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Yield, nutrient uptake and post-harvest soil available Nutrient status of dhaincha as influenced by varied times of sowing and spacings

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Abstract
A field experiment was conducted during *rabi*, 2022-23 on sandy clay loam soils of Tirupati in a split-plot design and replicated thrice. The treatments consisted of four times of sowing *viz.*, I FN of October (T_1), II FN of October (T_2), I FN of November (T_3) and II FN of November (T_4) allotted to main plots and three spacings *viz.*, 30 cm x 20 cm (S_1), 45 cm x 20 cm (S_2) and 60 cm x 20 cm (S_3) assigned to sub plots. The results of the experiment revealed that among varied times of sowing tried in dhaincha, I FN of November sown crop resulted in highest seed and stalk yield, nutrient uptake and lower amounts of post-harvest soil available nutrients. Significantly higher seed and stalk yield, nutrient uptake and lower amounts of post-harvest soil available nutrients were observed when dhaincha was sown at a spacing of 30 cm x 20 cm.

Keywords: Dhaincha, fortnight, spacing, time of sowing and nutrient uptake

Introduction
Green manuring is one of the most effective and environmentally sound method for Achieving sustainable soil productivity in agriculture. It increases soil fertility by adding organic matter back into the soil. This organic matter increases the water-holding capacity of the soil, improves soil structure and encourages the activity of beneficial soil biota. Plant nutrients are provided in a better form and over a longer period for the crops grown after green manuring.

Dhaincha is a multi-purpose green manure crop, can be grown in all seasons having sufficient moisture in the soil. It not only improves physical properties but also helps in meeting the nitrogen requirement of succeeding crop, by fixing nitrogen through nodules. It is a quick growing, succulent and easily decomposable upon incorporation and can release nutrients as per the need of the crop. Dhaincha as a green manure crop has the potential to add 8-21 tonnes of green matter and 42-95 kg N ha^{-1} (Mishra and Nayak, 2004). [3] Further, the biomass is rich in nutrients especially nitrogen (3.5%), phosphorus (0.6%) and potassium (2.1%). Additionally, it is more resistant to salinity, alkalinity and poor drainage conditions than other green manure crops. It serves as a cover crop and guards against wind and water erosion of the soil.

The availability of seed in the market depends on its multiplication but, the farmers are perplexed regarding the optimum time of sowing. More efficient use of time, light, temperature, precipitation and other elements is made possible by sowing the crop at the right time. It is therefore essential to adjust the sowing time in such a way to provide optimum soil and atmospheric conditions required for better growth and development of the crop. Spacing is one of the most important parameter determining the seed yield as well as other agronomic attributes of crop. Spacing adopted affects the plant architecture and alters growth and development pattern. Spacing with optimum plant population maintained unit $area^{-1}$ for any crop helps it to expresses it's full genetic potential in an ideal environment with optimum soil fertility. Hence, it is necessary to find out the suitable time of sowing with optimum spacing for maximizing the yields of dhaincha in the Southern Agro-Climatic Zone of Andhra Pradesh.

