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Response of Super Early Pigeonpea to Varied Sowing Windows and Integrated Nutrient Management in Southern Telangana Zone

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ABSTRACT

The field experiments were conducted during *kharif* seasons (July–November) 2018 to determine the physiological, yield parameters and yield of super early pigeonpea under different sowing windows and with integrated nutrient management practices at Regional Agricultural Research Station, Palem, Telangana, India situated at 16° 51' N Latitude and 78°25' E Longitude with an average Altitude of 478 m above the mean sea level of Southern Telangana Zone of Telangana State, India. The experiment was laid out in strip plot design for pigeonpea with 3 main treatments i.e., (M_1) 1st July, (M_2) 20th July and (M_3) 10th August sowings and four integrated nutrient management practices as sub treatments viz. S_1: 75% RDF, S_2: 75% RDF+FYM enriched with microbial consortia (1 t ha^{-1}), S_3: 100% RDF and S_4: 100% RDF+FYM enriched with microbial consortia (1 t ha^{-1}) and replicated thrice. The findings of two years of field study revealed that, among the three sowing dates in main treatments, 1st July (M_1) recorded a greater number of days to 50% flowering and 75% pod maturity of SEPP. Similar trend in the CGR, RGR, yield parameters and yield except 1000 seed weight of SEPP was noticed superior with 10th August sowing (M_3) compared to other two sowing dates viz. July 1st and July 20th. The sub treatment containing INM practices revealed higher values of physiological, yield parameters and yield with application 100% RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} (S_4) compared to other INM practices.

KEYWORDS: Crop and relative growth rate, super early pigeonpea

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

Pulses play vital role in providing food, nutrition and environmental security in a sustainable manner through crop intensification and diversification of cropping systems in Indian agriculture (Barik, 2021). India is the World's largest producer and consumer of pulses accounting for 34% of area and 24% of production followed by Myanmar, Canada, China, Nigeria, Brazil, and Australia (Chattopadhyay, 2016). Our capita^{-1} availability of pulses is 43 g capita^{-1} day^{-1} only (15 kg capita^{-1} year^{-1}) against the ICMR recommendation of 52 g capita^{-1} day^{-1} (20 kg capita^{-1} year^{-1}). Among the pulses, Pigeonpea occupies the second position in terms of acreage, production, and productivity after chickpea. Pigeon pea (*Cajanus cajan* L. Millsp.) is a climate-resilient pulse crop ranks sixth in global grain legume production and it is one of the oldest food crops to provide rich source of food proteins and rich in iron, iodine, essential amino acids like lycine, threonine, cystine and arginine etc (Meena et al., 2020). Pigeonpea is an excellent and affordable source of plant-based protein, substantially higher (21.7 g 100 g^{-1}) coupled with other nutritional components as compared to major cereals (6.0–15.0 100 g^{-1}) (Kishore et al., 2022). In India, the capita^{-1} availability of protein 37 g day^{-1} against 80 g day^{-1} as per the WHO recommendations, this consequently create serious problem of the malnutrition among the poor people, where most of the people have vegetarian diet and avoid the animal protein (Singh, 2020). Pigeonpea is grown in an area of 6.99 mha and produces 5.96 mt with a productivity of 852 kg ha^{-1} (Anonymous, 2020b). In Telangana state, pigeonpea occupies 0.30 mha and contribute 0.27 mt with productivity of 647 kg ha^{-1} (Anonymous, 2020a). The productivity is low as pigeonpea is seldom grown as sole crop in India and non availability of fast growing, short duration, high yielding photo insensitive pigeonpea cultivars. The available medium and long duration cultivars grown under rainfed conditions were experiencing terminal drought at flowering due to cessation of the south-west monsoon in October leads to lower productivity in India. The Photo and thermo sensitivity of existing pigeonpea cultivars is also another drawback restricting the horizontal expansion to different cropping systems in varied agro ecologies (Kumar et al., 2022). Traditional cultivars of pigeonpea are of early (120-140 days), Medium (140-160 days) and long duration (>160 days) types which cannot fit in preceding or succeeding crop situations of rainfed and irrigated ecology. Super early pigeonpea varieties developed from ICRISAT are of 100 days duration with yield potential of 0.6-1.5 t ha^{-1} (Vales et al., 2012; Kumar et al., 2015). Yield maximization of super early pigeonpea and its cropping system depends on optimum time of sowing and its succeeding crop. Hence it is necessary to standardize the optimum date of sowing of super early photo insensitive pigeonpea cultivars. Besides, the high cost of chemical fertilizers, the low purchasing power of small and marginal farmers and their adverse effect on environment has led to look for some alternative strategies. Integrated nutrient management with microbial consortia constitute of *Rhizobium* and *Pseudomonas putida*, *P. fluorescens* and *Bacillus cereus* enhanced plant biomass and yields of pigeon pea (Tilak et al., 2006; Bargaz et al., 2018; Sontayo et al., 2021). The *Rhizobium* is a gram-negative bacterium, fix the atmospheric nitrogen into plant available forms with the help of enzyme nitrogenase (Sullivan et al., 2014; Vitousek et al., 2013). *Rhizobia* strains as inoculants have been considered as a common approach to improve the effectiveness of symbiotic nitrogen fixation and legume productivity (Adhikari et al., 2013; Taylor et al., 2008). Symbiotic nitrogen (N_2) fixation is an alternative farming system which is eco-friendly, resilient to climate change, enhance soil biodiversity and soil ecosystem management (Adissie et al., 2020; Soumare et al., 2020). The PSB like *Pseudomonas striata* bacterial inoculation was found as equivalent to supply 50 kg P_2O_5 ha^{-1} through single super phosphate (Gour et al., 1980). Hence judicious use of microbial consortia with inorganic sources of nutrients is essential to minimize the cost of inputs, increase the yield and maintain soil health.

