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Research Paper

Yield, weed dynamics and nutrient balance of machine-planted chickpea under varying seed rate and nutrient management

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ABSTRACT

The present investigation studied the growth, yield, weed dynamics and nutrient balance of machine-planted chickpea under varied seed rates and nutrient management. The experiment was laid in split plot design with four main plots *viz.*, seed rate (52, 70, 77 and 105 kg ha^{-1}) and seven nutrient management practices in sub-plots *viz.*, absolute control, 75% RDF, 100% RDF, 125% RDF, 75% + soil application of microbial consortia (MC), 100% RDF + MC and 125% RDF + MC. Results revealed that higher weed density and weed dry matter were recorded with 52 kg ha^{-1} seed rate and with 125% RDF + MC. Higher crop growth and seed yield (2580 kg ha^{-1}) were recorded with a seed rate of 105 kg ha^{-1}. Among the nutrient management treatments, growth and seed yield (2.58 t ha^{-1}) were better with 125% RDF + MC. Soil nutrient status was found better with 52 kg ha^{-1} seed rateand 125% RDF + MC resulted in better soil status.

Key words: Weed dynamics, Crop growth, Machine planting, Sustainability, Yield

INTRODUCTION

Production of pulses is largely restricted to Asian countries and especially to the Indian sub-continent. India can be proud of growing the largest number of pulse crops (grain pulses) in the world. Over a dozen pulse crops are grown in one or the other part of the country (Kumar and Yadav 2018). Among pulses, chickpea (*Cicer arietinum* L.) dominates with over 49.3% share of total pulses during 2020-21 (Gaur 2021). Chickpea remains a crucial contributor to crop diversification for agricultural sustainability. It is well adapted to abiotic stresses and commonly cultivated in rainfed areas on residual soil moisture. Despite the silent revolution, there is still a great scope in Telangana state to expand the area under chickpea to sustain farmers' income and the 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 way of partial or complete mechanization. Mechanization can be practiced in chickpea for various operations like sowing, spraying, harvesting, and threshing (Dhimate *et al.* 2018). Thus, mechanization, a key factor in increasing the area under chickpea is a dire necessity in the current scenario. Planting density, proper selection of sowing dates and fertilizer management are key agronomic interventions that help to improve the potential yield of any crop (Maruthi *et al.* 2017). These interventions in mechanized farming scenarios require proper standardization.

The next biggest challenge in rainfed agriculture is the cost incurred on fertilizers. Particularly in the post-green revolution era, intensive agriculture with the use of high-analysis inorganic fertilizers alone beyond the threshold requirement of crop and soil resulted in diminishing soil fertility and posed a stern hazard to sustainable crop production. Among the various sources of plant nutrients, biofertilizers have emerged as a high potent that complement chemical fertilizers on account of their eco-friendly, non-toxic nature, ease of application, and cost-effectiveness. The application of biofertilizers in chickpea enhances crop yield and quality by fixing the atmospheric nitrogen and improving the availability of native soil nutrients besides maintaining soil fertility (Uddin *et al*. 2014).

The effect of agronomic interventions on weed dynamics is of much significance in reducing the competition for crop plants (Lakra *et al.* 2019). The principles behind nutrient balance studies and the comparison of inputs and outputs from a system have been at the heart of the development of plant nutrition as a science and the development of world agriculture (Lefroy and Wijnhoud 2001). Keeping these facts in view, the present study focuses on the performance of machine-planted chickpea, in terms of growth, weed dynamics, and nutrient balance under different seed rates and nutrient management systems.

MATERIALS AND METHODS

Experimental site

The present field investigation was carried out at Agricultural Research Institute (ARI), Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar, Hyderabad during the *Rabi* seasons of 2020-21 and 2021-22 (November - February). The climate of the experimental site was classified as dry tropical and semi-arid and comes under the Semi-Arid Tropical region (SAT) according to Troll's climatic classification.

The textural class of the soil was sandy clay loam and the reaction of the soil was slightly alkaline (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 (524 kg ha^{-1}). The pH, EC, and available K were analyzed using standard procedures.

