Original Research Article

Impact of seed rate and nutrient management on growth analysis of chickpea under semi-arid zones

ABSTRACT

Aim: To study the effect of seed rate and nutrient management on growth and development of chickpea.

Study design: The study consisted of mechanized sowing at different planting densities as one factor which required a bigger plot size and second factor was nutrient management which is to be analyzed precisely. Thus as one factor (planting densities) need a bigger plot size and the other (nutrient management) required a more precise results with small plot size, suitable design for the study was chosen as split-plot design.

Place and duration of study: Agricultural Research Institute (ARI), Main Farm, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad during *rabi* 2020-21 and 2021-22.

Methodology: This experiment consisted of four seed rates (planting densities with planter) imposed in main plots and seven nutrient management practices in sub plots with a total of 28 treatment combinations and replicated thrice. Data obtained on various parameters were analysed using WINDOSTAT software for split plot design.

Results: Crop growth indices *viz.,* absolute growth rate, relative growth rate and net assimilation were found to be significantly higher with the seed rate of 52 kg ha^{-1} (321.4 mg day^{-1}, 19.5 and 2.07 mg g^{-1} day^{-1}) respectively. Among the nutrient management practices, 125 % RDF + Soil application of Microbial consortia (N –Azotobacter + PSB + KRB+ ZnSB) @ 5 kg ha^{-1} resulted in significantly higher values of all crop growth indices followed by 125 % RDF and 100 % RDF + Soil application of Microbial consortia (N –Azotobacter + PSB + KRB+ ZnSB) @ 5 kg ha^{-1} (256.5 mg day^{-1} and 17.1 mg g^{-1} day^{-1}) respectively.

Conclusion: Seed rate of 52 kg ha^{-1} and 125 % RDF along with soil application of Microbial consortia (N –Azotobacter + PSB + KRB+ ZnSB) @ 5 kg ha^{-1} resulted in better growth and development which can be recommended for obtaining higher yield of chickpea.

INTRODUCTION

Pulses are the versatile crops for sustainable future owing to their inherent ability to biologically fix atmospheric nitrogen. From their critical role in the release of soil bound P, they require of less resources and have capacity to withstand abnormal weather conditions and suitable for different cropping systems over a wide range of soils (Rakesha *et al.,* 2016). Production of pulses is largely restricted to Asian countries and especially to the Indian sub-continent. In particular, India plays crucial role as the largest producer (25 % of global production), consumer (27 % of global consumption) and importer (14 %) of pulses in the world (Mohanty and Satyasai, 2015). In India, pulses are cultivated in an area of 29 M ha with a production of 25.4 M t and productivity of 806 kg ha^{-1} (Annual report, 2019-20, Department of Agriculture, Cooperation and Farmers Welfare). Inspite of the pivotal role played by India towards pulse production, there has been a continuous demand-supply gap resulting in a steep increase in prices and import of pulses. Pulse production has been caught in the vicious cycle of unstable and low yields owing to farmer's preference to cultivate them on marginal lands. Thus, there is still a need of second green revolution for technological progress in pulse crops (Ahlawat *et al.,* 2016).

Among the pulses, chickpea (*Cicer arietinum* L.) dominates with over 49.3 % share of total pulses during 2020-21 (Gaur, 2021). The area, production and productivity of chickpea during 2018-19 in India were 10.73 M ha, 10.9 M t and 1016 kg ha^{-1} respectively in India (Annual report, 2019-20 Directorate of Pulse Development). In Telangana, it was cultivated in an area of 1.040 L ha with a production of 1.632 L t and productivity of 1569 kg ha^{-1} during 2018-19 (Annual report, 2019-20 Directorate of Pulse Development). Despite the silent revolution, there is still a great scope in Telangana state to expand area under chickpea for sustaining farmer's income and state's nutritional security on marginal lands.

The timeliness of field operations *i.e.,* timely sowing in large areas has assumed greater significance in achieving optimal yields in different crops, which could be achieved by the way of partial or complete mechanization. Mechanized planters ensure uniform crop stand with optimum plant spacing and depth of operation, apart from the reduced cost of cultivation due to elimination of thinning operation coupled with saving of seed and fertilizer (Dhimate *et al.,* 2018). Plant geometry and fertilizer management are interlinked and have positive influence on crop growth, development and seed yield of chickpea (Verma *et al*., 2019). An additional dose of N, P and K is essential for the increased plant population, hence, in the present investigation redefining the recommended dose (20: 50: 20 N, P_2O_5 and K_2O kg ha^{-1}) as per the plant density under mechanized planting is crucial and hence, the treatments were defined accordingly.