Materials and Methods

The present investigation was carried out at wetland farm, S.V. Agricultural College, Tirupati campus of Acharya N. G. Ranga Agricultural University which is in the Southern Agro-climatic Zone of Andhra Pradesh. The experiment was laid out in a split-plot design with four main plots and three sub plots and replicated thrice. The treatments consisted of four times of sowing *viz.*, I FN of October (T_1), II FN of October (T_2), I FN of November (T_3) and II FN of November (T_4) assigned to main plots and three spacings *viz.*, 30 cm x 20 cm (S_1), 45 cm x 20 cm (S_2) and 60 cm x 20 cm (S_3) allotted to sub plots. The experimental field was sandy clay loam in texture which is low in organic carbon (0.19%). The soil is neutral in reaction (pH 6.8), medium in available nitrogen (283.5 kg ha^{-1}), available phosphorus (54.5 kg ha^{-1}) and available potassium (264.5 kg ha^{-1}). Total rainfall of 310 mm was received in 20 rainy days during the crop growing period. Nitrogen, phosphorus and potassium were applied as per the recommendation *i.e.*, 20-40-30 kg N, P_2O_5 & K_2O ha^{-1} through urea, single super phosphate and muriate of potash (MOP) uniformly to all the plots. Available soil nitrogen (N) was estimated by the method as described by Subbiah and Asija (1956) [12], available phosphorus by Olsen *et al.* (1954) [4] using a spectrophotometer and available potassium by using flame photometry (Stanford and English, 1949) [11] and were expressed in kg ha^{-1}. Plant samples collected for estimation of dry matter production were used to estimate the nutrient uptake by the crop at the time of harvest. The oven dried samples of plant material were ground in a willey mill and analyzed for N, P and K contents. The nitrogen, phosphorus and potassium uptake were calculated by multiplying the nutrient content of the plant sample with the corresponding total dry matter and expressed in kg ha^{-1}. The data collected on yield, nutrient uptake at harvest and post-harvest soil available nutrients were analyzed statistically following the procedure given by Panse and Sukhatme (1978) [5] wherever the treatment differences were significant, critical differences were worked out at a 5 percent level of probability. Treatment differences that were not significant are denoted as NS.

Results and Discussion

Yield

Significantly higher seed and stalk yield of dhaincha was realized when the crop was sown during I FN of November (T_3). The next best time of sowing for obtaining higher seed and stalk yield was II FN of October (T_2) which was significantly superior than that of I FN of October (T_1). Lower seed and stalk yield was obtained with II FN of November (T_4) sown crop. Higher yield of dhaincha in I FN of November (T_3) sown crop can be attributed to longer vegetative phase leading to improvement in growth parameters (plant height and dry matter production) due to better availability of the moisture, nutrients and prevalence of congenial weather conditions in terms of higher GDD, PTU and HTU which in turn maintained better source to sink relationship as well as maximum uptake of nutrients by the crop. Cumulative effect of improvement in growth and yield attributes resulted in higher yield. The present findings corroborate with that of Chandrasekhar (2011) [1] and Reddy *et al.* (2015) [8].

Dhaincha sown at a spacing of 30 cm x 20 cm (S_1) produced higher seed and stalk yield followed by that with 45 cm x 20 cm (S_2) and 60 cm x 20 cm (S_3) in order of descent with a significant disparity between any two of the three spacings tested. Maintenance of higher plant population at 30 cm x 20 cm spacing resulted in higher seed and stalk yield. These findings are in support of Kavin *et al.* (2018) [2], Tungoe *et al.* (2018) [13] and Shinde *et al.* (2021) [10].

Nutrient uptake

With reference to the varied times of sowing tried, the higher nutrient (nitrogen, phosphorus and potassium) uptake at harvest of dhaincha was recorded when the crop was sown during I FN of November (T_3), which was significantly superior to that of II FN of October (T_2). Higher nutrient uptake with the crop sown during I FN of November (T_3) might be due to longer growth period of the crop resulting in efficient utilization of growth resources combined with added advantage of favourable weather conditions, that lead to elevated growth stature in terms of dry matter production. The present investigation confirms the documented evidence of Reddy *et al.* (2015) [8]. Lower nutrient uptake was recorded with the crop sown during II FN of November (T_4) which was closely followed by that of I FN of October (T_1).

Dhaincha sown at a spacing of 30 cm x 20 cm (S_1) resulted in significantly higher nutrient uptake. The next best spacing was 45 cm x 20 cm (S_2) which was significantly superior to that of 60 cm x 20 cm (S_3). Higher nutrient uptake at 30 cm x 20 cm spacing might be due to higher dry matter production which have lead to removal of higher amount of nutrients from the soil. These results were similar with the findings of Sangeetha *et al.* (2011) [9].

