J. Indian Soc. Coastal Agric. Res. 39(1): 78-85 (2021)

Productivity and Nutrient Uptake of *Rabi* Pigeon Pea [*Cajanus cajan* (L.)] under Varied Sowing Window, Plant Geometry and Residual Fertility after Rice in Coastal Odisha

B. P. PATRA*, S. N. JENA, R. K. PAIKARAY, L. M. GARNAYAK and R. K. NAYAK

Department of Agronomy, Odisha University of Agriculture and Technology
Bhubaneswar - 751 003, Odisha, India

Received: 12.05.2021 Accepted: 15.06.2021

A field experiment was conducted during the *rabi* seasons for two consecutive years of 2018-19 and 2019-20 to study the influence of sowing window, planting geometry and residual soil fertility on yield and nutrient uptake of *rabi* pigeon pea on sandy loam soil of coastal Odisha. The experiment was conducted in a split-split plot design with pigeon pea grown after harvesting of *kharif* rice each year and, consisting of two sowing windows in main plots, three residual effects of nutrient management in subplots and three row spacings in sub-sub plots. Pigeon pea sown during the 2nd fortnight of October (after harvest of 10th July planted rice) produced significantly higher seed (48.8 and 40.3% in both the years) and stalk yield (47.9 and 37.3% in both the years). The pooled data for both the years revealed that the nitrogen content of seed increased by 6.6% while the N, P and K uptake in seed and stalk increased by 53.6, 49.6, 51.2, 60.8, 41.9 and 55.5%, respectively over the second sowing window (1st fortnight of November). The residual effect of nutrients applied to rice registered a significant effect in improving the yield and nutrient uptake and the highest yield and nutrient uptake in pigeon pea was observed in STBFR (Soil test based fertilizer recommendation) + FYM treated plot. The pigeon pea crop grown at 40 cm row spacing realized higher nitrogen content of 3.23 and 1.11% while all other nutrients being at par. However, the nutrient uptake (N-50.28, P-6.24 and K-8.59 kg ha^{-1}) by seed and stalk (N-46.50, P-5.96, K-48.15 kg ha^{-1}) was higher under 30 cm row spacing. Interaction between sowing window and plant geometry were significant in influencing yield as well as N uptake indicating a higher amount of yield and nutrient uptake in early sowing with 30 cm row spacing and STBFR+FYM.

(***Key words:*** *Nutrient uptake, Pigeonpea yield, Row spacing, Residual effect, Sowing window)*

Pigeon pea is an important grain legume of the semi-arid tropics, of the world and is one of the major pulse crops of India where it is generally grown as an annual crop, though it is intrinsically perennial. Pigeon pea has special morphological characters with respect to deep rooting and drought tolerance that have made this crop adaptable for growing in a wide range of unfavourable conditions with uncertain rainfall and varied soil depth. One of the significant achievements in the field of grain legume cultivation in India is that pigeon pea can be grown as a rabi crop (Sengupta and Roy, 1982) particularly in the areas where winter is mild and short like Andhra Pradesh, West Bengal, Bihar and Odisha. In Odisha, the area under pigeon pea increased from 27.0 thousand ha in 1965-66 to 140.0 thousand ha in 2016-17. The total production is around 0.12 million tonnes and the total productivity is 884 kg ha^{-1} in 2016-17 (Directorate of Economics and Statistics, 2016-17). Production of pulses is concentrated in districts like Cuttack, Puri, Kalahandi, Koraput, Dhenkanal, Bolangir, Rayagada, Nuapada and Sambalpur.

Among the various agronomic practices, sowing date and plant geometry have more influence on yield than other production factors. Appropriate sowing window causes optimal utilization of climatic factors such as temperature, humidity and day length. Early sowing in the season encourages higher vegetative growth whereas, delayed sowing may shrink the vegetative phase, which in turn reduces dry matter accumulation leading to poor partitioning to reproductive parts and ultimately poor realization of the potential yield. Optimum plant population needs to be maintained in order to exploit maximum natural resources such as, nutrients, sunlight, soil moisture and to ensure satisfactory yield hence they are known to affect crop environment, which influence the yield and yield components.

