Original Research Article

Impact of Tillage Practices and Chickpea Varieties on Nutrient Uptake in a Mungbean-Chickpea Cropping System

ABSTRACT

Aims: To study the effect of tillage management on nutrient concentration and uptake of different varieties in chickpea (*Cicer arietinum* L.) under mungbean-chickpea crop sequence

Study design:strip plot design

Place and Duration of Study: Pulses Research Unit, Washim Road, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (Dr. PDKV), Akola, Maharashtra, Indiaduring the *rabi* season of 2019-20.

Methodology: There were four tillage practices and two varieties (eight treatments) replicated five times.Main plot treatments include tillage practices for chickpea crop and Sub plot treatments includes two varieties of chickpea, JAKI-9218 and PDKV-Kanak (AKG-1303).

Results: There were four tillage practices and two varieties (eight treatments) replicated five times. The findings showed that the effect of different tillage treatments and varieties on the nitrogen (% N), phosphorus (% P) and potassium (% K) content in seed and straw of chickpea crop was found non-significant. Nutrient uptake (kg/ha) in seed and straw and total uptake (kg/ha) of nutrient by crop was higher with treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding (T_1). The variety JAKI-9218 recorded significantly greater nutrient uptake than the PDKV-Kanak.

Conclusion: Nutrient concentration (%) and uptake (kg/ha) in seed and straw and total uptake (kg/ha) of nutrient by crop was higher with treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding and JAKI-9218.

***Key Words:** Chickpea, Tillage practices, Nutrient uptake, Nutrient content*.

INTRODUCTION

The growing demand for sustainable agricultural practices has led to increased interest in optimizing tillage management and crop variety selection, particularly in nutrient-intensive cropping systems. Among these, the mungbean-chickpea sequence offers a promising solution for enhancing soil fertility, improving nutrient cycling, and maximizing crop productivity. Chickpea (*Cicer arietinum* L.), an important legume in this rotation, relies heavily on effective tillage management and suitable variety selection to achieve optimal nutrient concentration and uptake.

“With an output of 1344 kg/ha, Madhya Pradesh had the highest chickpea production in 2018–19, reaching 4.61 million tonnes. With a productivity of 1103 kg/ha, 1.76 million million tonnes were produced in Rajasthan” [1]. In India, 10.32 million tonnes of chickpeas were produced[2]. “During *rabi* 2018-19, 1.69 million hectares of land in Maharashtra were cultivated for chickpea farming and 1.39 million tons were produced. In Maharashtra, the yield of chickpeas was 824.5 kg/ha” [3].“Mungbean-chickpea cropping system is popular in the Vidarbha region of the Maharashtra state and followed on 0.1 million ha area” [4].

“Tillage as a part of a cropping system is one of the basic agricultural operations because of its influence on soil properties, environment and crop growth. Tillage practices, including conventional and conservation tillage, play a crucial role in determining soil health, nutrient dynamics, and crop performance. Conventional tillage, characterized by intensive soil disturbance, enhances nutrient availability by breaking down soil aggregates and improving nutrient release; however, it may lead to soil erosion and degradation over time. In contrast, conservation tillage practices, such as reduced or no-till methods, aim to minimize soil disturbance, improve moisture retention, and maintain soil organic matter" [5]. While conservation tillage can foster a more resilient soil ecosystem, the trade-off in nutrient release and crop uptake requires careful evaluation.

A healthy chickpea crop can fix up to 141 kg of nitrogen per hectare, saving 56–58 kg of nitrogen per hectare for subsequent cereals [6]. "The ability of plants to form vast root systems is largely responsible for their power to absorb water and mineral nutrients from the soil. However, deep root growth is hindered by soil compaction, particularly in subsoil layers, which limits plant access to nutrients and water in the subsoil" [6].

In this study, we explore the impact of different tillage practices and chickpea varieties on nutrient concentration and uptake within a mungbean-chickpea sequence. By evaluating both the nutritional profile and the crop's response to tillage methods, this work aims to provide insights for agronomists and farmers on enhancing nutrient availability and maximizing yield potential in chickpea cultivation.

