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Impact on growth characteristics and yield of chickpea (*Cicer arietinum* L.) under different FYM and NPK levels in vertisols

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Abstract
A field experiment was conducted at Research farm of department of soil science & Agricultural chemistry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP) during Rabi 2022-23 and 2023-24 to study the impact of FYM (0, 5, and 10 t-ha^{-1}) and NPK fertilizer levels (10, 20 and 30 kg N ha^{-1}), P_2O_5 (30,60 and 90 kg ha^{-1}) and K_2O (10, 20 and 30 kg ha^{-1}) on the growth, yield, and quality of chickpea (*Cicer arietinum* L.) in Vertisols. The results showed that the application of 10 t-ha^{-1} FYM, 30 kg N, 90 kg P_2O_5, and 30 kg K_2O increased the maximum plant height, number of branches plant^{-1}, pods plant^{-1} and haulm yield of chickpea. While the highest grain yield was observed with 10 t-ha^{-1} FYM, 20 kg N, 90 kg P_2O_5, and 30 kg K_2O ha^{-1} application.

Key words: FYM and NPK levels and vertisol, growth, yield attributes

1. Introduction
Chickpea (*Cicer arietinum* L.) is a highly nutritious pulse crop contains 18-22% protein and significant amounts of all the essential amino acids and fatty acids (Singh *et al.*, 2021) [12]. It is grown in an area of 14.96 m ha with production of 16.22 million tonnes and productivity of 1252 kg ha^{-1} in the world. In India, it is grown in an area of 10.17 m ha^{-1}, with production of 11.35 million tonnes and productivity of 1116 kg ha$^{-1.}$ However, it-had an area of 1.92 m ha^{-1} and production of 30.62 metric tonnes along with the productivity of 1591 kg ha^{-1} in the state of Madhya Pradesh. The target yield equations minimize the usage of expensive fertilizer inputs and also ensuring sustainable crop production. It is essential to popularize the practice of using fertilizer prescription equations among farmers (Ranjan *et al.*, 2018) [9]. However, Ramamoorthy *et al.*, 1967 established that the theoretical basis and field experimental proof and validation for the fact that Liebig's Law of Minimum of Plant nutrition operates equally well for N, P and K for the high yielding varieties of wheat, rice and pearl millet, although it is generally believed that this law is valid for N and not for P and K which were supposed to follow the percentage sufficiency concept of Mitscherlich's and Baule and Mitscherlich's and Bray. NPK requirements are linearly correlated with the target yield, depending on the soil test values. In the STCR approach, the fertilizer doses are prescribed according to the developed fertilizer adjustment equations, after the establishment of a significant relationship between STVs, the added fertilizer nutrients, and the crop response for a particular soil type. Thus, precise fertilizer recommendations can be made using this approach, as it involves data of soil and plant analysis (Singh *et al.*, 2021) [12].

2. Materials and Methods
The research entitled "Impact on growth characteristics and yield of chickpea (*Cicer arietinum L.*) under Different FYM and NPK levels in a Vertisol "conducted at Research farm of Department of Soil Science & Agricultural Chemistry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP) during Rabi season of 2022-23 and 2023-24.

The experimental site situated in the South-Eastern part of Madhya Pradesh at 23°13′ North latitude, 79°57′ East longitudes at an elevation of 393 meters above mean sea level.

Table 1: Detail of experimental field

Particulars	Values (0-15) cm	Method
Soil pH (pH 1:2) at 25°C	7.66	Glass Electrode Ph Meter (Jackson, 1973) [5]
Electrical Conductivity (dS m^{-1}) at 25°C	0.21	Electrical conductivity meter (Jackson, 1973) [5]
Organic Carbon (g kg^{-1})	5.1	Wet oxidation method (Walkley and Black, 1934) [15]
Available Nitrogen (kg ha^{-1})	195	Alkaline potassium permanganate method (Subbiah and Asija,1956)
Available P (kg ha^{-1})	21	Soil extracted with 0.5 M $NaHCO_3$ and colour development by ascorbic acid (Watanabe and Olsen, 1965) [16]
Available K (kg ha^{-1})	279	Neutral normal ammonium acetate method by using Flame photometer (Jackson, 1973) [5]