*Corresponding author: E-mail: bishnupriya11patra@gmail.com

It is widely recognized that neither the use of organic manures alone nor chemical fertilizers can achieve sustainability in yield under modern intensive farming. Contrary to the detrimental effects of inorganic fertilizers, organic manures are available indigenously which improve soil health resulting in enhanced crop yield. However, the use of organic manures alone might not meet the plant requirement due to the presence of relatively low levels of nutrients. Therefore, to make the soil well supplied with all the plant nutrients in the readily available form and to maintain good soil health, it is necessary to use organic manures in conjunction with inorganic fertilizers to obtain optimum yield as well as a better residual effect. Rice-pulse cropping system is one of the important cropping systems in Odisha. With the advantage of the considerable area under rice-fallow system and retreating monsoon, higher demand for pigeon pea in state and mild winter suitable for the crop, *rabi*-pigeon pea is taken as a second crop after rice. A declining trend in productivity has been observed in several long term experiments all over India in this cropping system. The information on appropriate sowing window, plant population and nutrient management for *rabi*-pigeon pea are very meagre in different parts of the country under the rice-pigeon pea cropping system. Hence, the present investigation involving the residual effect of organic fertilizers integrated with inorganics applied in rice, different sowing window and plant population in pigeon pea was taken up to study their influence on productivity, nutrient content and uptake.

MATERIALS AND METHODS

The experiment was conducted during two consecutive *rabi* seasons of 2018-19 and 2019-20 under the medium land situation in the Agronomy Main Research Farm, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India (20°15″ N Latitude and 85º 52″ E Longitude). The soil of the experimental site was sandy loam in texture, acidic (pH - 5.30), non-saline (EC 0.20 dS m^{-1}), low in organic carbon (0.32%), low in available nitrogen (198 kg ha^{-1}), medium in available phosphorus (18 kg ha^{-1}) and medium in available potassium (193 kg ha^{-1}). The rice (cv. Naveen) – pigeon pea (cv. PT-12) cropping system was laid in a split-split plot design, consisting of two sowing windows, *viz*., 1st sowing at 2nd fortnight of October (after harvest of 10th July planted *kharif* rice), 2nd sowing at 1st fortnight of November (after 25th July planted *kharif* rice) in main plots, three residual effects of nutrient [Residual effect of soil test based fertilizer recommendation (STBFR), STBFR + GM (Green manure, Dhaincha) and STBFR + FYM (Farmyard manure)] which were applied to the preceding rice crop in subplots and three sowing geometry (row-row spacing of 20, 30 and 40 cm) in sub-sub plots. Fertilizer was applied to the previous rice crop after testing the soil @ 100:40:40::N:P:K kg ha^{-1}. Green manure (Dhaincha) was incorporated @ 25 kg ha^{-1} and FYM was applied @ 4 t ha^{-1} (dry weight basis) to the respective treatments. Herbicide imazethapyr was sprayed as a pre-emergence application @ 1.5 ml L^{-1} of water on the second day after sowing. At harvest after threshing with the help of a mini-plot thresher, the seed yield was measured for each net plot area and converted into q ha^{-1}. Stalk yield was calculated by subtracting seed yield from biological yield for each net plot area and expressed in q ha^{-1}.

Nitrogen, phosphorus, potassium content in each part of the pigeon pea at each stage was determined. For analysis of N, P and K, oven-dried plant material (seed and stalk at harvest) from each plot was ground separately. Nitrogen, phosphorus and potassium contents in the samples were analyzed using Nessler's reagent method (Lindner, 1944), Vanadomolybdo-phosphoric acid yellow colour method (Jackson, 1973) and flame photometer method (Richards, 1954), respectively as mentioned by Nagamani *et al*. (2020).

The uptake of each nutrient was computed as:

$$\text{Nutrient uptake by seed (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content in seed (\%) x Seed yield (kg ha}^{-1}\text{)}}{100}$$

$$\text{Nutrient uptake by stalk (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content in stalk (\%)} \times \text{Stalk yield (kg ha}^{-1}\text{)}}{100}$$

The data were statistically analyzed by analysis of variance as described by Panse and Sukhatme (1985) at 5% level of significance.