MATERIALS AND METHODS

This research was conducted in vertisols of Agricultural Research Institute, Main Farm, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad during two consecutive seasons *rabi* 2020-21 and 2021-22 (November 2020 to March, 2021 and November 2021 to March, 2022). The soil of the experimental site was slightly alkaline in nature (pH-8.31), non saline (EC, 0.191 dsm^{-1}), low in organic carbon (0.37 %), low in available nitrogen (176 kg ha^{-1}), high in available phosphorus (73 kg ha^{-1}), high in available potassium (523 kg ha^{-1}) and medium in available zinc (0.99 ppm). A total rainfall of about 18.86 mm was received during 2020-21 and 3.3 mm was recorded during 2021-22.

The experiment was laid out in split plot design with 4 main plots with seed rate of 52, 70, 77 and 105 kg ha^{-1} with a corresponding planting densities of P_1 – 2.22 lakh ha^{-1}, P_2 – 2.96 lakh ha^{-1}, P_3 – 3.33 lakh ha^{-1} and P_4 – 4.44 lakh ha^{-1} sown at spacings of 45 cm x 10 cm, 45 cm x 7.5, 30 cm x 10 cm and 30 cm x 7.5 cm respectively. The planter was calibrated in the Engineering workshop, AICRP on farm implements and machineries, PJTSAU to obtain desired seed rate under four planting densities consisting of 2 inter row spacings (45 cm and 30 cm) and 2 intra row spacings (7.5 and 10 cm) achieved by using seed metering plates of 18 and 16 cells. The seven sub-plot treatments consisted of Nutrient management practices *viz.,* N_1- Absolute Control (0-

N, P and K), N_2- 75 % RDF, N_3- 100 % RDF (20:50:20 kg N, P_2O_5 and K_2O ha^{-1}), N_4 - 125 % RDF, S_5- 75 % RDF + soil application of Microbial consortia (MC) - Azotobacter + Phosphorus solubulising bacteria (PSB) + Potassium releasing bacteria (KRB)+ Zinc solubulising bacteria (ZnSB) @ 5 kg ha^{-1}, N_6- 100 % RDF + MC and N_7- 125 % RDF + MC. All the treatments were replicated thrice. Entire dose of P (Single super phosphate) and K (Muriate of potash) and 50 % dose of N (urea) were applied as basal while, remaining 50 % dose of N was top dressed at 30 days after sowing (DAS). Microbial consortia (Azotobacter + PSB (*Pseudomonas fluorescence*) + KRB (*Bacillus striatus*)+ ZnSB (*Bacillus sp*.)) was obtained by mixing all the biofertiliser strains in equal proportion and it was applied @ 5 kg ha^{-1} along with 250 kg vermicompost to soil as basal by spreading uniformly throughout the respective sub plot treatment plots (N_5, N_6 and N_7 respectively).

Statistical analysis for all parameters was carried out using WINDOSTAT software. To the find significance, critical difference or least significance difference was worked out with 'F' test at P=0.05 level of significance.

Growth analysis was carried out formulae given below

Absolute Growth Rate (AGR): It is defined as the increase in weight per unit time. It was computed 0 – 30 DAS, 30-60 DAS, 60-90 DAS and 90 DAS – harvest by the formula outlined by West *et al.,* 1920

$$\text{Absolute growth rate (g day}^{-1}) = \frac{W_2 - W_1}{t_2 - t_1}$$

where,

W_1 and W_2 are the total dry weights per plant (g) at time t_1 and t_2 respectively.

Relative Growth Rate (**RGR**): defined as the rate of increase in dry weight per unit dry weight already present. It was calculated 0 – 30 DAS, 30-60 DAS, 60-90 DAS and 90 DAS – harvest by the formula outlined by Radford (1967)

$$\text{Relative Growth Rate (g g}^{-1}\text{ day}^{-1}) = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{t_2 - t_1}$$

where,

W_1 and W_2 are the total dry weight per plant (g) at time t_1 and t_2 respectively.

