of Agriculture, Rajendranagar, Hyderabad, Telangana during *rabi* 2023- 2024. The experimental field soil was clay loam soils with a pH of 7.56 and EC of 0.97 dS m^{-1}. The experimental soil was low in organic carbon (0.39%) and available nitrogen (180.4 kg ha^{-1}), phosphorous (19.3 kg ha^{-1}) while high in available potassium (317.1 kg ha^{-1}). The experiment was laid out in split plot design with 12 treatments, consisting of four dates of sowing *viz*., first fortnight of October, second fortnight of October, first fortnight of November, second fortnight of November as main plots and three Irrigation levels *viz*., 0.6 IW/CPE ratio (I_1), 0.8 IW/CPE ratio (I_2) and 1.0 IW/CPE ratio (I_3) as sub plots. Among the dates of sowing, significantly highest plant height (158.5 cm), dry matter production (7056.7 kg ha^{-1}), number of branches plant^{-1} (12.3) number of pods plant^{-1} (49.8), number of seeds pod^{-1} (25.8), pod length (17.3 cm), seed yield (730.2 kg ha^{-1}) and stalk yield (6664.4 kg ha^{-1}), harvest index (9.8%) and water productivity (0.17 kg m^{-3}) was recorded when sown during first fortnight of November and was on par with second fortnight of October and it has shown significantly superior over during first fortnight of October and the second fortnight of November in dhaincha. Among different irrigation levels, significantly higher plant height (151.6 cm), dry matter production (6445.4 kg ha^{-1}), number of branches plant^{-1} (11.4), number of pods plant^{-1} (45.6), number of seeds pod^{-1} (23.8), pod length (16.8 cm), seed yield (671.7 kg ha^{-1}), stalk yield (6113.4 kg ha^{-1}) and harvest index (9.8%) was observed in 1.0 IW/CPE ratio compared to the 0.8 IW/CPE ratio and 0.6 IW/CPE ratio in dhaincha. water productivity was significantly highest in irrigation scheduled at 0.6 IW:CPE ratio (0.17 kg m^{-3}).

Keywords: Dhaincha, dates of sowing, fortnight, irrigation levels, growth, yield, water productivity, significant

1. Introduction

Dhaincha (*Sesbania aculeata* L.) belongs to the Fabaceae family. It is native to Asia and North Africa. Dhaincha is the cheapest and best source as compared to other green manure crops for improving soil fertility due to its fast growth, high biomass production and ability to convert large amounts of atmospheric nitrogen into a usable form for plants. It also increases the water holding capacity of soil and bears more nodules which fix atmospheric nitrogen. (Bhuker *et al*., 2019) [1]. Dhaincha (*Sesbania aculeata* L.) is a large genus of herbs and shrubs. Dhaincha crop makes good growth within short period about 2-4 months (for green manuring), having straight stem up to 4 m in height, which is very soft in nature, the leaflets of crop are very tender and produces maximum amount of organic matter. In this respect dhaincha is a potential green manure crop which can produce up to 22.5 t ha^{-1} of biomass, the highest among all green manure crops and has nutrient content 3.3% N, 0.7% P, and 1.3% K. It is an annual crop with lower C: N ratio reported that 12-15% of yield of rice was increased by green manure with dhaincha crop. It is also cultivated as a preceding crop to paddy in *kharif* season as it increases the nitrogen content in the soil which in turn reduces the usage of urea. Roots of dhaincha crop produce large number of bacterial nodules through which fixes large amount of atmospheric nitrogen in the soil. Besides green manuring, it is also used as a cover crop. It protects soil from water and wind erosion (Shinde *et al*., 2020) [2]. Water is the basic need in agricultural development and its demand is increasing day by day. At the same time, availability of water is decreasing due to climatic changes. Industrialization, increasing population, addition of heavy metals, pesticides, organic pollutants leading to these climatic changes. Also, the predominant use of outdated and inefficient flood irrigation methods leads to excessive water use. Therefore, it is necessary to economize the use of water for agriculture to bring more areas under irrigation, as agriculture alone consumes 80% of total water usage. Scientific irrigation scheduling with a deep understanding of soil-water-atmospheric relationship is very important for successful irrigation water management. (Salim *et al.*, 2018) [3]. A lot of work on its utility as green manure crop has been done. But no serious efforts were made to develop proper agronomic practices for seed crop of dhaincha in Telangana in *rabi* season. (Sangeetha *et al.,* 2011) [4]. The lack of availability of adequate quality seeds at appropriate time at reasonable price for small holdings and marginal farmers becomes a major constraint in dhaincha cultivation. Quality seed production of dhaincha is given meager importance despite huge demand from farmers. Till date there are few studies with respect to the influence of different dates of sowing, spacing and pinching etc. but studies regard crop weather relationship and precise application of irrigation are lacking. Keeping this in view, the present study was undertaken to evaluate "Effect of sowing dates and irrigation levels on growth, yield, and water productivity of dhaincha*"*.