MATERIALS AND METHODS

An investigation on the effect of tillage management techniques and varieties on chickpea nutrient concentration and uptake under the mungbean-chickpea sequence was conducted during the 2019–20 rabi season at the Pulses Research Unit, Washim Road, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India. The experimental plot's soil had a clay loam texture and reacted slightly alkalinely (pH 8.20). The soil's chemical composition revealed that its available nitrogen content was low (173 kg/ha), its available phosphorus level was medium (20 kg/ha), and its potassium content was high (523 kg/ha). With an electrical conductivity of 0.18 dS/m, the total soluble salt level was normal. Using a strip plot design, the experiment was set up.Table 1. lists the particulars of the treatment and symbols employed. Overall, two cultivars and four tillage techniques (eight treatments) were duplicated five times. Plots of 40 units were used to lay out the experimental field. Plot dimensions were 10.0 m x 9.0 m for the gross plot and 9.80 m x 8.40 m for the net plot.

On October 18, 2019, seeds of the chickpea varieties PDKV-Kanak and JAKI-9218 were planted at a rate of 75 kg/ha, with a spacing of 10 cm between plants and 30 cm between rows. All treatments received the full recommended dosage of fertilizers (25 kg N, 50 kg P2O5, and 30 kg K2O/ha) at the time of sowing (basal application). To safeguard the chickpea crop from pests and diseases, timely recommended plant protection measures were used. Harvesting the chickpea crop was done by hand. Periodically, various growth and yield components were documented. As recommended by Panse and Sukhatme (1995), the data on different parameters obtained from experimental plots were statistically examined using the "F" test at P=0.05. [7]

RESULTS AND DISCUSSION

Nutrient content

Nitrogen (% N), phosphorus (% P) and potassium (% K) content

From the data it is revealed that, the effect of different tillage treatments and varieties on the nitrogen (% N), phosphorus (% P) and potassium (% K) content in seed and straw of chickpea crop was found non-significant in the present investigation (Table 2). Interaction effect of various tillage treatments and varieties on thenitrogen (% N), phosphorus (% P) and potassium (% K) content in seed and straw of chickpea crop during the course of present investigation. (Table 2)

Nitrogen uptake, phosphorus uptake and potassium uptake (kg/ha)

Nitrogen uptake (kg/ha)

The data presented in Table3 showed that various tillage treatment significantly influenced on nitrogen (N) uptake by seed and straw by the crop. The treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding (T_1) recorded significantly higher nitrogen (N) uptake by grain (78 kg/ha) which was at par with the treatment rotavator immediately after the harvest of mungbean + sowing + one hoeing (T_4) (74 kg/ha). The lowest nitrogen (N) uptake by grain was observed in the treatment application of glyphosate immediately after the harvest of mungbean + sowing (T_2) (69 kg/ha). The treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding (T_1) recorded significantly higher nitrogen uptake by straw (24 kg/ha). To encourage N absorption and translocation, plough and rotary tillage may increase root activity. Hence in the present investigation the nitrogen (N) uptake was higher in the treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding (T_1). Similar results were also reported earlier by Guana *et al*. (2014) [8].Variety JAKI-9218 recorded significantly greater N uptake by grain (77 kg/ha) over the PDKV-Kanak (69 kg/ha). The effect of varieties on nitrogen uptake (N) by straw was found non-significant.Interaction effect of various tillage treatments and varieties on the N uptake by the seed and straw of chickpea crop was found non-significant during the course of present investigation.