Net Assimilation Rate (NAR): Net assimilation rate indirectly indicates the rate of net photosynthesis. It is expressed as g of dry matter produced per cm^2 of leaf area in a day. It was calculated by the formula outlined by Gregory, 1926. NAR was calculated 0 – 30 DAS, 30-60 DAS, 60-90 DAS and 90 DAS – harvest.

$$\text{Net assimilation rate (g m}^{-2}\text{ day}^{-1}) = \frac{(W_2 - W_1)\ (\text{Log}_e L_2 - \text{Log}_e L_1)}{(t_2 - t_1)\ (L_2 - L_1)}$$

where,

W_1 and W_2 are the total dry weight per plant (g) at time t_1 and t_2 respectively.

L_1 and L_2 are leaf area (cm^2) at time t_1 and t_2 respectively.

Results and discussion:

Growth analysis is quantitative measurement of daily variation in crop growth and development. However, increase in dry weight may not coincide with changes in size. Thus, dry matter is the most important parameter for quantitative analysis of plant growth. In general, growth rate increased from sowing to 60 DAS thereafter showed a declining trend which might be due to assimilate translocation to the seed, the senescence and leaf fall at later stage.

Absolute growth rate (mg day^{-1})

Absolute growth rate is the function of amount of growing material present. From Table 1, it can be inferred that the effects of seed rate and nutrient management on absolute growth rate of chickpea were found to be significant during the intervals 0-30 DAS and 30 - 60 DAS. Although, the effects of seed rate remained significant during 60-90 DAS, nutrient management could not produce significant effect during 60-90 DAS. At 90- harvest, the effects of both seed rate and nutrient management remained non-significant. The interaction effects of seed rate and nutrient management were also found to be non-significant at all the intervals of observation during both the years (2020-21 and 2021-22)

Among the seed rate treatments, 52 kg ha^{-1} resulted in significantly higher absolute growth rate during 0-30 DAS (112.4 and 113.7 mg day^{-1}) and 30-60 DAS (308.6 and 334.1 mg day^{-1}) during 2020-21 and 2021-22 respectively over all other treatments. While, the lowest was recorded with the seed rate of 105 kg ha^{-1} during 0-30

DAS (95.7 and 95.9 mg day^{-1}) and 30-60 DAS (164.0 and 177.1 mg day^{-1}). At 90 DAS – harvest also, seed rate of 52 kg ha^{-1} was significantly higher absolute growth rate (187.6 and 187.8 mg day^{-1}) maintained its superiority over rest of the treatments. Mean data of 2 years also followed a same trend as that of individual years.

Lower seed rate of 52 kg ha^{-1} resulted in higher absolute growth rate. At this seed rate, plant growth was luxuriant which might have helped them in absorption in moisture, nutrients and light more efficiently and resulted in higher dry matter production that might have resulted in higher absolute growth rate over rest of the seed rate treatments. Similar results were reported by Amanullah *et al.,* 2010.

With regard to nutrient management, at 0-30 DAS interval, application of 125 % RDF + MC resulted in significantly higher absolute growth rate (107.9 mg day^{-1}) which remained at par with 125 % RDF (105.4 mg day^{-1}) and 100 % RDF + MC (102.7 mg day^{-1}) and significantly superior to all other treatments *viz.,* 100 % RDF (101.4 mg day^{-1}), 75 % RDF + MC (101.3 mg day^{-1}), 75 % RDF (99.3 mg day^{-1}) and absolute control (99.1 mg day^{-1}) during 2020-21. While, during 2021-22, application of 125 % RDF + MC resulted in significantly superior absolute growth rate (110.4 mg day^{-1}) over all other treatments except 125 % RDF (108.7 mg day^{-1}) at 0-30 DAS. While at 30-60 DAS, application of 125 % RDF + MC resulted in significantly higher absolute growth rate (243.7 and 269.3 mg day^{-1}) over all other treatments except absolute control (195.2 and 214.1 mg day^{-1}) during 2020-21 and 2021-22 respectively. Mean data of absolute growth rate as affected by nutrient management followed same trend as 2021-22 during all the intervals.

Higher dose of inorganic nutrients along with soil application of microbial inoculants might have resulted in higher nutrient availability, higher uptake of nutrients and reflected in higher dry matter production. Similar results on higher absolute growth rate with combined application of inorganic fertilizer with biofertilizers was reported by Mondal *et al.,* 2010 in mungbean.

Relative growth rate (mg g^{-1}day^{-1})

Relative growth rate (RGR) is an index that takes into account the original difference in size of plants and, specifically, expresses growth in terms of the rate of increase in size per unit of size. Perusal of data from Table 2 indicated that effect of seed rate treatments was significant during early stages of crop growth (0-30 DAS, 30-60 DAS) while it remained non- significant during later stages of crop growth (60-90 DAS and 90 DAS-harvest). On contrary, nutrient management treatments could produce significant effect only at 0-30 DAS and remained non-significant during other intervals. Interaction of seed rate and nutrient management was also found to be non-significant during all the stages of crop growth.