RESULTS AND DISCUSSION

Seed and stalk yield

Data pertaining to the seed and stalk yield as influenced by different times of sowing, the residual effect of nutrient management and row spacing are presented graphically in Fig. 1 (a & b). The differences

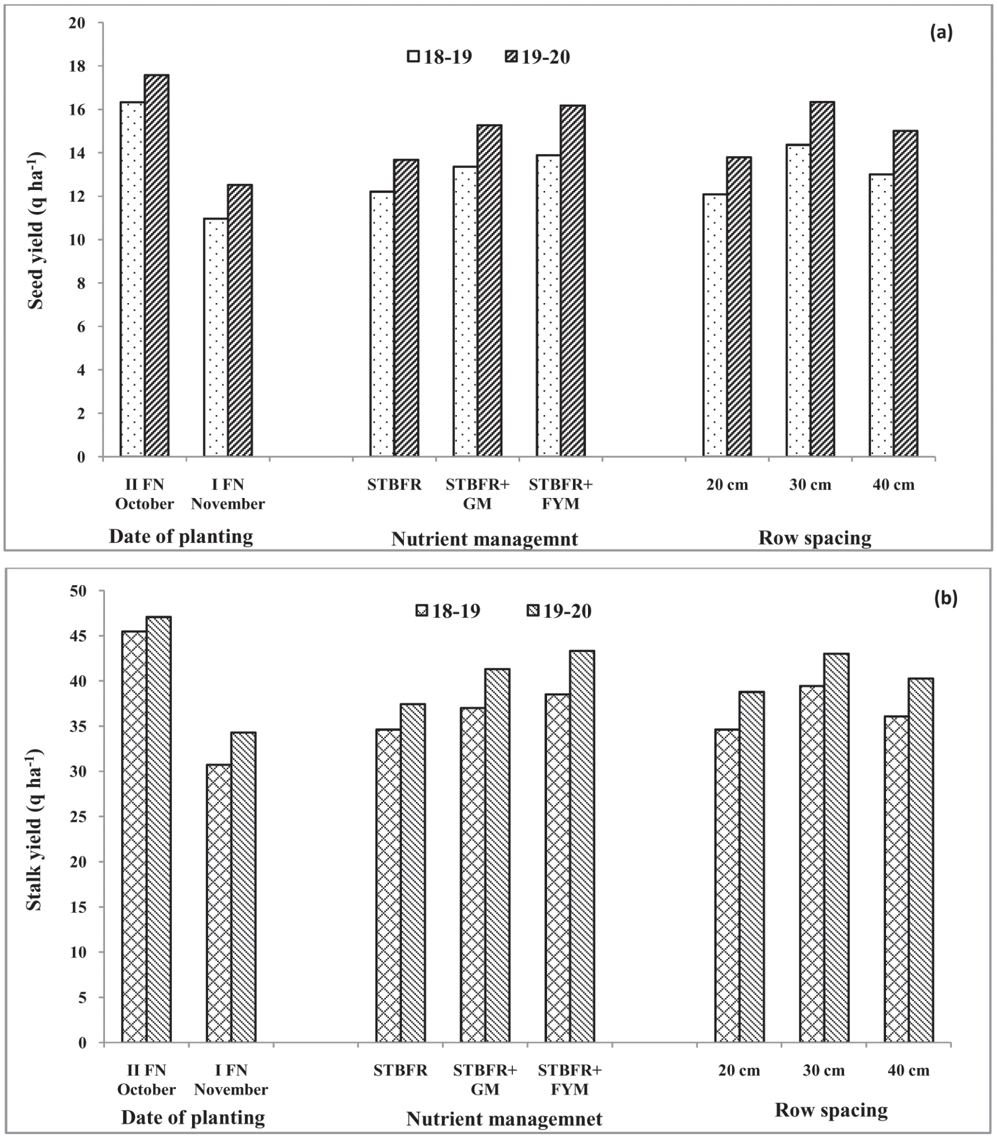

Fig. 1. *Seed (a) and stalk yield (b) of pigeon pea as affected by the date of planting, nutrient management and row spacing*