Plot No	Strip I(L0)	Strip II(L1)	Strip III(L2)	
1.	N2P1K2F0	N2P3K3F0	N2P1K1F0	FYM 0-t-ha^{-1}
2.	N3P1K1F0	N1P2K2F0	N2P2K2F0	
3.	N0P0K0F0	N2P2K1F0	N1P1K1F0	
4.	N3P2K3F0	N3P3K2F0	N2P2K3F0	
5.	N3P2K2F0	N3P3K1F0	N0P0K0F0	
6.	N2P3K2F0	N0P0K0F0	N3P2K1F0	
7.	N0P2K2F0	N1P2K1F0	N1P1K2F0	
8.	N3P3K3F0	N2P2K0F0	N2P0K2F0	
9.	N2P1K1F1	N2P1K2F1	N2P3K3F1	FYM 5-t-ha^{-1}
10.	N2P1K2F1	N3P1K1F1	N1P2K2F1	
11.	N1P1K1F1	N0P0K0F1	N2P2K1F1	
12.	N2P2K3F1	N3P2K3F1	N3P3K2F1	
13.	N0P0K0F1	N3P2K2F1	N3P3K1F1	
14.	N3P2K1F1	N2P3K2F1	N0P0K0F1	
15.	N1P1K2F1	N0P2K2F1	N1P2K1F1	
16.	N2P0K2F1	N3P3K3F1	N2P2K0F1	
17.	N2P3K3F2	N2P1K1F2	N2P1K2F2	FYM 10-t-ha^{-1}
18.	N1P2K2F2	N2P1K2F2	N3P1K1F2	
19.	N2P2K1F2	N1P1K1F2	N0P0K0F2	
20.	N3P3K2F2	N2P2K3F2	N3P2K3F2	
21.	N3P3K1F2	N0P0K0F2	N3P2K2F2	
22.	N0P0K0F2	N3P2K1F2	N2P3K2F2	
23.	N1P2K1F2	N1P1K2F2	N0P2K2F2	
24.	N2P2K0F2	N2P0K2F2	N3P3K3F2	

2. Test crop experiment: Treatments details

Three varied fertility gradient strips were again split into twenty-four plots (21 treatments + 3 controls), resulting in a total of 72 (24 × 3) plots with a size of 3.6 m × 5 m each. The treatments were different identified groupings of 4 levels of N (0, 10, 20 and 30 kg ha^{-1}), P_2O_5 (0, 30, 60 and 90 kg ha^{-1}), and K_2O (0, 10, 20 and 30 kg ha^{-1}), which were randomized in each strip. The treatments (0, 5, and 10 t-ha^{-1} FYM) were superimposed across the strips. The experiment was laid out in fractional factorial randomized block design.

3. Agronomic practices

The crop was sown on 25/11/22 and 22/11/2023 and harvested on dated 04/04/23 and 08/04/24 and threshed for recording plot-wise grain and haulm yield during first and second year respectively. Supplemented irrigation, weeding and other recommended cultural operations were followed as and when required.

4. Collection of plant samples

Plant samples of the test crop were collected from each plot at the time of harvest and dried. These plant samples were dried in the oven at 70℃ to constant weight and then ground to the homogeneous powder by power-operated grinder and stored in bags for chemical analysis.

5. Growth parameters

5.1 Plant height

Plant height was measured at different growth stages with the help of meter scale and it was measured from ground level to the top of the upper leaf, averaged and then expressed in cm.