2. Materials and Methods

The experiment was conducted at Water Technology Center, College Farm, College of Agriculture, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar, Hyderabad, Telangana during *rabi* 2023-2024. The experimental study location is situated at 17°32' 18" N latitude, 78°41' 31" E longitude and at an altitude of 542.5m above mean sea level in the Southern Telangana Agro-Climatic Zone of Telangana. In this research, dhaincha was grown in open field conditions under irrigation levels. The key objective of the study was to determine the date of sowing and irrigation level, water productivity, nutrient uptake and to compute the cost economics of dhaincha during *rabi*. The experimental field soil was clay loam soils with a pH of 7.56 and EC of 0.97 dS m^{-1}. The experimental soil was low in organic carbon (0.39%) and available nitrogen (180.4 kg ha^{-1}), phosphorous (19.3 kg ha^{-1}) while high in available and potassium (317.1 kg ha^{-1}). The experiment had been designed in split plot design with 12 treatments, consisting of four dates of sowing *viz*., first fortnight of October (D_1), second fortnight of October (D_2), first fortnight of November (D_3), second fortnight of November (D_4) as main plots and three Irrigation levels *viz*., 0.6 IW/CPE ratio (I_1), 0.8 IW/CPE ratio (I_2) and 1.0 IW/CPE ratio (I_3) as sub plots which replicated thrice. The water source for the irrigation was from an open well near the field. Irrigation scheduling was imposed based on daily evaporation data taken down from USWB class 'A' open pan evaporimeter at Agro Climatological Research Centre, ARI Farm, Rajendranagar, Hyderabad. The total water used by the crop was 312.6, 413.3 and 514.3 mm in 0.6, 0.8 and 1.0 IW/CPE ratio respectively. The recommended dose of fertilizer was 25, 40 and 30 kg N, P_2O_5 and K_2O ha^{-1}, which were given to the field in the form of urea, single super phosphate and muriate of potash.

3. Results and Discussion

3.1 Growth attributes

3.1.1 Plant height (cm)

Plant height was significantly influenced by dates of sowing and irrigation levels at harvest of the crop. Interaction was found to be non-significant at harvesting stage (Table 1 and Figure 1).

Among the different dates of sowing, the highest plant height in dhaincha was recorded when sown in the first fortnight of November (158.5 cm) which was significantly on par with the crop sowing at second fortnight of October (155.5 cm) and significantly lowest plant height recorded with second fortnight of November (107.9 cm) and first fortnight of October (131.3 cm) at harvest. The increased plant height in earlier sowing dates may be attributed to optimal weather conditions during the crop growth period, which likely promoted rapid cell division and multiplication. This, in turn, led to greater plant elongation, with more nodes and increased internodal length. In delayed sowing conditions, internodal length was reduced, possibly due to the shorter day length. Early sowing generally enhanced growth characteristics compared to late sowing conditions. Similar findings were reported by Sangeetha *et al*. (2015) [4] in dhaincha, Sekar *et al*. (2013) [5] in sunhemp.