Among the seed rate treatments, application of 52 kg ha^{-1} resulted in significantly higher relative growth rate (17.6 and 17.7 mg $g^{-1}day^{-1}$) over all other treatments `during 2020-21 and 2021-22 respectively. At 30-60 DAS, relative growth rate followed a same trend with significantly higher relative growth rate registered by lower seed rate of 52 kg ha^{-1} (19.1 and 18.9 mg $g^{-1}day^{-1}$) and significant lower relative growth rate was registered with 105 kg ha^{-1} (14.3 and 15.0 mg $g^{-1}day^{-1}$) during 2020-21 and 2021-22 respectively.

Lower seed rate of 52 kg ha^{-1} lowers plant population which might have offered advantage to individual plants in effective utilization of resources (nutrients, water and space) thereby resulting in higher growth rate. Similar results on higher relative growth rate with lower seed rate were reported by Choudhary *et al.,* 2020.

With respect to nutrient management practices, application of 125 % RDF + MC resulted in significantly higher relative growth rate (16.9 mg $g^{-1}day^{-1}$) followed by 125 % RDF (16.6 mg $g^{-1}day^{-1}$), 100 % RDF + MC (16.2 mg $g^{-1}day^{-1}$) and 100 % RDF (16.1 mg $g^{-1}day^{-1}$) and proved superior to all other treatments at 0-30 DAS during 2020-21. While during 2021-22, application of 125 % RDF + MC was significantly higher relative growth rate (17.3 mg $g^{-1}day^{-1}$) over all other treatment while, it remained at par with 125 % RDF (17.1 mg $g^{-1}day^{-1}$) and 100 % RDF + MC (16.5 mg $g^{-1}day^{-1}$).

Higher dose of nutrients along with microbial consortia might have increased the availability of nutrients, by solubilization and mineralization process that attributed to higher dry matter accumulation at active vegetative stages which ultimately increased the relative growth rate. The results are in conformity with Mondal *et al.,* 2010 who also reported a similar increase in relative growth rate by combined application of urea and biofertilizers.

Net assimilation rate (mg m^{-2} day^{-1})

Net assimilation rate (NAR) represents the productive efficiency of plants in capturing light, assimilating carbon dioxide and storing photo assimilates. Combined analysis of variance presented in Table 2 showed that net assimilation rate was significantly influenced only by seed rate.

Seed rate of 52 kg ha^{-1} were significantly higher net assimilation rate (2.07 mg m^{-2} day^{-1}) which remained on par with 70 kg ha^{-1} (1.99 mg m^{-2} day^{-1}) and proved its superiority over 77 (1.85 mg m^{-2} day^{-1}) and 105 (1.84 mg m^{-2} day^{-1}) kg ha^{-1} at 0-30 DAS during 2020-21. Similarly during 2021-22, significant higher net assimilation rate was registered with 52 kg ha^{-1} (2.08 mg m^{-2} day^{-1}) which remained at par with all other treatments except 105 kg ha^{-1} (1.81 mg m^{-2} day^{-1}). At 30-60 DAS, 52 kg ha^{-1} recorded significantly higher net assimilation rate (0.51 and 0.54 mg m^{-2} day^{-1}) over all other treatments during 2020-21 and 2021-22 respectively. Mean data on net assimilation rate as affected by seed rate followed same trend as 2020-21.

Higher number of branches and leaf area produced sown at seed rate of 52 kg ha^{-1} coupled with lower competition for growth factors (nutrient, moisture and light) might have resulted in higher net assimilation rate at 52 kg ha^{-1}. Similar findings on higher net assimilation rate with lower seed rate in chickpea were reported by Choudhary *et al.,* 2020.

Conclusion

From the present study, it can be concluded that following the seed rate of 52 kg ha^{-1} and 125 % RDF along with soil application of Microbial consortia (N-azotobacter + PSB+KRB+ ZnSB) @ 5 kg ha^{-1} resulted in better growth and development which might be recommended to farmers for achieving higher yields.