6. Results and Discussion

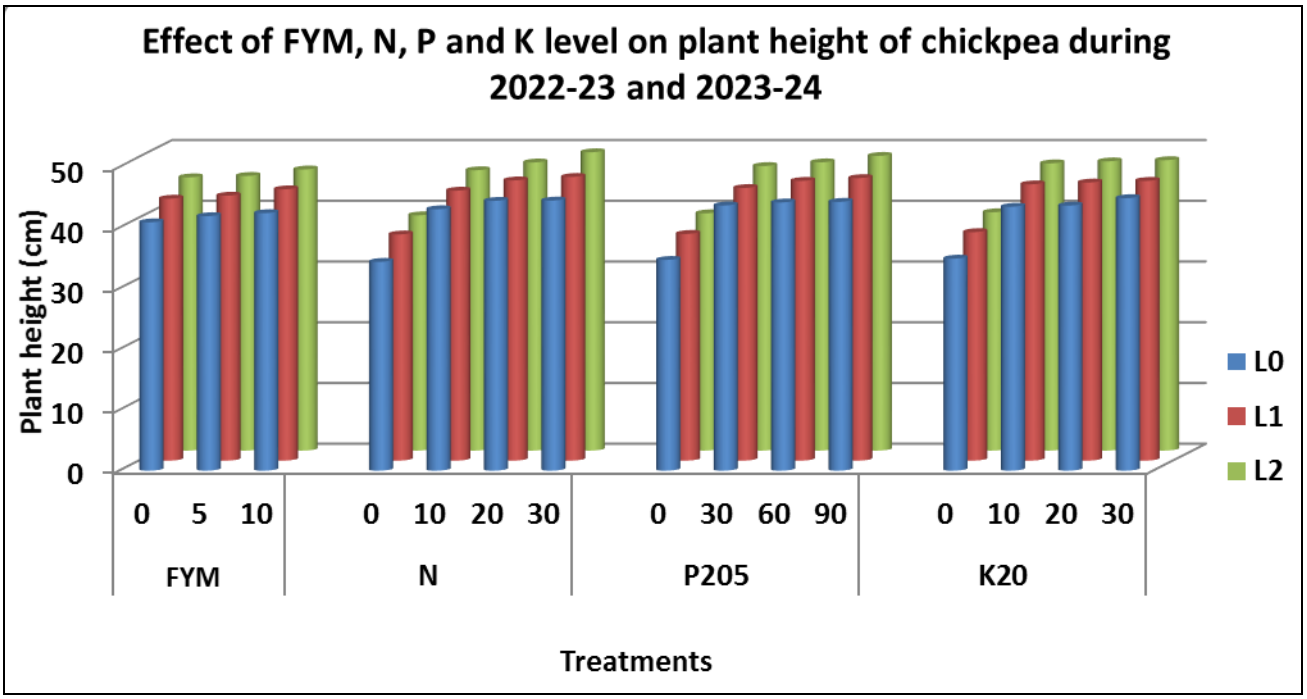
6.1 Effect of FYM, N, P and K levels on plant height

Data present in Table-1 indicated that the application of 5 and 10 t-ha^{-1} FYM increased the mean plant height by 2.47% and 3.72%, 1.16 and 3.56% and 0.24% and 2.89% over control in L0 (N, P_2O_5, K_2O); L1 (N-120, P_2O_5-80, and K_2O-60) and L2 (N-240, P_2O_5-160, K_2O-120) strip respectively. The maximum mean plant height 42.42, 44.68, and 46.3 cm was observed in L0, L1 and L2 strips respectively. The application of N @, 10, 20, and 30 kg ha^{-1} increased the mean plant height by 25.18%, 29.19% and 29.33%; 19.36%, 23.89% and 25.42% and 19.15%, 22.48% and 26.79% over control in L_0, L_1 and L_2 strip respectively. The maximum mean plant heights 44.48, 46.72 and 49.13cm was observed @ 30 kg N ha^{-1} in L0, L1 and L2 strip respectively. The application of P_2O_5 @, 30, 60, and 90 kg ha^{-1} increased the mean plant height by 25.81%, 27.25% and 27.54%; 20.25%, 23.38% and 24.61% and 19.18%, 21.44% and 24.17% over control in L_0, L_1 and L_2 strip respectively. The maximum mean plant heights 44.27, 46.53 and 48.55 cm was observed @ 90 kg P_2O_5 ha^{-1} in L0, L_1 and L_2 strip respectively. The application of K_2O @, 10, 20, and 30 kg ha^{-1} increased the

mean plant height by 24.46%, 25% and 28.52%; 20.91%, 21.71% and 22.43% and 20.51%, 21.35% and 21.86% in L_0, L_1 and L_2 strip respectively. The maximum mean plant heights 44.88, 46.07 and 47.83 cm was observed 30 kg K_2O ha^{-1} in L_0, L_1 and L_2 strip respectively. The increase of plant height with highest nutrient application might increased the plant growth as a result of high nutrient availability. Similar finding on that the plant height was reported by Sreenivasan *et al.* (2017).