Among the irrigation levels, the highest plant height in dhaincha was observed with the 1.0 IW/CPE ratio (151.6 cm) compared to the 0.8 IW/CPE ratio (139.7 cm) and lowest at 0.6 IW/CPE ratio (123.6 cm) at harvest. The greater plant height observed with the 1.0 IW/CPE ratio may be due to the adequate soil moisture around the root zone, which improved nutrient uptake and translocation. This enhancement in growth and development, reflected in the plant height, was likely a result of the more frequent irrigations (10 irrigations) implemented throughout the entire crop growth period compared to the 0.8 IW/CPE ratio (8 irrigations) and the 0.6 IW/CPE ratio (6 irrigations). Another possible reason for the increased plant height under the 1.0 IW/CPE ratio could be that adequate soil moisture supply encourages cell division and expansion, leading to stem elongation. This, in turn, supports vegetative growth, which ultimately may have contributed to the improved plant height. The reduced plant height under the 0.6 IW/CPE ratio less irrigations (6 irrigations) implemented throughout the entire crop growth period might be due to moisture stress, which likely impacted plant growth. Similar findings were reported by Yadav *et al*. (2014) [6] in green gram.

3.1.2 Drymatter production (kg ha^{-1})

Drymatter production was significantly influenced by dates of sowing and irrigation levels at harvest. Interaction was found to be non-significant at harvest (Table 1).

Among the different dates of sowing, the significantly highest drymatter production in dhaincha was recorded when sown in the first fortnight of November (7056.7 kg ha^{-1}) and was comparable to sowing in the second fortnight of October (6851.13 kg ha^{-1}) and significantly lowest dry matter production recorded with second fortnight of November (4822.6 kg ha^{-1}), first fortnight of October (5615.0 kg ha^{-1}) at harvest of the crop. The increase in dry matter production during the first fortnight of November, compared to other sowing dates, is primarily due to the crop experiencing favourable weather conditions, such as longer day lengths during the vegetative phase. This exposure led to higher dry matter accumulation. Additionally, the early sown crop exhibited greater plant height and a higher number of branches, which enhanced the production of photosynthates and further contributed to increased dry matter accumulation. These results are consistent with the findings reported by Sekar *et al*. (2013) [5] in sunhemp.

Among the irrigation levels, the highest drymatter production in dhaincha was observed with the 1.0 IW/CPE ratio (6445.4 kg ha^{-1}) compared to the 0.8 IW/CPE ratio (6026.4 kg ha^{-1}) and significantly recorded lowest dry matter production 0.6 IW/CPE ratio (5787.2 kg ha^{-1}) at harvest. The increased dry matter production observed with the 1.0 IW/CPE ratio can be attributed to the consistent moisture availability in the root zone throughout the entire crop period. This ample moisture likely enhanced nutrient mobility in the soil and promoted vegetative growth, which in turn contributed to higher dry matter production. Similar findings were reported by Kaur *et al*. (2019) [7], sonal *et al*. (2021) [8] in green gram.

3.1.3 Number of branches Plant^{-1}.

Number of branches Plant^{-1} significantly influenced by dates of sowing and irrigation levels at 90 DAS. Interaction was found to be non-significant at 90 days after sowing (DAS) (Table 1).

Among the different dates of sowing, the highest number of branches Plant^{-1} in dhaincha was recorded when sown in the first fortnight of November (12.3) and which was comparable with second fortnight of October (10.9) and which was significantly superior with second fortnight of November (5.7), first fortnight of October (8.6) at 90 days after sowing (DAS). The maximum number of branches per plant with early sowing can be attributed to the longer vegetative stage experienced by the early sown crop, along with favourable weather conditions such as optimal temperature and light during the growing period. This combination stimulated the production of more nodes, resulting in a higher number of branches per plant. In contrast, the lowest number of branches per plant observed with sowing in the second fortnight of November is likely due to the reduced crop growth duration, leading to fewer nodes and branches per plant. Similar findings were reported by Patel *et al*. (2021) [9] in sunhemp.

Among the irrigation levels, the highest number of branches plant^{-1} in dhaincha was observed with the 1.0 IW/CPE ratio (11.4) compared to the 0.8 IW/CPE ratio (9.4) and 0.6 IW/CPE ratio (7.4) at 90 days after sowing (DAS). The higher number of branches at the 1.0 IW/CPE ratio is due to the ample moisture in the root zone from frequent irrigations (10 irrigations) throughout the crop growth period. This compared to the 0.8 IW/CPE ratio (8 irrigations) and 0.6 IW/CPE ratio (6 irrigations), which provided less moisture. The increased irrigation promoted higher nutrient uptake, rapid cell division, and cell enlargement, ultimately enhancing vegetative growth and increasing the number of branches per plant. These results are similar with the findings by Bhowmik *et al.* (2020) [10] in cowpea.