in seed yield due to different times of sowing were found significant. It was observed from the result (Fig 1a.) that early sowing after 10th July planted rice crop *i.e.,* during 2nd fortnight of October registered significantly higher seed yield over 15 days delay in planting. The increase in yield over delayed sowing (1st fortnight of November) was found to be 48.8, 40.3% (data not given) in 2018-19 and 2019-20, respectively. This was might be due to higher dry matter production because of the longer vegetative phase which resulted in greater translocation of food materials to the reproductive parts and was reflected in the superiority of yield attributing parameters (Ram and Dixit, 2001; Laxminarayana, 2003; Vakeswaran *et al*., 2016). Similarly, early sowing resulted in higher stalk yield (47.9 and 37.3%, respectively in both years). than late sowing *i.e.,* after harvest of 25th July sown rice (pigeon pea sown on 1st fortnight of November). The growth and yield parameters in the early sown crop were influenced significantly over delayed sowing due to enhanced photosynthetic activity and efficient transfer of metabolites to the seed led to the resultant increase in crop yield. These results are in agreement with the findings of Nagamani *et al*. (2020).

The results presented in Fig. 1a. revealed an appreciable effect of the residual effect of nutrient management on seed yield of pigeon pea. The seed yield decreased linearly in the order of the residual effect of STBFR + FYM > STBFR + GM > STBFR alone. Higher stalk yield was recorded in the STBFR + FYM treatment while in the other two treatments *i.e*., STBFR + GM and STBFR alone, the yields were found to be statistically similar. The higher seed and stalk yield of pigeon pea due to residual effect might be attributed to the higher availability of both macro and micronutrients, facilitating their uptake. This resulted in better growth and dry matter production by the occurrence of different beneficial microorganisms, presence of growth-promoting substances, hormones, enzymes, antibiotics etc., in organic manure treated plots. Similar results were reported by Barik *et al*. (2008) and Laxmi *et al*. (2012).

Optimum plant population plays an important role in harnessing the yield potential. Row spacing had a significant effect on the seed yield of pigeon pea (Fig. 1a). Higher seed yield was recorded under 30 cm row spacing, which is significantly higher by 9.13 and 16.45% (data not given) over 40 cm and 20 cm row spacings, respectively. Different row spacings also had a significant influence on stalk yield. Row spacing of 30 cm produced a higher stalk yield than wider (40 cm) and narrow (20 cm) spacings. The better availability of growth resources like water, nutrients, air, mulching, better cultural practices and effective weed control in wider plant geometry helped the plants to exhibit their full potential and produced higher yields than closely spaced plants. Corroborative results were reported by Gajera *et al*. (2002), Meena *et al*. (2011), Vakeswaran *et al*. (2016) and Swathi *et al*. (2017).

Nutrient content and uptake

The data on N, P, K content and uptake has been presented in Tables 1 and 2. The results revealed that the date of sowing had a significant effect in improving the nitrogen content of seed and stalk. Nitrogen content and uptake in both seed and stalk were found to be significantly higher in early sown condition (after harvest of 10th July sowing of rice *i.e*., 2nd fortnight of October) as compared to 15 days delayed sown crop (1st fortnight of November). Pigeon pea sown during 2nd fortnight of October resulted in significantly higher nitrogen content in seed by 6.5% and N, P and K uptake in seed and stalk increased by 53.6, 49.6, 51.2, 60.8, 41.9 and 55.5%, respectively over the second sowing window (1st fortnight of November). The longer duration of the crop due to early sowing allowed the crop to absorb nutrients for a longer time leading to a higher concentration of nutrients in the plant (Nagamani *et al*., 2020). In the case of P and K contents, early sowing resulted in numerically higher nutrient content in both seed and stalk while they were statistically similar. Early sown crop (2nd fortnight of October) had significantly higher P uptake by seed as well as K in both seed and stalk. However, P uptake in the stalk did not differ significantly from the late sown crop in the first year. This anomaly might have occurred because of the non-significant differences in the nutrient content of the crop. Higher nutrient uptake with the early sown crop was due to the longer vegetative phase of the crop that has lead to efficient use of growth resources and hence higher dry matter production. Similar results were reported by Nagamani *et al*. (2020).