Phosphorus uptake (kg/ha)

The data presented in Table 3 showed that various tillage treatment significantly influenced on phosphorus (P) uptake by seed and straw by the chickpea crop. The treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding (T_1) recorded significantly higher phosphorus (P) uptake by grain (12 kg/ha) and it was found at par with the treatment rotavator immediately after the harvest of mungbean + sowing + one hoeing (T_4) (11 kg/ha). The P uptake by straw was significantly higher with the treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding (T_1) (10 kg/ha) followed by treatment rotavator immediately after the harvest of mungbean + sowing + one hoeing (T_4) (9 kg/ha). Variety JAKI-9218 recorded higher P uptake by grain (13 kg/ha) over the PDKV-Kanak (10 kg/ha). Whereas, P uptake by straw was found non-significant.Interaction effect of various tillage treatments and varieties on the Puptake by the seed and straw of chickpea crop was found non-significant during the course of present investigation.

Potassium uptake (kg/ha)

The data presented in Table 3 showed that various tillage treatment significantly influenced the potassium (K) uptake by seed and straw by the chickpea crop. The treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding (T_1) recorded significantly higher K uptake by grain (39 kg/ha) which was at par with the treatment rotavator immediately after the harvest of mungbean + sowing + one hoeing (T_4) (37 kg/ha). The lowest K uptake by grain was observed with the treatment application of glyphosate immediately after the harvest of mungbean + sowing (T_2) (34 kg/ha). The treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding (T_1) recorded significantly higher K uptake by straw (55 kg/ha) which was statistically similar with the treatment rotavator immediately after the harvest of mungbean + sowing + one hoeing (T_4) (51 kg/ha). The lowest K uptake by straw was found in the treatment application of glyphosate immediately after the harvest of mungbean + sowing (T_2) (45 kg/ha).The effect of varieties on Kuptake by the seed and straw of chickpea crop was found non-significant during the course of present investigation. Interaction effect of various tillage treatments and varieties on the Kuptake by the seed and straw of chickpea crop was found non-significant during the course of present investigation.

Total nitrogen uptake, phosphorus uptake and potassium uptake (kg/ha) in seed and straw of chickpea

The data presented in Fig. 1 showed that various tillage treatment significantly influenced on total N, P and K uptake (kg/ha) by the chickpea. The treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding (T_1) recorded significantly higher total nitrogen (N) uptake by chickpea crop (102 kg/ha) which was at par with the treatment rotavator immediately after the harvest of mungbean + sowing + one hoeing (T_4) (96 kg/ha). The lowest total nitrogen (N) uptake by the chickpea crop was found in the treatment application of glyphosate immediately after the harvest of mungbean + sowing (T_2) (88 kg/ha).

The treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding (T_1) recorded significantly higher total phosphorus (P) uptake by crop (22 kg/ha) which was at par with the treatment rotavator immediately after the harvest of mungbean + sowing + one hoeing (T_4) (20 kg/ha). The lowest total P uptake by chickpea crop was found in treatment application of glyphosate immediately after the harvest of mungbean + sowing (T_2) (18 kg/ha). (Fig. 1)

The treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding (T_1) recorded significantly higher total potassium (K) uptake by crop (94 kg/ha) which was at par with the treatment rotavator immediately after the harvest of mungbean + sowing + one hoeing (T_4) (88 kg/ha). The lowest total K uptake by chickpea crop was found in treatment application of glyphosate immediately after the harvest of mungbean + sowing (T_2) (79 kg/ha). (Fig. 1)

The higher values of uptake of nutrients were a result of higher grain yield. Beneficial effect of conventional tillage practice might be due to sustained availability of nutrients and their efficient translocation to the economic sink. Similar result reported by Arya *et al.* (2005) [9], Nayak *et al.* (2018) [10] and Seth *et al.* (2020) [11].Variety JAKI-9218 recorded significantly highest total nitrogen uptake and potassium uptake (99 and 90 kg/ha nitrogen and potassium, respectively) than the variety PDKV-

Kanak (89 and 81 kg/ha nitrogen and potassium, respectively). The effect of varieties on the total phosphorus uptake was found non-significant.Interaction effect of tillage practices and varieties in respect to total N, P and K uptake (kg/ha) by the chickpea crop were found to be non-significant during the course of investigation.