3.2 Yield attributes

3.2.1 Number of pods plant^{-1}

The number of pods plant^{-1} was significantly affected by sowing dates and irrigation levels. Interaction was found to be non-significant (Table 2)

Among the different dates of sowing, the higher number of pods per plant in dhaincha was recorded when sowing in the first fortnight of November (49.8) and which was on par with second fortnight of October (46.7). and significantly lowest number of pods plant^{-1} recorded with second fortnight of November (34.4), first fortnight of October (38.97). The higher number of pods per plant may be attributed to favourable weather conditions, which likely enhanced nutrient absorption particularly nitrogen, phosphorus, and potassium. This supported better growth, increased the availability of photosynthates, and improved seed filling, maintaining an optimal source-sink relationship in the first fortnight of November sowing. increase in number of pods plant^{-1} with early sowing over late sowing. These results are consistent with the findings of Singh *et al*. (2019) [11] in green gram.

Among the different irrigation levels, the number of pods plant^{-1} in dhaincha was significantly highest in irrigation scheduled at 1.0 IW/CPE ratio (45.6) than 0.8 IW/CPE ratio (42.8) and lowest at 0.6 IW/CPE ratio (39.0). This could be attributed to the increased frequency of irrigations applied at shorter intervals and the higher total consumptive use of water. These conditions helped to avoid soil moisture stress, creating an environment that was highly favourable for moisture and nutrient availability to the plants, ultimately leading to a higher number of pods per plant. Another reason for the increased number of pods per plant could be the frequent and higher supply of water to the soil, which enhanced water uptake. This, in turn, contributed to improved yield attributes and, ultimately, higher yield. These results are in accordance with those of Karande *et al*. (2019) [12] in green gram.

3.2.2 Number of Seeds Pod^{-1}

The number of seeds pod^{-1} was significantly affected by sowing dates and irrigation levels. Interaction was found to be non-significant (Table 2).

Among the different dates of sowing, the sowing dhaincha in the first fortnight of November (25.8) resulted in a significantly higher number of seeds per pod and which was on par with first fortnight of October (24.0) and significantly lowest number of seeds per pod recorded with second fortnight of November (17.1), first fortnight of October (21.2). Early sowing of dhaincha during the *rabi* season has been shown to produce a greater number of seeds per pod. Plants sown in the first fortnight of November benefited from favourable weather conditions, leading to enhanced growth and greater plant *vigor*. The vigorous plants can absorb more nutrients, including phosphorus. This enhanced phosphorus uptake likely played a significant role in reproductive processes such as pollination, fertilization, and seed set thereby increasing the number of seeds per pod in dhaincha. Late sowing (second fortnight of November) resulted in a significantly lower number of seeds per pod due to poor plant growth, including reduced height and dry matter production. This likely led to inefficient translocation of food reserves, contributing to the decreased seed count per pod. These results are consistent with those of Swarnkar *et al*. (2023) [13] in dhaincha, Kurubetta *et al*. (2008) [14] in cowpea.

Among the different irrigation levels, the number of seeds pods^{-1} in dhaincha was significantly highest in irrigation scheduled at 1.0 IW/CPE ratio (23.8) than 0.8 IW/CPE ratio (22.1) and 0.6 IW/CPE ratio (20.2). This could be attributed to higher biomass accumulation along with effective translocation and distribution of photosynthates from source to sink, which in turn led to enhanced stature of yield attributes (number of seeds pod^{-1}). These results are in accordance with those of Yadav *et al*. (2014) [7] in green gram, Bhowmik *et al*. (2020) [10] in cowpea

3.2.3 Pod length (cm)

Pod length was significantly affected by sowing dates and irrigation levels. Interaction was found to be non-significant (Table 2).