Nutrient content of both seed and stalk were found to be statistically similar among the different nutrient management treatments given to previous rice crop. The residual effect of nutrient management had an appreciable effect on improving nutrient uptake of pigeon pea crop. A significant difference was observed in the case of N, P and K uptake in the seed. N and P uptake by the stalk were found significantly higher in STBFR+FYM treatments given to preceding rice crop. Both organic manure based treatments were found to be statistically similar in nutrient uptake by seed and stalk but were significantly higher over STBFR alone. This might be due to the application of organic manure in lowland rice that increased the activity of beneficial microbes and colonization of mycorrhizal fungi, which played an important role in the mobilization of nutrients and had better residual effect thereby leading to higher availability of nutrients facilitating uptake by plants (Chakravorti and Samantaray, 2006; Laxmi *et al*., 2012). There is no significant difference in K uptake in stalk due to the residual effect of the nutrients applied to the previous rice crop. This could be possibly attributed to the non-significant differences among the treatments in terms of nutrient content.

Plants grown under wider row spacing *i.e* 40 cm was superior in nutrient content, while both 30 cm and 40 cm row spacing had no significant disparity in nutrient content by seed and stalk. It might be due to less

Table 1. *Effect of sowing window, planting geometry and residual effect of nutrient management on nutrient content of pigeon pea*

Treatment	N content in seed (%)			N content in stalk (%)			P content in seed (%)			P content in stalk (%)			K content in seed (%)			K content in stalk (%)		
	18-19	19-20	Pooled	18-19	19-20	pooled	18-19	19-20	Pooled	18-19	19-20	Pooled	18-19	19-20	Pooled	18-19	19-20	Pooled
Date of sowing																		
2nd fortnight of October	3.222	3.325	3.274	1.078	1.127	1.103	0.398	0.408	0.403	0.135	0.153	0.144	0.531	0.598	0.565	1.098	1.242	1.170
1st fortnight of November	3.044	3.100	3.072	0.953	1.000	0.976	0.373	0.404	0.389	0.145	0.148	0.147	0.507	0.576	0.541	0.959	1.169	1.064
SEm±	0.039	0.032	0.025	0.065	0.062	0.045	0.005	0.010	0.006	0.010	0.004	0.005	0.022	0.017	0.014	0.034	0.059	0.034
CD at 5%	0.174	0.142	0.086	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Nutrient management																		
STBFR	3.083	3.217	3.150	0.979	1.019	0.999	0.371	0.398	0.384	0.139	0.151	0.145	0.508	0.566	0.537	0.975	1.177	1.076
STBFR+ GM	3.150	3.238	3.194	1.038	1.097	1.067	0.377	0.408	0.393	0.140	0.147	0.143	0.518	0.588	0.553	1.041	1.200	1.120
STBFR+ FYM	3.167	3.183	3.175	1.029	1.075	1.052	0.409	0.413	0.411	0.143	0.153	0.148	0.532	0.606	0.569	1.069	1.240	1.155
SEm±	0.047	0.023	0.026	0.066	0.060	0.045	0.014	0.007	0.008	0.003	0.005	0.003	0.029	0.017	0.017	0.072	0.076	0.052
CD at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Row Spacing																		
20 cm	3.042	3.129	3.085	0.896	0.923	0.909	0.380	0.401	0.391	0.144	0.147	0.145	0.492	0.565	0.528	0.968	1.144	1.056
30 cm	3.150	3.254	3.202	1.063	1.129	1.096	0.380	0.411	0.395	0.139	0.152	0.146	0.506	0.586	0.546	1.042	1.234	1.138
40 cm	3.208	3.254	3.231	1.088	1.139	1.113	0.397	0.407	0.402	0.138	0.153	0.146	0.560	0.609	0.584	1.076	1.240	1.158
SEm±	0.042	0.033	0.027	0.045	0.047	0.032	0.011	0.010	0.007	0.003	0.003	0.002	0.027	0.020	0.017	0.040	0.047	0.031
CD at 5%	0.121	0.096	0.076	0.128	0.135	0.091	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 2. *Effect of sowing window, planting geometry and residual effect of nutrient management on nutrient uptake of pigeon pea*