Experimental design and growing conditions

The experiment was laid out in split plot design consisting of four main plots *viz*; seed rate (52, 70, 77 and 105 kg ha^{-1})with 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 45 cm × 10 cm, 45 cm × 7.5 cm, 30 cm × 10 cm and 30 cm × 7.5 cm spacings, respectively. The CIAE planter (Manufactured by Central Institute of Agricultural Engineering, Bhopal) was calibrated in the Engineering workshop, AICRP on Farm implements and Machinery, PJTSAU to obtain the desired seed rate for four planting densities consisting of 2 inter-row spacings (45 cm and 30 cm) and 2 intra row spacing (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 solubilizing bacteria (PSB) + potassium releasing bacteria (KRB) + zinc solubilizing bacteria (ZnSB) @ 5 kg ha^{-1}), N_6- 100% RDF + MC and N_7- 125% RDF + MC. The entire dose of P (Single super phosphate) and K (Muriate of potash) and 50% dose of N (urea) were applied as basal while,the remaining 50% dose of N was top dressed at 30 days after sowing (DAS). Microbial consortia (*Azotobacter* + PSB + KRB + ZnSB) was obtained by mixing all the bio-fertilizer strains in equal proportion and was applied @ 5 kg ha^{-1} along with 250 kg vermicompost to the soil as basal by spreading uniformly throughout the respective treatment plots ($N_{5,}$ N_6 and N_7).

Basal application of vermicompost @ 200 kg ha^{-1} was applied uniformly to all experimental plots along with 750 g of *Rhizobium*, 750 g of *Trichoderma viridae,* and 750 g of *Pseudomonas sp.* to ensure control against fungal diseases. Pre-emergence herbicide application with a tank mixture of pendimethalin and imazethapyr @ 1 kg a.i ha^{-1} was done at 2 days after sowing (DAS). In plots with a row spacing of 45 cm, weeding was done with the help of a power weeder while, in plots with a row spacing of 30 cm, weeding was carried out using wheel hoe. Plant protection measures were taken up as per the recommendation to the crop. Harvesting was done using a mechanical reaper.

Nutrient balance sheet

The balance sheet of available nutrients was computed by using the following formulae given by Tandon (2007). The determined nutrient balance may be positive or negative.

Nutrient balance = Available soil nutrient status−Initial soil status before each crop

Statistical analysis

Data on growth, nodulation, yield, protein content, and economics were scrutinized using analysis of variance technique for split-plot design suggested by Gomez and Gomez (1984). To test the significance, the least significant difference was worked out using WINDOSTAT software. The means were separated by the Duncan Multiple

Range Test (DMRT) for normally distributed data at a 95% confidence level and correlation studies were conducted using SPSS software.

RESULTS AND DISCUSSION

Growth parameters and yield

The data from Table 1 highlights significant variations in leaf area and leaf area duration (LAD) across different seed rates and nutrient management treatments, emphasizing their critical impact on chickpea growth and yield.

The seed rate of 52 kg ha^{-1} recorded the highest leaf area (540.3 cm^2), while the lowest leaf area (479.7 cm^2) was observed with the seed rate of 105 kg ha^{-1}. The reduced plant density at 52 kg ha^{-1} allowed individual plants to access more resources such as nutrients and moisture, resulting in better growth, increased branching, and a larger leaf area. Conversely, the seed rate of 105 kg ha^{-1} resulted in a significantly higher LAD (39.12 days) compared to lower seed rates (52, 70, and 77 kg ha^{-1}). The higher LAD at increased plant density was attributed to improved interception and utilization of solar radiation per unit area. These findings corroborate Patil (2013), who also observed increased LAD with higher seed rates in chickpea.

Seed yields also varied significantly with seed rate and nutrient management practices. Although the seed rate of 52 kg ha^{-1} produced the highest number of pods per plant, the seed rate of 105 kg ha^{-1} recorded the highest seed yield. This was attributed to the higher plant density at 105 kg ha^{-1}, which enabled optimal utilization of growth resources such as light, water, and nutrients, leading to efficient photosynthesis and assimilating translocation from source (leaf) to sink (pod). Conversely, lower plant density at 52 kg ha^{-1} allowed for better growth of individual plants but resulted in reduced yield due to fewer plants per unit area. These observations align with Patil *et al.* (2021) who reported higher seed yields at higher seed rates in machine-planted chickpea.