Table 1: Effect of FYM, N, P and K level on plant height of chickpea during 2022-23, 2023-24

FYM (tha^{-1})	L0 ($N_0P_0K_0$)			L1 ($N_{120}p_{80}k_{60}$)			L2 ($N_{240}p_{160}k_{120}$)		
	2022-23	2023-24	Mean	2022-23	2023-24	Mean	2022-23	2023-24	Mean
0	41.50	40.30	40.90	43.67	42.60	43.14	45.03	44.97	45.00
5	41.83	42.00	41.91	43.50	43.77	43.63	44.97	45.50	45.23
10	42.63	42.20	42.42	44.63	44.73	44.68	46.70	45.90	46.30
N ($kgha^{-1}$)									
0	34.17	34.61	34.39	37.94	36.56	37.25	38.94	38.56	38.75
10	42.42	43.67	43.05	43.92	45.00	44.46	45.76	46.58	46.17
20	44.67	44.18	44.43	45.93	46.36	46.15	47.27	47.64	47.45
30	45.07	43.89	44.48	46.96	46.48	46.72	49.22	49.04	49.13
P_2O_5 (kg ha^{-1})									
0	34.67	34.75	34.71	37.67	37.00	37.34	39.67	38.50	39.08
30	43.87	43.47	43.67	45.07	44.73	44.90	46.60	47.13	46.86
60	44.40	43.87	44.17	45.87	46.27	46.07	47.10	47.87	47.47
90	44.57	43.97	44.27	46.73	46.33	46.53	48.90	48.20	48.53
K_2O (kg ha^{-1})									
0	35.17	34.67	34.92	38.33	36.92	37.63	39.92	38.58	39.25
10	44.33	42.58	43.46	45.50	45.50	45.50	47.00	47.59	47.30
20	43.70	43.59	43.65	45.41	46.19	45.80	47.00	48.25	47.63
30	44.90	44.86	44.88	46.33	45.81	46.07	48.01	47.67	47.83



6.2 Number of branches $plant^{-1}$

Data presented in table-2 indicated that the application of 5 and 10 t-ha^{-1} FYM increased the mean number of branches $plant^{-1}$ by 1.98% and 5.63%; 4.82% and 7.95% and 4.58% and 6.75% over control in L0 ($N_0P_0K_0$), L1 (N-120, P_2O_5-80, and K_2O-60) and L2 (N-240, P_2O_5-160, K_2O-120) strip respectively. The maximum mean of number of branches $plant^{-1}$ 3.75, 4.48 and 4.90 was observed @10 t FYM ha^{-1} in L_0, L_1 and L_2 strips respectively. The application of N @ 10, 20, and 30 kg ha^{-1} increased the mean number of branches $plant^{-1}$ by 27.10%, 34.58% and 40.23%, 27.27%, 29.11% and 30.27% and 35.50%, 39.02%, 42.27% over control in L_0, L_1 and L_2 strip respectively. The maximum mean number of branches 4.10, 4.64 and 5.24 was observed @ 30 kg N ha^{-1} in L0, L1 and L2 strips respectively. The application of P_2O_5 @ 30, 60, and 90 kg ha^{-1} increased the mean number of branches $plant^{-1}$ by 25.98%, 31.08% and 34.96%; 24.67%, 25.82% and 31.73%; and 25.08%, 27.67% and 32.97% over control in L_0, L_1 and L_2 strip respectively. The maximum mean number of bra branches $plant^{-1}$ inch per plant 4.10, 4.60 and 5.30 was observed @ 90 kg P_2O_5 ha^{-1} in L0, L1 and L2 strip respectively. The application of K_2O @ 10, 20, and 30 kg ha^{-1}, increased the mean number of branches $plant^{-1}$ by 26.64% 27.16% and 28.65% ; 26.17%, 28.92% and 29.77%; and 23.82%, 25.96% and 28.26% over control in L_0, L_1 and L_2 strip respectively. The maximum mean number of branches $plant^{-1}$ 3.95%, 4.67% and 5.21% was observed @ 30 kg K_2O ha^{-1} in L0, L1 and L2 strip respectively. The increased number of branches $plant^{-1}$ with the highest

nutrient application due to increased nutrient uptake by plant. The similar findings on plant height, total number of branches.