Treatment	N uptake in seed (Kg ha^{-1})			N uptake in stalk (Kg ha^{-1})			P uptake in seed (Kg ha^{-1})			P uptake in stalk (Kg ha^{-1})			K uptake in seed (Kg ha^{-1})			K uptake in stalk (Kg ha^{-1})		
	18-19	19-20	Pooled	18-19	19-20	pooled	18-19	19-20	Pooled	18-19	19-20	Pooled	18-19	19-20	Pooled	18-19	19-20	Pooled
Date of sowing																		
2nd fortnight of October	52.67	58.48	55.58	49.25	53.46	51.35	6.52	7.23	6.87	6.15	7.26	6.70	8.70	10.63	9.66	50.05	58.70	54.38
1st fortnight of November	33.46	38.88	36.17	29.43	34.42	31.92	4.10	5.07	4.59	4.36	5.07	4.72	5.58	7.22	6.39	29.67	40.26	34.96
SEm±	0.53	0.84	0.50	2.54	1.63	1.51	0.11	0.17	0.10	0.43	0.33	0.28	0.24	0.49	0.27	1.49	3.04	1.69
CD at 5%	2.40	3.81	1.73	11.41	7.32	5.21	0.48	0.79	0.36	N.S.	1.48	0.97	1.07	2.19	0.94	6.74	13.69	5.87
Nutrient management																		
STBFR	39.59	44.23	41.91	36.12	38.66	37.39	4.77	5.45	5.11	4.82	5.66	5.24	6.47	7.85	7.16	35.49	44.38	39.94
STBFR+ GM	43.95	49.87	46.91	40.46	45.96	43.21	5.26	6.26	5.76	5.27	6.09	5.68	7.28	9.01	8.15	40.62	49.76	45.19
STBFR+ FYM	45.67	51.93	48.79	41.44	47.19	44.31	5.91	6.74	6.32	5.68	6.74	6.21	7.68	9.91	8.79	43.47	54.29	48.88
SEm±	0.75	1.42	0.81	2.32	2.34	1.65	0.23	0.26	0.17	0.14	0.32	0.17	0.44	0.37	0.28	2.59	2.92	1.96
CD at 5%	2.31	4.39	2.35	7.16	7.21	4.81	0.72	0.79	0.51	0.44	0.98	0.51	N.S.	1.15	0.84	N.S.	N.S.	5.71
Row Spacing																		
20 cm	38.56	43.34	40.95	32.57	36.37	34.47	4.81	5.56	5.19	5.10	5.75	5.42	6.23	7.86	7.04	35.36	44.79	40.07
30 cm	47.10	53.46	50.28	44.02	48.98	46.50	5.72	6.76	6.24	5.36	6.56	5.96	7.56	9.64	8.59	43.19	53.09	48.15
40 cm	43.55	49.23	46.39	41.42	46.47	43.94	5.41	6.12	5.76	5.30	6.18	5.74	7.63	9.28	8.45	41.03	50.56	45.79
SEm±	0.72	0.92	0.58	1.83	2.27	1.46	0.18	0.21	0.14	0.14	0.24	0.14	0.43	0.39	0.29	1.58	2.18	1.35
CD at 5%	2.07	2.63	1.65	5.24	6.52	4.11	0.51	0.59	0.38	0.39	N.S	0.39	1.23	1.14	0.83	4.54	6.26	3.80

population available per resource. Crops grown at 40 cm row spacing realized higher nitrogen content in seed (3.23%) and stalk (1.11%) while other nutrients being at par. However at 30 cm row spacing, the N, P and K uptake was 50.28, 6.24, 8.59 kg ha^{-1} by seed and 46.50, 5.96, 48.15 kg ha^{-1} by stalk, respectively. Both the wider spacings had no significant disparity among them but recorded significantly higher uptake than 20 cm row spacing. Increase in spacing enhanced the individual plant performance. Further, it might have improved the rate of photosynthesis, drymatter accumulation and its translocation to economic parts. As a result, lesser competition for intercepted light accumulation referred in terms of higher values of growth and yield components produced higher total yield per hectare, that determines to a large extent the quantum of nutrient uptake (Reddy, 2011; Goud *et al*., 2016; Swathi *et al*., 2017).