Nutrient management practices significantly influenced growth parameters and yield. The application of a 125% recommended dose of fertilizers (RDF) + microbial consortia (MC) resulted in the highest leaf area, crop growth rate (CGR), and LAD, closely followed by 125% RDF alone, while the absolute control recorded the lowest values. The combined application of 125% RDF and MC provided a sustained nutrient supply throughout the growth period, enhancing cell division, elongation, and photosynthesis. This led to better branching, higher leaf area, and improved photosynthetic efficiency. These results align with findings from Arya *et al.* (2007), Rani *et al.* (2017), and Meena *et al.* (2020), who documented increased growth parameters with the combined application of inorganic fertilizers and biofertilizers in chickpea. Further, 125% RDF + MC also produced the highest seed yield (25.8 kg ha^{-1}), while the absolute control yielded the lowest (17.8 kg ha^{-1}). The improved

Table 1. Mean of growth and yield of chickpea as influenced by seed rate and nutrient management over two years (*Rabi* 2020-21 and 2021-22)

Treatments	Leaf area (cm^2)	Crop growth rate (g m^{-2} day^{-1})	Leaf area duration (days)	Number of pods plant^{-1}	Seed yield (t ha^{-1})
Seed rate (kg ha^{-1})					
52	540.3a	7.07a	21.75d	45.7a	1.82d
70	511.5ab	7.09a	27.59c	44.6a	2.16c
77	502.7ab	7.47a	30.53b	44.0ab	2.29b
105	479.7b	7.50a	39.12a	41.2b	2.58a
LSD (P=0.05)	25.85	NS	1.74	3.03	0.08
Nutrient management					
Absolute control	444.1b	6.13b	26.78c	39.6c	1.78e
75% RDF	488.8ab	7.05ab	28.76bc	42.1bc	2.00d
100 RDF	506.0ab	7.33ab	29.10abc	44.0ab	2.17cd
125% RDF	548.7a	7.63a	32.03a	45.6ab	2.46ab
75% RDF + MC	502.5ab	7.24ab	29.36abc	42.4bc	2.12c
100% RDF + MC	516.0a	7.64a	29.63abc	45.2ab	2.38b
125% RDF + MC	553.7a	7.97a	32.57ab	47.4a	2.58a
LSD (P=0.05)	62.16	1.05	3.25	3.85	0.15

Note: *In a column figures having similar letter(s) do not differ significantly at 5% level whereas figures with dissimilar letter(s)differ significantly as per DMRT at same level; DMRT= Duncan's Multiple Range Test; LSD= Least significant difference.*

seed and haulm yield with 125% RDF + MC was due to adequate nutrient availability, enhanced root development, and better photosynthetic efficiency. Microbial inoculants further promoted root elongation and leaf expansion, contributing to improved growth and yield. These findings are consistent with those of Nawange *et al*. (2018) and Sangma and Changde (2020), who reported improved yields in chickpea with higher nutrient doses combined with microbial inoculants.

Weed dynamics

Plant density and nutrient management significantly influence weed distribution in crop systems. Among seed rate treatments, higher weed density and dry matter were observed at a seed rate of 52 kg/ha, while the lowest was recorded at 105 kg ha^{-1}. The lower seed rate provided more space and resources, favoring weed growth, whereas higher seed rates promoted crop density, enabling crops to better utilize light, nutrients, moisture, and space, thereby suppressing weeds through competition and shading effects. Similarly, nutrient management practices showed that the application of 125% RDF resulted in significantly higher weed density and dry matter compared to the absolute control. The increased nutrient availability under higher fertilizer doses likely facilitated better weed growth alongside the crop. These results align with findings from Patil (2013), Yadav *et al*. (2016), and Deva and Kolhe (2018), highlighting the role of higher seed rates and optimal nutrient management in reducing weed interference in crops.