Table 2: Effect of FYM, N, P and K level no of branches Plant^{-1} of chickpea during 2022-23 and 2023-24

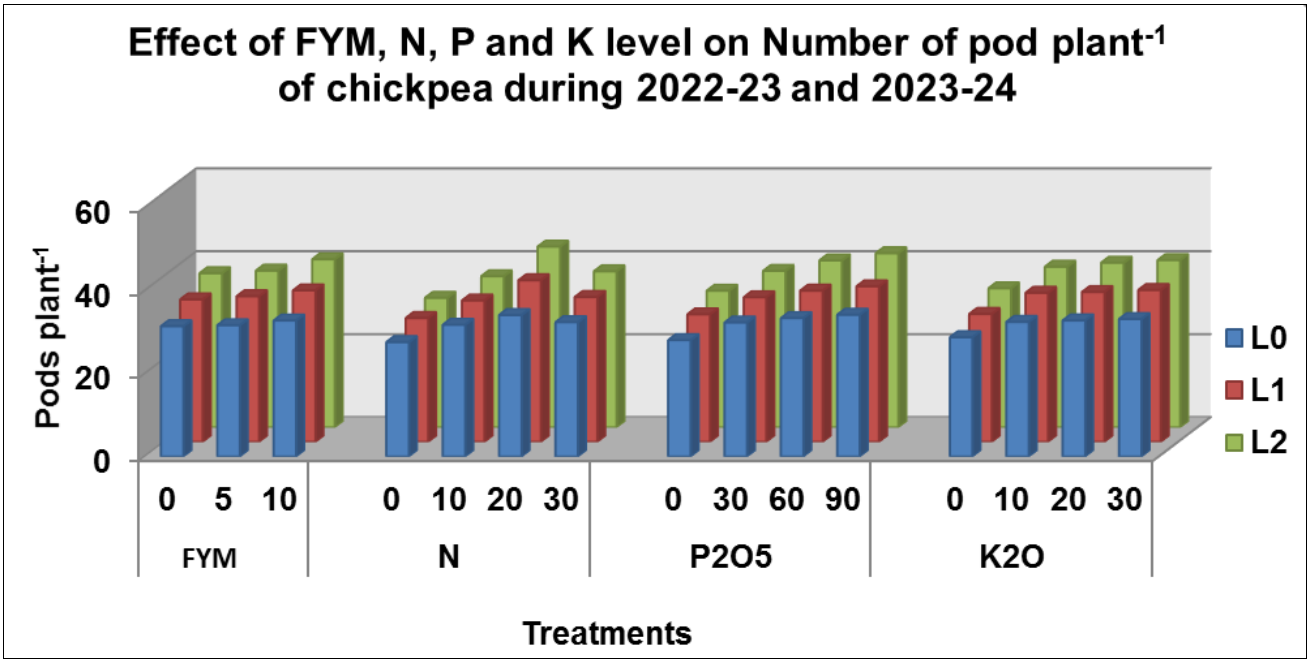
FYM (t-ha^{-1})	L0($N_0P_0K_0$)			L1($N_{120}p_{80}k_{60}$)			L2($N_{240}p_{160}k_{120}$)		
	2022-23	2023-24	Mean	2022-23	2023-24	Mean	2022-23	2023-24	Mean
0	3.53	3.57	3.55	4.27	4.03	4.15	4.67	4.5	4.59
5	3.63	3.6	3.62	4.43	4.27	4.35	4.77	4.83	4.8
10	3.67	3.83	3.75	4.63	4.33	4.48	4.83	4.96	4.9
N (kg ha^{-1})									
0	3.17	2.67	2.92	3.78	3.06	3.42	4.06	3.33	3.70
10	3.50	3.92	3.71	4.50	4.50	4.50	4.83	5.08	4.96
20	3.79	4.06	3.93	4.76	4.41	4.59	5.15	5.11	5.13
30	4.00	4.19	4.10	4.70	4.58	4.64	5.24	5.24	5.24
P2O5 (kg ha^{-1})									
0	3.08	2.67	2.88	3.50	3.17	3.34	3.92	3.67	3.80
30	3.67	3.80	3.74	4.24	4.31	4.28	5.00	4.78	4.89
60	3.80	4.07	3.94	4.33	4.33	4.33	5.03	5.00	5.02
90	3.93	4.27	4.10	4.67	4.53	4.60	5.40	5.20	5.30
K2O (kg ha^{-1})									
0	3.08	2.83	2.96	3.67	3.25	3.46	4.00	3.83	3.92
10	3.75	3.96	3.86	4.47	4.53	4.50	4.90	5.05	4.98
20	3.81	3.98	3.90	4.72	4.54	4.63	5.00	4.89	5.09
30	3.86	4.10	3.95	4.74	4.60	4.67	5.30	5.42	5.21