2. MATERIALS AND METHODS

A field experiment was conducted at Regional Agricultural Research Station, Palem, Nagarkurnool, Southern Telangana Agro Climatic Zone of Telangana State during *kharif* (July-November, 2018 and 2019) to study the performance of super early pigeonpea in different sowing windows and with integrated nutrient management practices. The experimental site is situated at about 16° 51' N Latitude N latitude and 78°25' E longitude with an average altitude of 478 m above the mean sea level. The soil of experimental site was sandy clay loam with pH 6.7, electrical conductivity 0.34 dSm^{-1}, low organic carbon (0.52%), low available nitrogen (201.3 kg ha^{-1}) and medium phosphorus (16.7 kg ha^{-1}) and high in potassium (309.4 kg ha^{-1}). In *kharif*, crop was sown with three sowing dates as main treatments i.e., M_1 (1st July), M_2 (20th July) and M_3 (10th August) and four integrated nutrient management practices as sub treatments viz. S_1: 75% RDF, S_2: 75% RDF+FYM enriched with microbial consortia (1 t ha^{-1}), S_3: 100% RDF and S_4: 100% RDF+FYM enriched with microbial consortia (1 t ha^{-1}) in strip plot design with three replications.

Super early photo insensitive cultivar ICPL 20325 pigeonpea is a non-determinative type and it comes to maturity in 90–100 days. These seeds @ 10 kg ha^{-1} was hand dibbled at the rate of 2 seeds hill^{-1} by adopting spacing of 45×15 cm^2 in *kharif* season. The enriched farm yard manure with microbial consortia preparation initiated 20 days before sowing of the crop. Approximately 200 kg of well decomposed FYM is taken and to these microbial consortia consists of *Rhizobium sps,* Phosphorus solubilizing bacteria, Potassium releasing bacteria and Zinc releasing bacteria mixed thoroughly and covered with gunny bags under the shade. Water is provided to wet the FYM twice a day. This enable to build up of bacterial population in couple of weeks and it is ready for field application. This microbial consortium enriched FYM @ 1 t ha^{-1} was applied and incorporated into soil one week before sowing as per the treatments. The recommended doses of fertilizer (RDF) for pigeonpea *i.e*., 20:50:0 kg NPK ha^{-1} was applied through urea and single super phosphate (SSP) respectively. Entire N and P_2O_5 were applied basally by placement and covered with the soil. Other cultural operations and plant protection measures were followed as per the recommendations. During the crop period the average rainfall of 457.5 mm was received in 35 rainy days in the year 2018 and 2019. The average weekly mean maximum temperature during cropping period ranged from 25.73-33.8°C with an average of 31.4°C in both the years. Whereas, the pooled weekly mean minimum temperature varied in between 16.2-22.5°C with an average of 19.1°C in 2018 and 2019. The crop was harvested on 22nd October, 7th November, and 23rd November in 2018 and 29th October, 11th November, and 28th November in 2019 for the three different sowing dates *i.e.,* July 1st, July 20th and August 10th respectively.