Table 2. The mean of weed dynamics over two years (*Rabi* 2020-21 and 2021-22) in chickpea as influenced by seed rate and nutrient management

Treatments	Weed density (No. m^{-2})				Weed dry matter (g m^{-2})			
	20 DAS	40 DAS	60 DAS	80 DAS	20 DAS	40 DAS	60 DAS	80 DAS
Seed rate (kg ha⁻¹)								
52	52.9 (8.2)	33.9 (6.7)	42.4 (7.5)	27.1 (6.1)	34.3 (6.8)	29.9 (6.4)	41.8 (7.4)	32.5 (6.7)
70	49.3 (8.0)	28.5 (6.3)	39.9 (7.3)	24.4 (5.9)	32.1 (6.6)	27.8 (6.2)	39.2 (7.2)	25.6 (6.0)
77	38.9 (7.2)	21.1 (5.3)	37.7 (7.1)	23.1 (5.8)	29.6 (6.4)	23.9 (5.9)	33.6 (6.8)	21.6 (5.6)
105	38.7 (7.2)	16.7 (5.0)	34.6 (6.9)	20.5 (5.5)	28.4 (6.3)	20.8 (5.5)	30.0 (6.5)	19.5 (5.4)
LSD (P=0.05)	0.21	0.35	0.25	0.23	0.27	0.25	0.57	0.35
Nutrient management								
Absolute control	38.8 (7.2)	17.0 (5.0)	31.5 (6.6)	15.2 (4.9)	24.0 (5.9)	17.7 (5.2)	28.6 (6.3)	18.5 (5.2)
75% RDF	43.0 (7.5)	23.1 (5.7)	36.7 (7.0)	22.7 (5.7)	29.1 (6.4)	22.7 (5.7)	35.2 (6.9)	23.0 (5.7)
100 RDF	45.5 (7.6)	26.9 (6.1)	41.0 (7.4)	26.5 (6.1)	33.7 (6.8)	27.0 (6.2)	37.7 (7.1)	27.0 (6.2)
125% RDF	51.9 (8.1)	32.0 (6.6)	44.6 (7.6)	28.9 (6.3)	34.8 (6.9)	32.8 (6.7)	40.1 (7.2)	30.0 (6.4)
75% RDF + MC	42.2 (7.4)	21.6 (5.6)	35.4 (6.9)	21.5 (5.6)	28.5 (6.3)	22.3 (5.7)	34.2 (6.8)	22.4 (5.7)
100% RDF + MC	45.3 (7.7)	25.9 (6.0)	39.0 (7.2)	24.9 (6.0)	33.2 (6.8)	26.2 (6.1)	38.1 (7.1)	24.9 (6.0)
125% RDF + MC	48.0 (7.9)	28.4 (6.2)	42.5 (7.5)	26.9 (6.2)	34.3 (6.8)	30.5 (6.5)	39.4 (7.2)	28.0 (6.3)
LSD (P=0.05)	0.38	0.50	0.39	0.45	0.33	0.45	0.44	0.46

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}. Figures in parentheses are the transformed values. Square root transformation ($\sqrt{x+1}$) used for statistical analysis.

Soil nutrient balance

Nutrient balance sheets are not just mathematical computations but are very important for gaining insightinto the dynamics of soil fertility, nutrient budgeting, andpractical nutrient management planning. The balance sheet of N, P_2O_5, and K_2O indicates that the depletion of nutrients increases with an increase in the seed rate of chickpea. The increased negative balance of nutrients with higher seed rates may be attributed to the greater plant population per unit area, leading to enhanced nutrient absorption from the soil.

From Table 3, the computed balance of N was found to be higher with the application of 75% RDF followed by 100% RDF and absolute control. This might be due to an increase in nutrient content and higher uptake in higher fertilizer-applied treatments, which is reflected in the higher growth and yield of chickpea (Table 1). There was a net negative balance in available N. This could be due to unaccountable nitrogen fixation in any pulse crop including chickpea. Data from Table 4 indicates that higher computed balance of P_2O_5 with the application of higher doses of fertilizer. Net negative balance of P_2O_5 was observed only in absolute control plots whereas, in fertilizer treated plots showed a positive balance of P_2O_5. This is due to slow mobilization of phosphorus and the entire phosphorus applied will not be taken by the plant due to fixation in soil. The balance sheet of K_2O indicates a more negative balance in absolute control plots compared to fertilizer-treated plots. This is due to higher K content in the entire plant, increased biological yield and better K mining in soils. In general, there is an increase in the loss of nutrients with an increase in the dose of application which might be due to losses through leaching, volatilization, adsorption, and fixation. However, the conjunctive application of microbial consortia along with inorganic fertilizers has decreased the net loss of nutrients compared to the application of chemical fertilizers alone. These results are in line with the findings of Tanwar *et al.* (2010) and Patil *et al.* (2012) in chickpea.