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Table 1. Absolute growth rate (mg day^{-1}) of chickpea as influenced by seed rate and nutrient management

Treatments	0 - 30 DAS			30 - 60 DAS			60 – 90 DAS			90 DAS – harvest		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
Main Plot-Seed rate (M)												
M_1-52 kg ha^{-1}	112.4	113.7	113.0	308.6	334.1	321.4	187.6	187.8	187.7	83.1	51.6	67.4
M_2-70 kg ha^{-1}	104.3	106.1	105.2	227.1	245.6	236.4	154.3	162.0	155.7	71.6	52.0	61.8
M_3-77 kg ha^{-1}	97.4	103.7	100.5	216.8	236.1	226.5	148.0	150.9	149.4	59.2	42.8	51.7
M_4-105 kg ha^{-1}	95.7	95.9	95.8	164.0	177.1	170.5	119.7	130.4	125.1	44.7	40.9	42.8
S.Em±	1.81	1.59	1.48	6.38	11.09	9.64	9.81	8.15	7.99	18.25	21.93	13.55
CD (p=0.05)	6.27	5.49	5.13	22.07	38.36	33.37	33.95	28.19	27.66	NS	NS	NS
Sub plot-Nutrient management (S)												
S_1-Absolute control	99.1	100.3	99.7	195.2	214.1	204.6	123.5	138.4	131.0	14.6	26.4	17.7
S_2-75 % RDF	99.3	102.3	100.8	225.0	242.7	233.8	145.2	150.2	14.7	38.5	34.1	36.3
S_3-100 % RDF	101.4	103.8	102.6	233.8	252.4	243.1	150.2	155.0	152.6	53.7	38.8	47.5
S_4-125 % RDF	105.4	108.7	107.1	240.6	258.6	249.6	166.9	171.6	169.2	98.6	64.6	81.6
S_5-75 % RDF + MC	101.3	104.1	102.7	228.8	244.8	236.8	147.5	155.1	147.1	47.3	34.3	3.6
S_6-100 % RDF + MC	102.7	104.2	103.5	236.8	255.7	246.3	156.9	157.0	156.9	96.9	63.2	80.1
S_7-125 % RDF + MC	107.9	110.4	109.2	243.7	269.3	256.5	176.6	177.1	176.8	103.1	66.4	84.8
S.Em±	2.15	1.92	1.91	10.60	11.06	10.06	12.74	14.68	13.28	66.26	24.61	38.06
CD (p=0.05)	6.10	5.45	5.42	30.14	15.64	28.59	NS	NS	NS	NS	NS	NS
Interaction (M x S)												
S.Em±	4.37	3.89	3.83	20.64	23.29	20.97	25.54	28.37	25.86	124.07	50.57	71.76
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (M x S)												
S.Em±	4.29	3.84	3.82	21.20	22.13	20.11	25.54	29.35	26.57	132.52	49.22	76.12
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: RDF *(Recommended dose of fertilizer) 20:50:20 N, P_2O_5 and K_2O kg ha^{-1}*

MC *– Microbial consortia (N-azotobacter + PSB+KRB+ ZnSB) @ 5 kg ha^{-1}*

Table 2. Relative growth rate (mg $g^{-1}day^{-1}$) of chickpea as influenced by seed rate and nutrient management

Treatments	0 - 30 DAS			30 - 60 DAS			60 – 90 DAS			90 DAS –harvest		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
Main Plot-Seed rate (M)												
M_1-52 kg ha^{-1}	17.6	17.7	17.6	19.1	18.9	19.5	5.2	5.0	5.1	1.8	1.2	1.5
M_2-70 kg ha^{-1}	16.5	16.7	16.6	16.7	17.3	17.0	5.5	5.5	5.5	1.7	1.4	1.5
M_3-77 kg ha^{-1}	15.4	16.4	15.9	16.8	16.9	16.8	5.7	5.6	5.6	2.0	1.4	1.7
M_4-105 kg ha^{-1}	15.2	15.3	15.3	14.3	15.0	14.6	5.4	5.7	5.6	1.5	1.6	1.5
S.Em±	0.28	0.24	0.23	0.57	0.58	0.57	0.33	0.28	0.31	0.54	0.59	0.40
CD (p=0.05)	0.98	0.82	0.79	1.98	2.00	1.97	NS	NS	NS	NS	NS	NS
Sub plot-Nutrient management (S)												
S_1-Absolute control	15.7	15.9	15.8	15.4	16.0	15.7	5.3	5.8	5.5	0.3	0.9	0.6
S_2-75 % RDF	15.8	16.2	16.0	16.7	17.2	17.0	5.4	5.4	5.4	0.8	1.1	1.0
S_3-100 % RDF	16.1	15.4	16.2	17.0	17.5	17.3	5.3	5.2	5.3	1.2	1.3	1.2
S_4-125 % RDF	16.6	17.1	16.9	16.9	17.3	17.1	5.7	5.6	5.7	2.6	1.8	2.2
S_5-75 % RDF + MC	15.9	16.3	16.1	16.9	17.3	17.1	5.4	5.3	5.4	1.2	1.2	1.2
S_6-100 % RDF + MC	16.3	16.5	16.4	17.2	17.8	17.5	5.4	5.2	5.3	2.9	1.6	2.2
S_7-125 % RDF + MC	16.9	17.3	17.1	16.8	17.7	17.3	5.9	5.5	5.7	3.2	1.8	2.5
S.Em±	0.32	0.27	0.28	0.61	0.64	0.59	0.46	0.51	0.40	2.08	0.73	1.19
CD (p=0.05)	0.92	0.78	0.80	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (M x S)												
S.Em±	0.66	0.56	0.57	1.26	1.32	1.24	0.92	0.98	0.80	3.89	1.47	2.23
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (S x M)												
S.Em±	0.64	0.55	0.56	1.21	1.28	1.19	0.92	1.02	0.80	4.16	1.45	2.38
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: RDF *(Recommended dose of fertilizer) 20:50:20 N, P_2O_5 and K_2O kg ha^{-1}*