The physiological parameters i.e., crop growth rate and relative growth rate were calculated as per the procedure given by Watson (1952) and Redford (1967) respectively. The data pertaining to the phenological indices *i.e.,* days to 50% flowering was recorded by the visual observation when 50% of the plants from the net plot of each treatment combination produced flowers and that period was counted as no. of days to 50% flowering. Similarly, days to 75% pod maturity is also calibrated by visual observing 75% of the plant's pods from the net plot of each treatment combination turn in to brown colour and that period was counted as no. of days to 75% pod maturity.

The yield contributing attributes of pigeonpea *i.e.,* number of pods $plant^{-1}$ were counted from ten randomly selected plants of each plot at harvesting stage average number of pods $plant^{-1}$ was recorded. Number of seeds pod^{-1} was recorded by collecting ten pods randomly from each plot were split open and the number of seeds in these pods was counted to the average number. Test weight was recorded from the representative sample of each plot one thousand bold seeds were counted and weighed to record 1000 seed weight and expressed in gram. The seed and stover yield recorded from the harvested samples of the net area and converted into kg ha^{-1}. The harvest index was determined by the following formula i.e., HI=Percentage of economic yield in biological yield as suggested by Donald (1962). The crop data of the year 2018 and 2019 were pooled and analysed by following the analysis of variance for strip plot design as suggested by Gomez and Gomez (1984). Wherever, the treatment differences were found significant (F-test), critical differences were worked out at five % probability level.

3. RESULTS AND DISCUSSION

3.1. Days to 50% flowering and days to 75% pod maturity

The 50% flowering and 75% pod maturity of pigeonpea as influenced by different sowing dates and integrated nutrient management were presented in Figure 1. The results indicated that, the super early pigeonpea sown on July 1st (M_1) has taken more days to 50% flowering (63.7 days) and 75 % pod maturity (111.8 days) and was significantly followed by July 20th sowing date (M_2) with 61 days to attain 50 % flowering. Whereas the number of days taken to attain 75 % pod maturity by July 20th sowing was significantly on par with July 1st sowing.

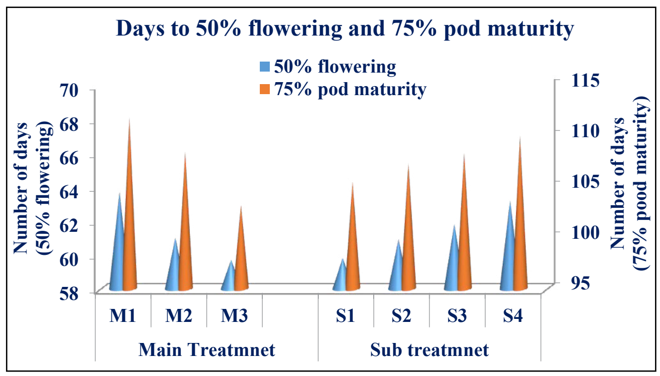

Figure 1: Effect of dates of sowing and INM on days to 50% flowering (Days) and days to 75% pod maturity (Days) of super early pigeonpea