Post-harvest soil available nutrient status

Dhaincha sown during II FN of November (T_4) recorded higher post-harvest soil available nitrogen, phosphorus and potassium which was on par with that sown during T_1 (I FN of October). The latter was significantly higher than that of crop sown during II FN of October (T_2). Significantly lower post-harvest soil available nitrogen, phosphorus and potassium were recorded with the crop sown during I FN of November (T_3). This might be attributed to higher nutrient uptake by the crop sown during I FN of November (T_3) to accumulate maximum dry matter resulting in greater reduction in soil available nitrogen, phosphorus and potassium at harvest of dhaincha. These results are in accordance with the findings of Pimpalshende (2022) [6].

Higher post-harvest soil available nitrogen, phosphorus and potassium were recorded when dhaincha was sown at a spacing of 60 cm x 20 cm (S_3) which was significantly superior to the rest of the plant spacings tested. This might be due to maintenance of lesser plant population which reduced the uptake of nutrients and increased the post-harvest soil available nitrogen, phosphorus and potassium. The next best spacing that recorded higher post-harvest soil available nutrients was 45 cm x 20 cm (S_2). Dhaincha sown at a spacing of 30 cm x 20 cm (S_1) recorded significantly lower post-harvest soil available nitrogen, phosphorus and potassium. These results corroborate with the findings of Prathibha (2017) [7].

Table 1: Yield and nutrient uptake of dhaincha at harvest as influenced by varied times of sowing and spacings

Treatments	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Nitrogen Uptake (kg ha^{-1})	Phosphorus Uptake (kg ha^{-1})	Potassium Uptake (kg ha^{-1})
Times of sowing					
T_1 - I FN of October	445	3502	106	26	55
T_2 - II FN of October	496	4022	116	30	60
T_3 - I FN of November	564	4587	126	33	67
T_4 - II FN of November	406	3482	104	25	53
S.Em±	10.5	127.8	2.2	0.7	1.0
CD (P=0.05)	37	451	8	2	4
Spacings					
S_1 - 30 cm x 20 cm	533	4401	128	31	63
S_2 - 45 cm x 20 cm	485	3827	110	29	59
S_3 - 60 cm x 20 cm	416	3466	100	26	54
S.Em±	10.7	115.8	2.1	0.5	0.9
CD (P=0.05)	32	350	6	1	3
Times of sowing (T) x Spacings (S)					
S at T					
S.Em±	18.2	221.4	3.8	1.1	1.8
CD (P=0.05)	NS	NS	NS	NS	NS
T at S					
S.Em±	20.5	228.3	4.1	1.0	1.8
CD (P=0.05)	NS	NS	NS	NS	NS

Table 2: Post-harvest soil available N, P_2O_5 and K_2O as influenced by varied time of sowings and spacings in dhaincha

Treatments	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
Times of sowing (T)			
T_1 - I FN of October	226	50	198
T_2 - II FN of October	200	45	170
T_3 - I FN of November	177	41	147
T_4 - II FN of November	237	53	204
S.Em±	5.7	0.8	5.5
CD (P=0.05)	20	3	19
Spacings (S)			
S_1 - 30 cm x 20 cm	185	40	156
S_2 - 45 cm x 20 cm	211	46	179
S_3 - 60 cm x 20 cm	234	56	204
S.Em±	6.1	1.0	4.8
CD (P=0.05)	18	3	15
Time of sowings (T) x Spacings (S)			
S at T			
S.Em±	9.9	1.5	9.5
CD (P=0.05)	NS	NS	NS
T at S			
S.Em±	11.5	1.8	9.6
CD (P=0.05)	NS	NS	NS

Conclusion

Dhaincha sown during I FN of November with a spacing of 30 cm x 20 cm performed well and resulted in higher seed and stalk yield, nutrient uptake and lower post-harvest soil available nutrients.

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