Among the different dates of sowing, the sowing dhaincha in the first fortnight of November (17.3 cm) resulted in a significantly higher pod length which was significantly on par with second fortnight of October (16.8 cm). significantly lesser pod length recorded with second fortnight of November (14.0 cm), first fortnight of October (15.2 cm). Early sowing of dhaincha during the *rabi* season demonstrated superior results in pod length. Plants sown in the first fortnight of November benefited from favourable weather conditions, which supported optimal growth and led to increased pod length. These results are consistent with those of Swarnkar *et al*. (2023) [13] in dhaincha.

Among the different irrigation levels, the pod length in dhaincha was significantly highest in irrigation scheduled at 1.0 IW/CPE ratio (16.8 cm) than 0.8 IW/CPE ratio (15.9 cm) and 0.6 IW/CPE ratio (14.8). The longest pod length was observed due to higher levels of available soil moisture, which significantly improved pod length. Smaller pods were recorded under the 0.6 IW/CPE ratio treatment, might be due to severe soil moisture stress affecting the plants, which ultimately led to a reduction in pod length. In general, the pod development stage is particularly sensitive to soil moisture stress. The findings are consistent with those reported by Patel *et al*. (2014) [11] in green gram, Deewan *et al*. (2014) [15] in cluster bean.

3.2.4 Seed yield (kg ha^{-1})

Seed yield was significantly affected by sowing dates and irrigation levels. Interaction was found to be non-significant. (Table 2 and Figure 2).

Among the different dates of sowing, the highest seed yield was recorded with dhaincha sowing in the first fortnight of November (730.2 kg ha^{-1}) which was significantly on par with second fortnight of October (689.8 kg ha^{-1}) and significantly lowest seed yield recorded with second fortnight of November (450.64 kg ha^{-1}), first fortnight of October (549.8 kg ha^{-1}). The significantly higher seed yield observed with sowing in the first fortnight of November, compared to delayed sowing dates, might be due to a greater proportion of the plant's total dry matter being allocated to the reproductive parts (seeds). The trend observed in seed yield for dhaincha sown during the first fortnight of November was also reflected in similar yield attributes, such as the number of branches per plant, pods per plant, seeds per pod, and hundred-seed weight. These factors likely played a significant role in enhancing the overall seed yield of dhaincha. Reddy *et al*. (2015) [16] also expressed similar views, attributing the higher seed yield in early-sown crops to the availability of optimal growing conditions such as temperature, light, humidity, and photoperiod that are favourable during the crop period. These conditions provide sufficient time for the crop to complete all physiological processes properly, unlike late-sown crops. The significantly lowest seed yield of dhaincha was recorded with sowing in the second fortnight of November. The reduction in yield for delayed sowings might be due to the cumulative effects of lower values in growth and yield components, which resulted in decreased seed yield. These results are consistent with those of Sangeetha *et al*. (2011) [4], Triveni *et al*. (2011) [17], Swarnkar *et al*. (2023) [3] in dhaincha.

Among the different irrigation levels, the seed yield in dhaincha was significantly highest in irrigation scheduled at 1.0 IW/CPE ratio (671.7 kg ha^{-1}) than 0.8 IW/CPE ratio (599.34 kg ha^{-1}) and 0.6 IW/CPE ratio (544.3 kg ha^{-1}). The higher seed yield observed at increased irrigation levels is might be due to the optimal moisture levels in the root zone throughout the crop growth period. This enhanced vegetative growth, resulting in greater plant height, dry matter production, and number of branches per plant. Improved photosynthesis and efficient translocation of photosynthates to the reproductive parts increased the number of pods per plant, seeds per pod, and pod weight per plant, ultimately leading to a higher seed yield of dhaincha. Another reason could be the increase in the number of irrigations applied at shorter intervals and the total consumptive use of water. This approach helps prevent soil moisture stress and provides very favourable conditions for moisture and nutrient availability. The lower number of green pods observed was due to an unsaturated soil moisture environment. Under water stress, a vapor gap can form around the roots due to decreased turgor pressure. This gap reduces nutrient availability to the roots, likely because of diminished contact between the roots and water particles, leading to a significant reduction in seed yield. These results are consistent with those of Yadav *et al*. (2014) [6], Karande *et al*. (2019) [12], Bhowmik *et al*. (2020) [9] in cowpea.