The lowest number of days was recorded at August 10th sowing (M_3) with 58.7 and 103.2 days to attain 50% flowering and 75% pod maturity during both the years of study. The days taken to 50 % flowering and 75% pod maturity with optimum time of sowing compared to rest of the sowing dates could be attributed to enhanced plant height, prolonged photosynthesis due to increasing leaf area there by improving the plant vigor due to source-sink relationship. These findings are in conformity with Muralidhara et al. (2017) and Lowrence et al. (2020). The integrated nutrient management practices had not exerted the significant difference with respect to 50% flowering in pigeonpea. However, the integrated nutrient management practice i.e., application of 100% RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} (S_4) had taken a greater number of days to attain 75% pod maturity (110.0 days) and was significantly on par with S_3 (100% RDF) (108.3

days) and S_2 (75% RDF+FYM enriched with microbial consortia @ 1 t ha^{-1}) (107.3 days). Significantly lowest number of days taken to 75% pod maturity was with 75% RDF (S_1) (105.5 days). These findings are in conformity with Singh et al. (2016).

3.2. Crop growth rate (g m^{-2} day^{-1}) and Relative growth rate (g g^{-1} day^{-1})

Crop growth rate and relative growth rate are important character to express the growth and metabolic efficiency of the plant under different stage, which ultimately influence the yield. Crop performance and final crop yield depends on crop growth rate and relative growth rate at different crop growth stages. To visualize the influence of different treatments, the data pertaining to crop growth rate and relative growth rate at different growth stages i.e., 0–30, 30–60 and 60–90 DAS were analyzed statistically and is presented in Table 1.

Crop growth rate is the result of higher metabolic activity of the plants and solar energy harvesting efficiency of plants. Due to optimum sowing time, like July 1st (M_1) coupled with favourable climate conditions especially temperature, rainfall and solar radiation which resulted in good crop growth rate as the plant advanced from 0–30 days, the CGR recorded 1.58 g m^{-2} day^{-1} later from 31–60 DAS, the CGR was 8.96 g m^{-2} day^{-1} and during 61–90 DAS CGR was 14.7 g m^{-2} day^{-1}. These outcomes were significantly superior over the July 20th (M_2) sowing with 1.43, 8.34 and 13.07 g m^{-2} day^{-1} respectively during 0-30, 31-60 and 61-90 DAS. Among the INM practices, the results showed that, at 0-30 DAS, pigeonpea crop sown with application of 100 % RDF + FYM enriched with microbial consortia @ 1 t ha^{-1} (S_4) recorded higher crop growth rate (1.65 g m^{-2} day^{-1}) and it was significantly superior over 100% RDF alone (S_3) (1.46 g m^{-2} day^{-1}) and was on par with application of 75 % RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} (S_2) with 1.39 g m^{-2} day^{-1}. Lowest crop growth rate was realized

Table 1: Effect of dates of sowing and INM on crop growth rate, yield contributing characters and yield of super early pigeonpea