Table 3. Balance sheet of available soil nitrogen after two years of experiment.

Treatments	Initial soil N (kg ha^{-1}) A	Added fertilizer N (kg ha^{-1})		Nutrient removal by crop (N) (kg ha^{-1})		Computed balance (N) (kg ha^{-1})		Actual balance (N) (kg ha^{-1})		Net loss (-) or gain (+) (N) (kg ha^{-1})	
		B		C		D=(A+B)-C		E		F=E-D	
		2020-21	2020-21	2020-21	2020-21	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Seed rate (kg ha^{-1})											
52	176.2	17.14	17.14	98.55	102.86	94.80	92.65	178.37	179.03	-83.57	-86.39
70	176.2	17.14	17.14	115.56	119.48	77.78	73.55	175.89	177.16	-98.11	-103.61
77	176.2	17.14	17.14	118.86	126.34	74.48	64.02	173.21	172.13	-98.73	-108.11
105	176.2	17.14	17.14	135.25	139.45	58.09	50.20	172.50	171.84	-114.42	-121.64
Nutrient management											
Absolute control	176.2	0	0	93.77	95.02	82.43	75.76	170.79	170.00	-88.35	-94.23
75% RDF	176.2	15	15	104.96	109.27	86.24	79.94	174.20	172.61	-87.96	-92.67
100 RDF	176.2	20	20	114.38	120.12	81.82	76.39	176.51	174.99	-94.70	-98.60
125% RDF	176.2	25	25	130.22	137.89	70.98	65.02	177.91	178.46	-106.93	-113.44
75% RDF + MC	176.2	15	15	112.33	115.87	78.87	71.40	172.27	173.74	-93.40	-102.34
100% RDF + MC	176.2	20	20	125.89	131.84	70.31	63.11	174.95	175.81	-104.64	-112.70
125% RDF + MC	176.2	25	25	137.85	144.21	63.35	59.11	178.32	179.69	-114.97	-120.57

***Note:** For calculating the computed balance for the second year (2021-22), the first year's actual balance was taken as initial soil N.*

Table 4. Balance sheet of available soil phosphorus (P_2O_5) after two years of experiment

Treatments	Initial soil P_2O_5 (kg ha^{-1}) A	Added fertilizer P_2O_5 (kg ha^{-1})		Nutrient removal by crop (P_2O_5) (kg ha^{-1})		Computed balance (P_2O_5) (kg ha^{-1})		Actual balance (P_2O_5) (kg ha^{-1})		Net loss (-) or gain (+) (P_2O_5) (kg ha^{-1})	
		B		C		D=(A+B)-C		E		F=E-D	
		2020-21	2020-21	2020-21	2020-21	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Seed rate (kg ha^{-1})											
52	72.7	42.86	42.86	9.56	10.12	106.00	109.02	76.29	76.04	29.71	32.99
70	72.7	42.86	42.86	11.14	11.76	104.42	105.92	74.83	74.17	29.59	31.76
77	72.7	42.86	42.86	11.50	12.42	104.06	102.20	71.77	69.70	32.29	32.50
105	72.7	42.86	42.86	12.91	13.74	102.64	97.70	68.58	68.84	34.06	28.85
Nutrient management											
Absolute control	72.7	0	0	8.80	8.92	63.90	60.16	69.07	67.99	-5.17	-7.84
75% RDF	72.7	37.5	37.5	9.99	10.50	100.21	97.73	70.73	69.61	29.48	28.12
100 RDF	72.7	50.0	50.0	10.99	11.79	111.71	111.89	73.67	71.99	38.04	39.89
125% RDF	72.7	62.5	62.5	12.59	13.73	122.61	123.74	74.97	75.46	47.64	48.27
75% RDF + MC	72.7	37.5	37.5	10.80	11.46	99.40	97.22	71.18	70.75	28.22	26.47
100% RDF + MC	72.7	50.0	50.0	12.33	13.20	110.37	110.99	74.19	72.81	36.18	38.18
125% RDF + MC	72.7	62.5	62.5	13.44	14.49	121.76	124.26	76.25	76.69	45.51	47.57