3.2.5 Stalk yield (kg ha^{-1})

Stalk yield was significantly affected by sowing dates and irrigation levels. Interaction was found to be non-significant. (Table 2).

Among the different dates of sowing, the highest stalk yield was recorded with sowing of dhaincha during first fortnight of November (6664.4 kg ha^{-1}) which was on par with second fortnight of October (6474.4 kg ha^{-1}) and significantly lowest stalk yield recorded with second fortnight November (4689.0 kg ha^{-1}), first fortnight of October (5365.0.2 kg ha^{-1}). This result was due to the cumulative effect of higher plant height, plant spread, number of leaves, and greater dry matter production. Additionally, the early-sown crop's best performance can be attributed to the favourable high temperature and moisture conditions during the crop growth period, which increased dry matter production and subsequently led to higher stalk yield. The lowest stalk yield was recorded with second fortnight November which was due to prevalence short day length at early stages of the crop growth. These results are consistent with those of Sangeetha *et al*. (2011) [4], Triveni *et al*. (2012) [17], Reddy *et al*. (2015) [16] in dhaincha.

Among the different irrigation levels, the stalk yield in dhaincha was significantly highest in irrigation scheduled at 1.0 IW/CPE ratio (6121.3 kg ha^{-1}) than 0.8 IW/CPE ratio (2881.0 kg ha^{-1}) and 0.6 IW/CPE ratio (5539.7 kg ha^{-1}). The increase in stalk yield was primarily due to adequate moisture supply throughout the entire crop growth period, which promoted better growth and development, resulting in higher plant height, more branches per plant, and a greater number of pods. These growth components likely contributed to the higher stalk yield. The significant reduction in stalk yield with limited water supply can be attributed to the internal water status affecting various physiological processes in the plant. Adequate moisture supports better vegetative growth, which enhances the absorption and utilization of nutrients and improves the efficiency of photosynthesis, ultimately leading to higher stalk yield. These results are consistent with those of Yadav *et al*. (2014) [6], Sonal *et al*. (2021) [8] in green gram.

3.2.6 Harvest Index (%)

Harvest index was significantly affected by sowing dates and irrigation levels. Interaction was found to be non-significant (Table 2).

Among the different dates of sowing, the highest harvest index was recorded with sowing of dhaincha during first fortnight of November (9.8%) which was on par with second fortnight of October (9.6%) and significantly lowest harvest index recorded with second fortnight November (8.7%), first fortnight of October (9.2%). The highest yield attributes observed with early sowing likely contributed to a higher harvest index, as it resulted in greater grain yield. This is due to the efficient partitioning of dry matter produced by the plant throughout all its growth stages. These results are in accordance with those. Sekar *et al*. (2013) [5] in sunhemp and Singh *et al*. (2019) [11] in green gram.

Among the different irrigation levels, the harvest index was significantly highest in irrigation scheduled at 1.0 IW/CPE ratio (9.7%) than 0.8 IW/CPE ratio (9.4%) and 0.6 IW/CPE ratio (8.8%). The reason might be due to the lowest grain yield and excessive vegetative growth might have attributed towards decrease in harvest index. Patel *et al*. (2014) [10], Karande *et al*. (2019) [12] in green gram.

3.2.7 Water productivity (kg m^{-3})

Water productivity significantly affected by sowing dates and irrigation levels. Interaction was found to be non-significant. (Table 2 and Figure 3).

Among the different dates of sowing. Highest water productivity was recorded with first fortnight of November (0.17 kg m^{-3}) which was significantly on par with second fortnight of October (0.16 kg m^{-3}) and significantly lowest water productivity recorded with second fortnight November (0.10 kg m^{-3}), first fortnight of October (0.13 kg m^{-3}),

Among the different irrigation levels, water productivity was significantly highest in irrigation scheduled at 0.6 IW:CPE ratio (0.17 kg m^{-3}) than 0.8 IW:CPE ratio (0.14 kg m^{-3}) and 1.0 IW:CPE ratio (0.13 kg m^{-3}). Water productivity was on par between 0.8 IW:CPE ratio and 1.0 IW:CPE ratio. The water productivity decreased slowly with the increase in the irrigation regime. These findings are in agreement with the findings of Salim *et al*. (2018) [3].