6.3 Number of pods plant^{-1}

Data present in table-3 indicated that the application of 5 and 10 t-ha^{-1} FYM increased the mean number of pods plant^{-1} by 0.73% and 4.25%, 2.22% and 6.30% and 1.67% and 9.02% over control in L0 ($N_0P_0K_0$), L1 (N-120, P_2O_5-80, and K_2O-60) and L2 (N-240, P_2O_5-160, K_2O-120) strip. The maximum mean of number of pods plant^{-1} 32.82, 36.55 and 40.54 were observed @ 10 t FYM ha^{-1} in L0, L1 and L2 strip respectively. The application of N @ 10, 20, and 30 kg ha^{-1} increased the mean number of pods plant^{-1} by 15.13, 23.64 and 17.35%, 14.19, 30.47 and 17.07% and 16.65, 39.49 and 20.68% over control in L_0, L_1 and L_2 strip respectively. The maximum mean number of pods plant^{-1} 32.41, 34.97 and 37.65 were observed 30 kg N ha^{-1} in L0, L1 and L2 strips respectively. The application of P_2O_5 @, 30, 60, and 90 kg ha^{-1} increased the mean number of pods plant^{-1} by 15.10%, 18.19% and 21.81%; 13.40%, 18.60%, and 21.90 and 14.5%, 22.10 and 27.40% over control in L_0, L_1 and L_2 strip respectively. The maximum mean number of pods plant^{-1} 34.21, 37.54 and 42.00 were observed @ 90 kg P_2O_5 ha^{-1} in L0, L1 and L2 strips respectively. The application of K_2O @ 10, 20, and 30 kg ha^{-1} increased the mean number of pods plant^{-1} by 12.83%, 14.03% and 15.24%; 16.55%, 17.18% and 18.75% and 15.50%, 18.36% and 20.24% over control in L_0, L_1 and L_2 strips respectively. The maximum mean number of pods plant^{-1} 33.17, 36.65 and 40.33 were observed @ 30 kg K_2O ha^{-1} in L0, L1 and L2 strip respectively. The increased number of pods plant^{-1} with the highest nutrient application might be due to increased nutrients availability and their uptake by plant. Similar result were observed with farmyard manure and chemical fertilizer application on pod yield were observed by Muhammad *et al.* (2015) [7] and Basir *et al.* (2008) [3].

Table 3: Effect of FYM, N, P and K level on number of pod plant^{-1} of chickpea during 2022-23 and 2023-24

FYM (t-ha^{-1})	L0($N_0P_0K_0$)			L1($N_{120}p_{80}k_{60}$)			L2($N_{240}p_{160}k_{120}$)		
	2022-23	2023-24	Mean	2022-23	2023-24	Mean	2022-23	2023-24	Mean
0	30.77	32.13	31.45	33.27	35.50	34.38	36.43	37.93	37.18
5	30.93	32.43	31.68	34.33	35.97	35.15	37.30	38.30	37.80
10	31.63	34.00	32.82	36.03	37.07	36.55	41.80	39.27	40.54
N (kg ha^{-1})									
0	26.78	28.44	27.61	29.56	30.22	29.89	30.94	31.56	31.25
10	31.33	32.25	31.79	32.42	35.83	34.12	35.83	37.08	36.45
20	32.70	35.55	34.13	37.76	40.24	39.00	43.67	43.52	43.59
30	32.15	32.67	32.41	35.67	34.26	34.97	38.93	36.37	37.65
P_2O_5 (ha^{-1})									
0	26.67	29.50	28.09	29.08	32.50	30.79	31.67	34.25	32.96
30	31.13	33.53	32.33	33.67	36.13	34.90	35.80	39.67	37.74
60	32.57	34.20	33.39	36.33	36.67	36.50	40.57	39.93	40.25
90	32.69	35.73	34.21	36.60	38.47	37.54	42.47	41.53	42.00
K_2O(kg ha^{-1})									
0	27.83	29.75	28.79	30.92	30.83	30.87	33.17	33.92	33.54
10	31.38	33.57	32.48	34.71	37.24	35.98	38.57	38.90	38.74
20	32.56	33.11	32.83	34.17	38.17	36.17	40.11	39.30	39.70
30	31.50	34.83	33.17	36.41	36.89	36.65	40.00	40.67	40.33