***Note:** For calculating the computed balance for the second year (2021-22), the first year's actual balance was taken as initial soil P.*

Table 5. Balance sheet of available soil potassium after two years of experiment

Treatments	Initial soil K_2O (kg ha^{-1}) A	Added fertilizer K_2O (kg ha^{-1})		Nutrient removal by crop (K_2O) (kg ha^{-1})		Computed balance (K_2O) (kg ha^{-1})		Actual balance (K_2O) (kg ha^{-1})		Net loss (-) or gain (+) (K_2O) (kg ha^{-1})	
		B		C		D=(A+B)-C		E		F=E-D	
		2020-21	2020-21	2020-21	2020-21	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Seed rate (kg ha^{-1})											
52	523.5	17.14	17.14	28.37	30.35	512.28	497.14	510.34	508.09	1.94	-10.95
70	523.5	17.14	17.14	32.59	34.96	508.05	487.81	505.63	506.84	2.42	-19.03
77	523.5	17.14	17.14	34.34	37.19	506.30	484.22	504.27	504.02	2.04	-19.80
105	523.5	17.14	17.14	38.48	40.81	502.16	476.44	500.10	502.32	2.06	-25.88
Nutrient management											
Absolute control	523.5	0	0	27.05	27.46	496.45	476.36	503.83	501.78	-7.37	-25.42
75% RDF	523.5	15	15	29.90	31.97	508.60	484.68	501.65	502.57	6.95	-17.88
100 RDF	523.5	20	20	33.19	35.42	510.31	489.78	505.20	504.55	5.11	-14.77
125% RDF	523.5	25	25	36.80	40.78	511.70	493.13	508.91	513.46	2.79	-20.33
75% RDF + MC	523.5	15	15	32.46	34.02	506.04	483.86	502.89	500.28	3.15	-16.42
100% RDF + MC	523.5	20	20	35.57	38.68	507.93	485.82	504.50	502.73	3.43	-16.91
125% RDF + MC	523.5	25	25	39.14	42.44	509.36	491.18	508.63	511.85	0.74	-20.66

Note: *For calculating the computed balance for the second year (2021-22), the first year's actual balance was taken as initial soil K*

CONCLUSION

From the present study in machine-planted chickpea, it can be concluded that a seed rate of 105 kg ha^{-1} resulted in better growth and yield apart from lower weed density and dry weight. Among the nutrient management practices, application of a higher dose of fertilizer application (125% RDF + soil application of Microbial consortia (MC) - *Azotobacter* + Phosphorus solubilizing bacteria (PSB) + Potassium releasing bacteria (KRB) + Zinc solubilizing bacteria (ZnSB) @ 5 kg ha^{-1} recorded higher growth and seed yield due to lower nitrogen status of experimental site. Further, in the long run, conjunctive application of microbial consortia along with inorganic fertilizers helps to reduce the net loss of nutrients and negative balance.

REFERENCES

Arya RL, Varshney JG and Kumar L. 2007.Effect of integrated nutrient application in chickpea + mustard intercropping system in the semi-arid tropics of North India.Communications in Soil Science and Plant Analysis **38**(1-2): 229-240.

Barrios M, Estarda JAS, Barrios P, Montano YA and Hernandez JC. 2020. Analysis of growth and productivity of green chickpea using nitrogen and phosphorus fertilization. Phyton-International Journal of Experimental Botany **90**(4): 1193-1203.

Deva S and Kolhe S.S. 2018. Nutrient and weed management practices influenced yield and weed dynamics in chickpea (*Cicer arietinum* L.). International Journal of Fauna and Biological Studies **5**(6): 45-51.

Gomez KA and Gomez AA. 1984. *Statistical procedures for agricultural research*. Second Edition.An International Rice Research Institute Book. A Wiley-Inter-science Publication, John Wiley & Sons, New York.