Table 1: Growth attributes of dhaincha as influenced by different sowing dates

Treatments	Plant height (cm)	Dry matter production (kg ha^{-1})	No of branches plant^{-1}
	At harvest	At harvest	90 DAS
Main plots: Dates of sowing			
D_1: 1st Fortnight of October	131.3	5615.0	8.65
D_2: 2nd Fortnight of October	155.5	6851.1	10.96
D_3: 1st Fortnight of November	158.5	7056.7	12.38
D_4: 2nd Fortnight of November	107.9	4822.6	5.77
S.Em±	3.58	155.0	0.44
CD (p=0.05)	12.37	536.5	1.52
Sub plots: Irrigation levels			
I_1: Irrigation scheduled at 0.6 IW/CPE	123.6	5787.2	7.45
I_2: Irrigation scheduled at 0.8 IW/CPE	139.7	6026.4	9.41
I_3: Irrigation scheduled at 1.0 IW/CPE	151.67	6445.4	11.45
S.Em±	2.82	71.6	0.29
CD (p=0.05)	8.45	214.8	0.88
Interaction			
Dates of sowing at same level of irrigation levels			
S.Em±	5.64	143.31	0.59
CD (p=0.05)	NS	NS	NS
Dates of sowing at different level of irrigation levels			
S.Em±	8.38	304.38	0.96
CD (p=0.05)	NS	NS	NS

Table 2: Yield attributes and Water use efficiency of dhaincha as influenced by different sowing dates and irrigation levels

Treatments	No of pods plant^{-1}	No of seeds pod^{-1}	Pod length	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest index (%)	Water productivity (kg m^{-3})
Main plots: Dates of sowing							
D_1: 1st Fortnight of October	38.9	21.2	15.2	549.8	5365.0	9.2	0.13
D_2: 2nd Fortnight of October	46.7	24.0	16.8	689.8	6474.4	9.6	0.16
D_3: 1st Fortnight of November	49.8	25.8	17.3	730.2	6664.4	9.8	0.17
D_4: 2nd Fortnight of November	34.4	17.1	14.0	450.6	4689.0	8.7	0.10
S.Em±	1.07	0.78	0.33	19.91	138.06	0.21	0.00
CD (p=0.05)	3.71	2.69	1.15	68.90	477.76	0.74	0.02
Sub plots: Irrigation levels							
I_1: Irrigation scheduled at 0.6 IW/CPE	39.0	20.2	14.8	544.3	5539.7	8.8	0.17
I_2: Irrigation scheduled at 0.8 IW/CPE	42.8	22.1	15.9	599.3	5741.4	9.3	0.14
I_3: Irrigation scheduled at 1.0 IW/CPE	45.6	23.8	16.8	671.7	6113.4	9.8	0.13
S.Em±	0.74	0.54	0.26	15.09	62.80	0.17	0.00
CD (p=0.05)	2.21	1.61	0.79	45.23	188.27	0.50	0.01
Interaction							
Dates of sowing at same level of irrigation levels							
S.Em±	1.47	1.07	0.52	30.17	125.60	0.33	0.08
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS
Dates of sowing at different level of irrigation levels							
S.Em±	2.37	1.72	0.78	45.82	270.11	0.50	0.12
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS

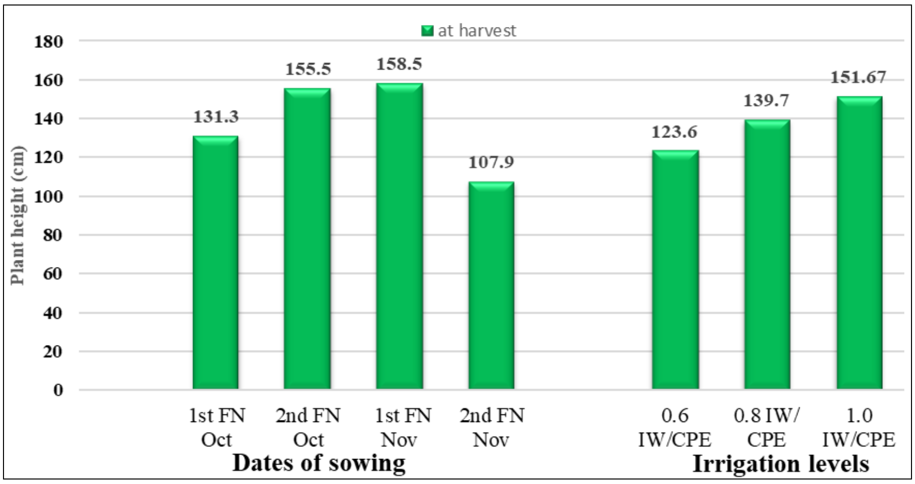

Fig 1: Plant height of dhaincha as influenced by different dates of sowing and irrigation levels

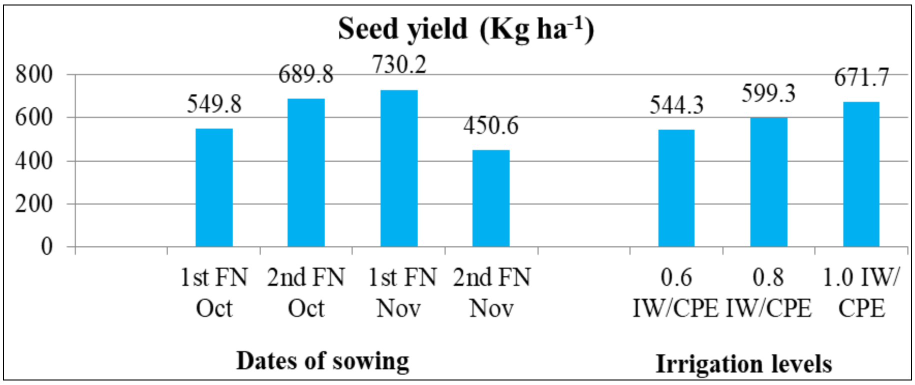

Fig 2: Seed yield of dhaincha as influenced by different dates of sowing and irrigation levels

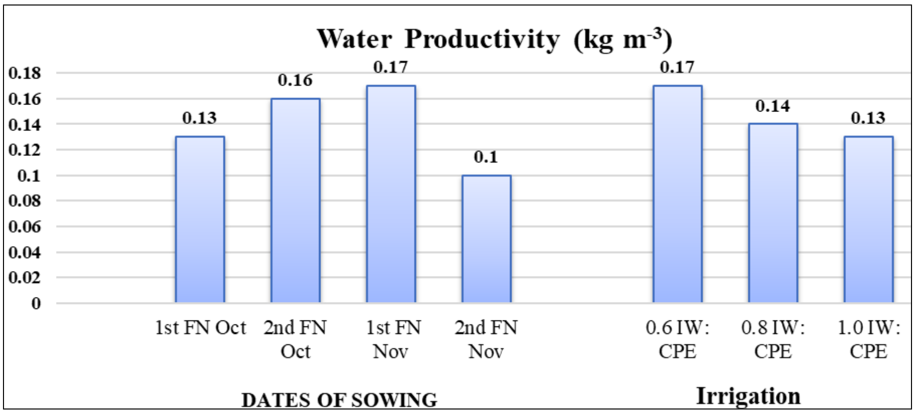

Fig 3: Water Productivity of dhaincha as influenced by different dates of sowing and irrigation levels

4. Conclusion

The present study has revealed that October second fortnight to November first fortnight is the optimum time of sowing for realizing higher seed yield of dhaincha during *rabi* in clay loam soils of Southern Telangana Agro-Climatic Zone of Telangana. Among the different irrigation levels, irrigation at 1.0 IW/CPE ratio significantly improved all growth, yield attributes and yield of dhaincha during *rabi*. Among the irrigation levels, irrigation scheduled at 0.6 IW/CPE ratio recorded higher water productivity during the *rabi* season which can be used at regions of limited water conditions.

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