CONCLUSION

The effect of different tillage treatments and varieties on the nitrogen (% N), phosphorus (% P) and potassium (% K) content in seed and straw of chickpea crop was found non-significant. Nutrient uptake (kg/ha) in seed, straw and total uptake (kg/ha) of nutrient by crop was higher with treatment tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding (T_1). The variety JAKI-9218 recorded significantly greater nutrient uptake than the PDKV-Kanak.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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Table 1: Details of treatment and symbol used for the experiment

A	**Main plot (Tillage practices for chickpea crop)**
T_1	Tractor drawn cultivator + rotovator + sowing + one hoeing + one hand weeding
T_2	Application of glyphosate immediately after the harvest of mungbean + sowing
T_3	Application of glyphosate immediately after the harvest of mungbean + sowing + pre-emergence application of pendimethalin @ 1.0 kg a.i./ha + one hoeing
T_4	Rotovator immediately after the harvest of mungbean + sowing + one hoeing
B	**Sub plot (Varieties of chickpea)**
V_1	JAKI-9218
V_2	PDKV-Kanak (AKG-1303)
Note: Conventional tillage (Summer ploughing + harrowing+ sowing+ one hoeing) followed for the mungbean crop	

Table 2: Effect of tillage practices and varieties on nitrogen, phosphorus and potassium content (%) in seed and straw of chickpea

Treatment	Nutrient content (%)					
	Nitrogen		Phosphorus		Potassium	
Tillage practices for chickpea crop (T)	**Seed**	**Straw**	**Seed**	**Straw**	**Seed**	**Straw**
T_1: Tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding	3.45	0.77	0.54	0.32	1.72	1.79
T_2: Application of glyphosate immediately after the harvest of mungbean + sowing	3.43	0.74	0.51	0.31	1.70	1.76
T_3: Application of glyphosate immediately after the harvest of mungbean + sowing + pre-emergence application of pendimethalin @ 1.0 kg a.i./ha + one hoeing	3.43	0.74	0.51	0.31	1.70	1.77
T_4: Rotavator immediately after the harvest of mungbean + sowing + one hoeing	3.45	0.75	0.52	0.32	1.71	1.78
S.E. (m)	0.01	0.01	0.01	0.01	0.01	0.01
C.D. @5%	NS	NS	NS	NS	NS	NS
Varieties (V)						
V_1: JAKI-9218	3.43	0.75	0.52	0.31	1.71	1.78
V_2: PDKV-Kanak (AKG-1303)	3.44	0.74	0.52	0.32	1.71	1.77
S.E. (m)	0.01	0.01	0.01	0.01	0.01	0.01
C.D. @5%	NS	NS	NS	NS	NS	NS
T x V						
S.E. (m)	0.01	0.01	0.01	0.01	0.01	0.01
C.D. @5%	NS	NS	NS	NS	NS	NS
GM	3.44	0.75	0.52	0.32	1.71	1.77

Means followed by the same letter do not differ significantly at the 0.05 probability level

Table 3: Effect of tillage practices and varieties on nitrogen, phosphorus and potassium uptake (kg/ha) in seed and straw of chickpea

Treatment	Nitrogen (N) uptake (kg/ha)		Phosphorus (P) uptake (kg/ha)		Potassium (K) uptake (kg/ha)	
Tillage practices for chickpea crop (T)	**Seed**	**Straw**	**Seed**	**Straw**	**Seed**	**Straw**
T_1: Tractor drawn cultivator + harrowing + sowing + one hoeing + one hand weeding	78	24	12	10	39	55
T_2: Application of glyphosate immediately after the harvest of mungbean + sowing	69	19	10	8	34	45
T_3: Application of glyphosate immediately after the harvest of mungbean + sowing + pre-emergence application of pendimethalin @ 1.0 kg a.i./ha + one hoeing	70	20	10	8	35	47
T_4: Rotavator immediately after the harvest of mungbean + sowing + one hoeing	74	22	11	9	37	51
S.E. (m)	2.11	0.59	0.38	0.25	1.08	1.27
C.D. @5%	6.51	1.80	1.18	0.76	3.32	3.92
Varieties (V)						
V_1: JAKI-9218	77	22	13	9	38	52
V_2: PDKV-Kanak (AKG-1303)	69	20	10	9	34	47
S.E. (m)	1.54	0.55	0.25	0.25	0.80	1.32
C.D. @5%	6.04	NS	0.97	NS	NS	NS
T x V						
S.E. (m)	3.08	1.11	0.50	0.50	1.59	2.65
C.D. @5%	NS	NS	NS	NS	NS	NS
GM	73	21	11	9	36	49