MC *– Microbial consortia (N-azotobacter + PSB+KRB+ ZnSB) @ 5 kg ha^{-1}*

Table 3. Net assimilation rate (mg m^{-2} day^{-1}) of chickpea as influenced by seed rate and nutrient management

Treatments	0 - 30 DAS			30 - 60 DAS			60 – 90 DAS			90 DAS –harvest		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
Main Plot-Seed rate (M)												
M_1-52 kg ha^{-1}	2.07	2.08	2.07	0.51	0.54	0.52	0.17	0.16	0.16	0.10	0.06	0.08
M_2-70 kg ha^{-1}	1.99	1.98	1.99	0.39	0.41	0.40	0.15	0.15	0.15	0.10	0.05	0.08
M_3-77 kg ha^{-1}	1.85	1.95	1.90	0.38	0.40	0.39	0.15	0.14	0.05	0.09	0.06	0.07
M_4-105kg ha^{-1}	1.84	1.81	1.83	0.29	0.31	0.30	0.13	0.13	0.13	0.07	0.03	0.05
S.Em±	0.05	0.04	0.04	0. 02	0.02	0.02	0.01	0. 01	0.01	0.04	0.04	0.04
CD (p=0.05)	0.17	0.14	0.15	0. 06	0.06	0.06	NS	NS	NS	NS	NS	NS
Sub plot-Nutrient management (S)												
S_1-Absolute control	1.96	1.97	1.96	0.38	0.40	0.39	0.14	0.15	0.14	0.03	0.06	0.04
S_2-75 % RDF	1.90	1.94	1.92	0.40	0.42	0.41	0.15	0.15	0.15	0.03	0.05	0.04
S_3-100 % RDF	1.91	1.93	1.92	0.40	0.42	0.41	0.15	0.14	0.14	0.11	0.05	0.08
S_4-125 % RDF	1.93	1.97	1.95	0.39	0.41	0.40	0.16	0.15	0.15	0.13	0.06	0.10
S_5-75 % RDF + MC	1.94	1.97	1.96	0.40	0.41	0.41	0.15	0.14	0.15	0.05	0.04	0.05
S_6-100 % RDF + MC	1.93	1.93	1.93	0.40	0.42	0.41	0.15	0.14	0.15	0.13	0.08	0.11
S_7-125 % RDF + MC	1.98	1.98	1.98	0.39	0.41	0.40	0.16	0.14	0.15	0.14	0.07	0.11
S.Em±	0.05	0.05	0.05	0.02	0.02	0.02	0.01	0.01	0.01	0.10	0.03	0.06
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (M x S)												
S.Em±	0. 11	0.11	0. 11	0.05	0.04	0.05	0.03	0.02	0.02	0.02	0.06	0.11
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (S x M)												
S.Em±	0. 11	0.11	0.10	0.05	0.04	0.05	0.03	0.02	0.02	0.02	0.06	0.10
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

***Note: RDF** (Recommended dose of fertilizer) 20:50:20 N, P_2O_5 and K_2O kg ha^{-1}*

***MC** – Microbial consortia (N-azotobacter + PSB+KRB+ ZnSB) @ 5 kg ha^{-1}*