Treatment details	CGR (g m^{-2} day^{-1})			No. of pods plant^{-1}	No. of seeds pod^{-1}	1000-seed weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
	0–30 DAS	31–60 DAS	61–90 DAS						
Main treatments (Dates of Sowing)									
M_1: 1st July	1.58	8.96	14.70	152.5	3.5	74.2	759	3464.9	17.9
M_2: 20th July	1.43	8.34	13.07	132.0	3.4	75.4	626	3195.9	16.3
M_3: 10th August	1.36	7.20	11.43	121.4	3.4	77.5	559	3087.0	15.3
SEm±	0.02	0.12	0.30	2.4	0.1	0.3	17.2	62.2	0.4
CD (p=0.05)	0.09	0.47	1.16	9.3	NS	1.0	67.7	244.2	1.6
Sub treatments (INM)									
S_1: 75% RDF	1.33	6.90	10.88	115.3	3.2	76.0	574	3078.2	15.7
S_2: 75% RDF+FYM enriched with microbial consortia (1 t ha^{-1})	1.39	7.63	12.24	129.6	3.3	76.0	615	3204.0	16.0
S_3: 100% RDF	1.46	8.59	13.90	141.8	3.6	74.7	662	3303.8	16.7
S_4: 100% RDF+FYM enriched with microbial consortia (1 t ha^{-1})	1.65	9.54	15.25	154.5	3.6	76.0	741	3411.0	17.7
SEm±	0.02	0.23	0.23	2.2	0.1	1.2	12.2	25.5	0.3
CD (p=0.05)	0.08	0.79	0.80	7.7	NS	NS	42.2	88.4	0.9
Interaction effect									
Main at same level of sub									
SEm±	0.08	0.28	0.47	0.08	0.28	0.47	26.4	79.7	0.7
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sub at same level of Main									
SEm±	0.06	0.24	0.45	0.06	0.24	0.45	25.5	82.7	0.6
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

with application of 75% RDF alone (1.33 g m^{-2} day^{-1}). As the crop proceeds to 60 days from 31 days revealed higher crop growth rate (9.54 g m^{-2} day^{-1}) with application of 100 % RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} (S_4) followed by 100% RDF alone (S_3) (8.59 g m^{-2} day^{-1}) and application of 75% RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} (S_2) with 7.63 g m^{-2} day^{-1}. Application of 75% RDF alone (S_1) was realized with least crop growth rate (6.90 g m^{-2} day^{-1}). Likewise, maximum crop growth rate of pigeonpea at 61-90 DAS was recorded with application of 100 % RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} (S_4) with 15.25 g m^{-2} day^{-1} and was significantly higher over supplication of 100% RDF alone (S_3) (13.90 g m^{-2} day^{-1}) and administering 75% RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} (S_2) with 12.24 g m^{-2} day^{-1}. The lowest crop growth rate was realized with 75 % RDF alone (S_1) (10.88 g m^{-2} day^{-1}). The progress in the crop growth with application of integrated fertilizer management may be attributed to increase in plant height and leaf area index resulting thereby in better light interception by crop which accumulated more photosynthates and thus produced more dry matter. Further, FYM enriched with microbial consortia brought nutrients to available form in gradual process and improved the soil physical characters, which might have increased the availability of nutrients. These results were in line with studies conducted on sunflower crop by Babu et al. (2014).

The relative growth rate of crop of 2018 and 2019 was observed that, at 0-30 DAS, July 1st sowing (M_1) recorded 0.039 g g^{-1} day^{-1} and was significantly superior over July 20th sowing with 0.035 g g^{-1} day^{-1} and August 10th sowing (M_3) with 0.039 g g^{-1} day^{-1}. At 31–60 DAS, significantly higher RGR was recorded with July 20th sowing (M_2) with 0.059 g g^{-1} day^{-1} and was on par with July 1st sowing (M_1) with 0.058 g g^{-1} day^{-1}. Lowest RGR was recorded with August 10th sowing date (M3) with 0.055 g g^{-1} day^{-1}. At 90 DAS from 60 DAS, there was no significant difference was noted among different sowing dates (Figure 2).