On the basis of all these agronomic management as well as yield performance it was found that early sowing (2nd fortnight October) as well as 30 cm row spacing is advantageous for improving productivity, nutrient content and uptake of *rabi* pigeon pea grown under the residual fertility of STBFR+FYM applied to *kharif* rice.

CONFLICTS OF INTEREST STATEMENT

There is no conflict of interest among the authors. All the authors were equally and actively involved in this article. B.P Patra has designed and involved in the field work. R.K Nayak and S.N Jena helped in laboratory work. R.K. Paikray and L.M. Garnayak helped in statistical analysis while S.N. Jena helped in the preparation of the manuscript.

REFERENCES

Barik, A.K., Raj, A. and Saha, R.K. (2008). Yield performance, economics and soil fertility through organic sources of nitrogen as substitute to chemical fertilizers in wet season rice. *Crop Research* **36**(1,2 & 3): 4-7.

Chakravorti, S.P. and Samantaray, R.N. (2006). *Annual Report*. ICAR-National Rice Research Institute, Cuttack, Odisha, India.

Gajera M.S and Ahlawat R.P.S. (2002). Effect of different depth of ploughing and mulches on moisture extraction and yield of rabi pigeon pea (*Cajanus cajan* (L.) Millsp.). *Legume Research* **25**(3): 165-169.

Goud, V.V., Konde N.M. and Patil A.N. (2016). Effect of sowing geometry on growth, nutrient uptake and yield of medium duration pigeonpea hybrid under rainfed condition. *PKV Research Journal* **40**(1): 10-13.

Lakshmi, C.H.S.R., Rao, P.C., Sreelatha, T., Madhavi, M., Padmaja, G. and Rao, P. V. (2012). Nitrogen use efficiency and production efficiency of rice under rice-pulse cropping system with integrated nutrient management. *Journal of Rice Research* **5**(1-2): 42-51.

Laxminarayana, P. (2003). Response of *rabi* redgram to dates of sowing and row spacings. *Annals of Agricultural Research* **24**(1): 187-189.

Meena, B.K., Hulihalli, U.K., Arvind Kumar, B.N. and Meena, M.K. (2011). Effect of fertility levels and sowing geometry on growth and yield of medium duration pigeonpea hybrid ICPH-2671. *Research Journal of Agricultural Science* **2**(3): 715-718.

Nagamani, C., Sumathi, V. and Reddy, G.P. (2020). Yield and nutrient uptake of pigeonpea [*Cajanus cajan* (L.)] as influenced by sowing window, nutrient dose and foliar sprays. *Agricultural Science Digest* **40**(2): 149-153.

Padhi, A.K. (1995). Effect of sowing date and sowing geometry on yield of redgram genotypes. *Indian Journal of Agronomy* **40**(1): 72-76.

Panse, V.G. and Sukhatme, R.V. (1985). *Statistical Methods for Agricultural Workers*, Fourth edition, Indian Council of Agricultural Research, New Delhi, India.

Ram, S.N. and Dixit, B.S. (2001). Growth, yield attributing parameters and quality of summer green gram (*Vigna radiata* L. Wilczek) as influenced by dates of sowing and phosphorus. *Indian Journal Of Agricultural Research* **35**(4): 275-277.

Reddy, A. (2011). Performance of pigeonpea genotypes under varied spacings during rabi seasons in southern agroclimatic zone of Andhra Pradesh. *Unpublished M.Sc. Thesis*, Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India.

Sengupta, K. and Roy, P.K. (1982). *Pulses and Oilseeds in West Bengal*, Directorate of Agriculture, Kolkata, West Bengal. pp. 87-90.

Swathi, Y.M., Reddy, M.S., Reddy, G.P. and Kavitha, P. (2017). Influence of density, sowing patterns and mulching on yield of drip irrigated pigeonpea [*Cajanus cajan* (L.) Millsp] *Indian Journal of Agricultural Research* **51**(6): 611-614.

Vakeswaran V., Jerlin R., Selvaraju P. and Bhaskaran M. (2016). Effect of time of sowing, spacing between plants and different fertilizer levels on green gram (*Vigna radiata* L. Wilczek) in seed yield attributing characters. *International Journal of Agricultural Science* **8**(57): 3147-3150.