Means followed by the same letter do not differ significantly at the 0.05 probability level

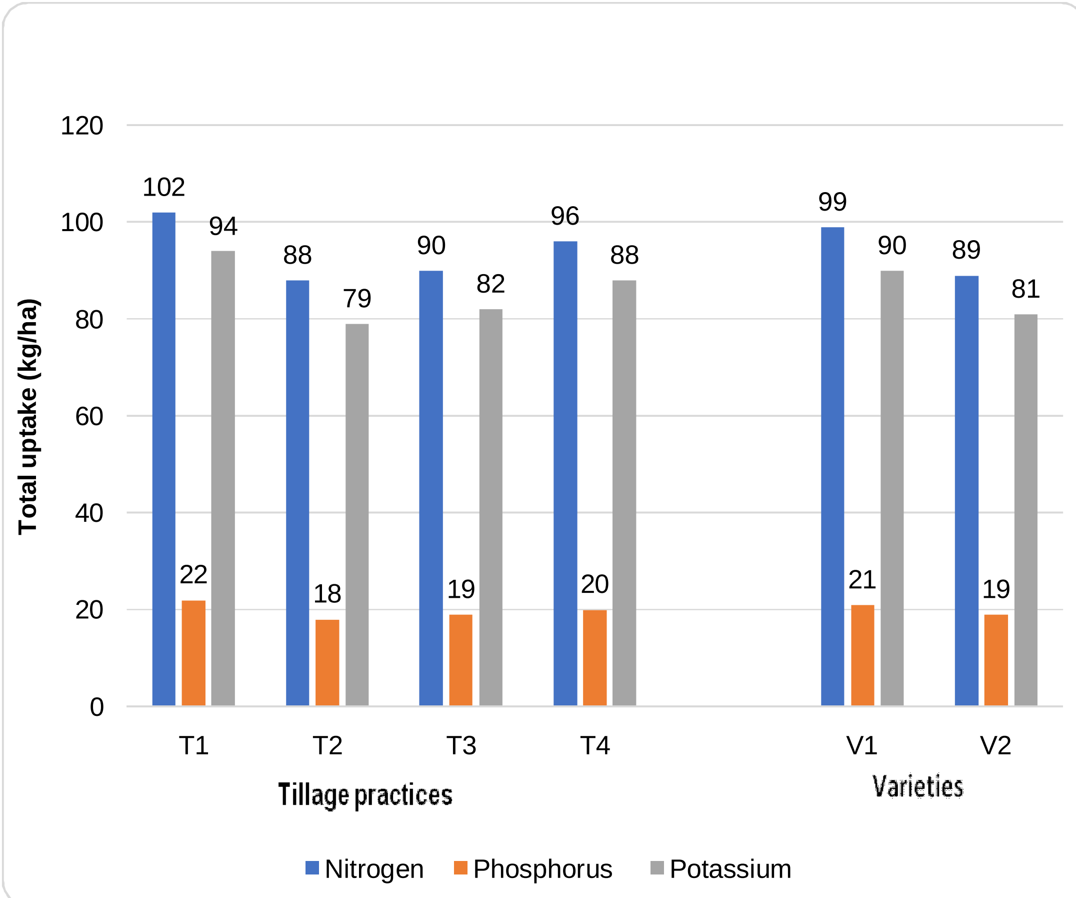

Fig.1. Effect of tillage practices and varieties on total nitrogen, phosphorus and potassium uptake (kg/ha) in seed and straw of chickpea