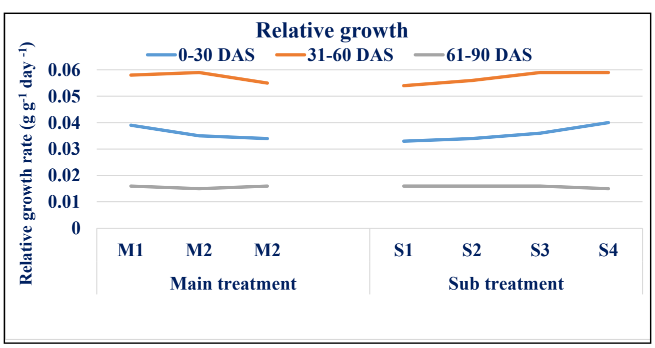

Figure 2: Effect of dates of sowing and integrated nutrient management on relative growth rate (g g^{-1} day^{-1}) of super early pigeonpea

At 0-30 DAS, the pigeonpea crop fertilized with 100 % RDF + FYM enriched with microbial consortia @ 1 t ha^{-1} (S_4) had produced significantly higher relative growth rate (0.040 g g^{-1} day^{-1}) and was followed significantly with application of 100% RDF (0.036 g g^{-1} day^{-1}). The application of 75 % RDF + FYM enriched with microbial consortia @ 1 t ha^{-1} (S_2) with 0.034 g g^{-1} day^{-1} was at par with 75 % RDF alone (S_1). Likewise, application of 100 % RDF + FYM enriched with microbial consortia @ 1 t ha^{-1} (S_4) had significantly higher relative growth rate (0.059 g g^{-1} day^{-1}) at 31-60 DAS and it was at par with 100 % RDF alone (S_3) with 0.059 g g^{-1} day^{-1}. The supplication of 75 % RDF +FYM enriched with microbial consortia @ 1 t ha^{-1} (S_2) with 0.056 g g^{-1} day^{-1} was found significantly higher over the 75 % RDF only (S_1) with 0.054 g g^{-1} day^{-1}. The relative growth rate recorded at 61- 90 DAS of crop period found significantly not differed due to sub treatments effect in both the years of study. The progress in the relative growth rate with the availability of nutrients. It was reported that the faster the crop accumulates biomass, the more carbon is available to increase growth of roots and shoots for greater access to light and soil nutrients, which inturn enables greater biomass accumulation. Enhancing crop RGR at initial stages can have profound effects on resource capture and competitiveness with weeds (Carolyn and Smith, 2018).

3.3. Yield attributes

3.3.1. Number of pods plant^{-1}

The number pods $plant^{-1}$ as affected by dates of sowing and integrated nutrient management different was clearly shown in Table 1. The results revealed that, with respect to different dates of sowing, Maximum number of pods $plant^{-1}$ were observed when pigeonpea crop was sown on July 1st (152.5) followed by July 20th sowing (132.0) while minimum pods $plant^{-1}$ were registered when pigeonpea crop was sown on August 10th (121.4). This might be due to congenial weather conditions prevailed during the growing period of early sown pigeonpea crop that helped in translocation of photosysnthesis from the source of plant to the sink i.e., number of pods $plant^{-1}$. Similar results were conformity with Lowrence et al. (2020) and Rajesh et al. (2020). Scrutiny of data revealed that number of pods $plant^{-1}$ was significantly influenced by integrated nutrient management treatments, application of 100% RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} (S_4) had recorded significantly highest number of pods $plant^{-1}$ (154.5) followed by application of 100% RDF alone (141.8) and 75% RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} (S_2) (129.6). The minimum number of pods $plant^{-1}$ was realized by 75% RDF (115.3). Conjunctive use of inorganic fertilizers with organic manures *i.e.,* FYM enriched microbial consortia consisting of *Rhizobium*, PSB, KRB and ZnRB release growth promoting enzymes, vitamins and nutrients, which play an important role in metabolic process of plant, increasing nutrient uptake and thus stimulating a greater number of pods plant^{-1}. Corroborative results have also been reported by Kumavath et al. (2013).