John AT, Makkar S, Swaminathan S, Minocha S, Webb P, Kurpad AV and Thomas T. 2021. Factors influencing household pulse consumption: A multilevel model analysis. Global Food Security **29**:100534

Kumar N and Yadav A. 2018. Role of pulses in improving soil quality and enhancing resource use efficiency. Conservation Agriculture for Advancing Food Security in Changing Climate, 2. Pp. 547-561.

Lakra K, Verma SK, Maurya AC, Singh SB, Meena RS and Shukla UN. 2019. Enhancing Crop Competitiveness Through Sustainable Weed Management Practices. Sustainable Agriculture, 109.

Lefroy RD and Wijnhoud JD. 2001. Nutrient balance studies: General use and perspectives for SE Asia. In International Workshop on Nutrient Balances for Sustainable Agricultural Production and Natural Resource Management in Southeast Asia (20-22 February 2001, Bangkok, Thailand): Selected Papers and Presentations. CIAT, Vientiane, Laos PR/IWMI, Bangkok, Thailand.

Maruthi V, Reddy PR, Reddy KS and Reddy BMK. 2017. Agronomic management of CRIDA-18R-a new variety of horse gram (*Macrotyloma uniflorum*) for South India matching monsoon patterns of rainfall. Legume research, **3680**: 1-6.

Meena R, Meena M, Sharma PK and Kumar C. 2020. Effect of fertility levels and bio-fertilizers on growth and yield of chickpea (*Cicer arietinum* L.). International Journal of Current Microbiology and Applied Sciences **9**(02): 3098-3103.

Nawange DD, Verma HD and Hemlata V. 2018. Growth and yield performance of kabuli chickpea (*Cicer arietinum* L.) genotypes under different planting geometry and fertility levels in vindhya plateau region. International Journal of Agriculture Sciences **10**(5): 5291-5293.

Patil SB, Mansur CP, Gaur PM, Salankinkop SR and Alagundagi SC. 2021. Planting density affected dry matter production, partitioning, and yield in machine harvestable chickpea genotypes in the irrigated ecosystem. International Journal of Plant Production **15**: 29-43.

Patil SV, Halikati SI, Thimmegowda MN, Gurumurthy SB and Lokesh MS. 2012. Integrated nutrient management practices on soil NPK nutrient balance under organic cultivation of chickpea (*Cicer arietinum* L.) grown in vertisol of northern dry zone of Karnataka. An Asian Journal of Soil Science **7**(1): 66-71.

Patil SB. 2013. Agronomic investigations on tall chickpea genotypes suitable for mechanical harvesting. *Ph D Thesis*. University of Agricultural Sciences. Dharwad.

Rakesha A, Jalander P, Sandeep S and Srijan A. 2016. Versatile crops for sustainable future: A review on pulses. Advances in Life Sciences **5**(19): 8092-8096.

Rani S, Kumar P and Yadav AK. 2017. Effect of biofertilizers in conjuction with chemical fertilizers on growth behavior and profitability of field pea (*Pisum sativum* L.) grown in western plains of Haryana. Chemical Science Review and Letters **6**(22): 801-805.

Sangma AS and Changade NM. 2020. Different fertilizer dose and biofertilizer inoculation's effect on N, P and K content and uptake of chickpea (*Cicer arietinum* L.).European Journal of Molecular and Clinical Medicine **7**(7): 2340- 2348.

Tandon HLS. 2007. Soil Nutrient Balance Sheets in India: Importance, Status, Issues, and Concerns. Better Crop India **1:** 15–19.

Tanwar SPS, Rokada P and Singh AK. 2010. Productivity, nutrient balance and economics of *kabuli* chickpea (*Cicer kabulium*) as influenced by integrated nutrient management. Indian Journal of Agronomy **55**(1): 33-37.

Watson DJ. 1956. Leaf growth in relation to crop yield, In: The growth of leaves (Ed. F.L. Milthpore) Button worthsscientific publications, London. Pp. 178-190.

Yadav A, Dwivedi A, Singh R, Tomar SS, Kumar V and Kumar S. 2016. Effect of seeding rates and weed management on weed dynamics, crop productivity and production economics of urdbean. Green Farming **7**(4): 845-849.