3.3.2. Number of seeds pod^{-1}

The influence of date of sowing and integrated nutrient management on the number seeds pods^{-1} during investigation is furnished in Table 1. Number seeds pod^{-1} did not differ significantly with the dates of sowing and integrated nutrient management practices. However, pigeonpea sown on July 1st (M_1) has recorded numerically higher number seeds pod^{-1} (3.5) compared to other two sowing dates viz. July 20th and August 10th and among the INM practices, 100% RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} (S_4) recorded higher seeds pod^{-1} (3.6) over the other INM treatments.

3.3.3. 1000 Seed weight (g)

The influence of date of sowing on the 1000 seed weight while investigation is furnished in Table 1. The results showed the values of test weight maximum for August 10th sowing date (M_3) with 77.5 g and was significantly followed by July 20th (M_2) with 75.4 g and July 1st date of sowing (M_1) with 74.2 g. There is no influence of INM practices on the 1000 seed weight was observed. Better photosynthetic activity coupled with better translocation of photosynthates from source to sink due to congenial weather conditions were optimum temperature and mean sunshine hours prevailed during crop growth might have led to higher test weight. These finding are substantiated with those reported by Reddy et al. (2012).

3.4. Yield

3.4.1. Seed, stover yield (kg ha^{-1}) and harvest index

Seed, stover yield and harvest index of pigeonpea as influenced by dates of sowing and different INM are presented in Table 1. The results indicated significantly higher seed, stover yield and harvest index of pigeonpea (759, 3465 kg ha^{-1} and 17.9) was recorded with early sowing on July 1st treatment followed by the July 20th sowing with 626, 3196 kg ha^{-1} and 16.3. Significantly lower seed, stover yield and harvest index of pigeonpea was noticed as pigeonpea crop sown on August 10th (M_3) with 559, 3087 kg ha^{-1} and 15.3. Similarly, the combination of 100% RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} (S_4) was identified as best INM practice to yield 741 kg ha^{-1} in seed, 3411 kg ha^{-1} in stover and 17.7 harvest index. The next best treatments were application of 100% RDF (S_3) with 662, 3304 kg ha^{-1} and 16.7 followed by application of 75% RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} (S_2) with 615, 3204 kg ha^{-1} and 16.0 of seed, stover yield and harvest index respectively. Significantly lower seed, stover and harvest index was recorded in application of 75% RDF (S_1) treatment with 574, 3078 kg ha^{-1} and 15.7. The higher seed yield with July 1st sowing was probably due to good seed set favoured by warm weather prevailed during at maturity. Similar results were reported by Yu et al. (2014) and Patil et al. (2018). Stover yield of crop is the outcome of plant through growth attributes like plant height, dry matter accumulation and partitioning of dry matter at grain filling stage. Sowing of pigeonpea on July 1st resulted maximum stover yield due to optimum utilization of solar radiation, temperature, higher assimilates production and its conversion to starch results in higher straw yield. These finding are similar to those reported by Egbe et al. (2013) and Malik and Yadav (2014). Optimum utilization of solar radiation, temperature, higher assimilates production and its conversion to starch results in higher biomass, seed yield leading to higher harvest index. These observations corroborate with those made by Kumar et al. (2008). Significant increase in seed and stover yield of pigeonpea with fertilizers coupled with organic manures might have supplied nutrients improving crop growth, uptake and yield attributes. Similar results were reported by Meena et al. (2019). Balanced nutrition through inorganic fertilizers coupled with organic manures had supplied nutrients for higher biomass, seed yields, partitioning of dry matter between grain and other plant parts leading to higher harvest index, similar results confirmed by Rekha et al. (2018).

The interaction effect of sowing dates and integrated nutrient management were not statistically significant on all above parameters during both the years of experimentation.

4. CONCLUSION

Sowing of super early pigeonpea crop in July 1st and in combination with 100 RDF+FYM enriched with microbial consortia @ 1 t ha^{-1} resulted in higher days taken to 50 % flowering, 75 % pod maturity, crop growth rate, relative growth rate, Number of pods plant^{-1}, 1000 Seed weight (g), seed and stover yield and harvest index over the other sowing dates and INM practices.

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