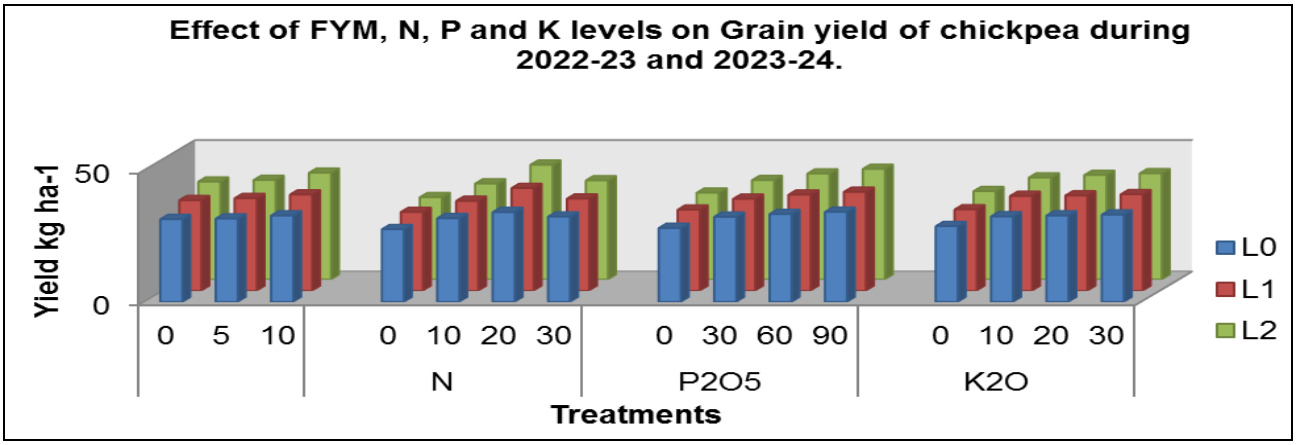


6.4 Effect of FYM, N, P and K levels on yield grain yield

Data present in table 4 indicated that the application of 5 and 10 t-ha^{-1} FYM increased the mean grain yield kg ha^{-1} by 2.02 and 6.50%; 2.65% and 7.2% and 7.30 and 11.9% over control in L0 ($N_0P_0K_0$), L1 (N-120, P_2O_5-80), and K_2O-60) and L2 (N-240, P_2O_5-160, K_2O-120) strip respectively. The maximum mean grain yield 1264, 1415 and 1632 kg ha^{-1} was observed @ 10 t FYM ha^{-1} in L0, L1 and L2 strips respectively. The application of N @ 10, 20, and 30 kg ha^{-1} increased the mean grain yield by 38.40%, 47.60% and 44.20%; 41.30%, 59.30% and 55.30%; and 51.70%, 71.20% and 63.30% over control in L_0, L_1 and L_2 strip respectively. The maximum mean grain yield 1296, 1492 and 1727 kg ha^{-1} was observed @ 20 kg N ha^{-1} in L0, L1 and L2 strip respectively. It might be due to the highest N application might increase the vegetative growth of plant hence reduce the grain yield. The application of P_2O_5 @, 30, 60, and 90 kg ha^{-1}, increased the mean grain yield by 35.10%, 42.20% and 46.30% ; 41.30%, 48.10% and 51.30% and 45.60%, 59.20% and 63.60% over control in L_0, L_1 and L_2 strip respectively. The maximum mean grain yield 1336, 1494 and 1741 kg ha^{-1} was observed @ 90 kg P_2O_5 ha^{-1} in L0, L1 and L2 strip respectively. The application of K_2O @ 10, 20, and 30 kg ha^{-1} increased the mean grain yield by 38.30%, 40.70% and 48.30%; 40.20%, 44.10% and 52.70% and 42.70%, 44.30% and 60.30% over control in L_0, L_1 and L_2 strip respectively. The maximum mean grain yield 1360, 1550 and 1796 kg ha^{-1} was observed @ 30 kg K_2O ha^{-1} in L0, L1 and L2 strips respectively. The increased grain yield with higher fertility levels might be due to increased nutrient uptake by chickpea. The similar findings were in agreement with Balai *et al*. (2017) who observed that dry matter yield has highly risen from low fertility (0X strip) to high fertility (2X strip). The similar results were also obtained in chickpea by Elis *et al.* (2020) [4] and in green gam by Rath *et al.* (2020) [10] and Kiran *et al*. (2020) [6].

Table 4: Effect of FYM, N, P and K levels on grain yield of chickpea during 2022-23 and 2023-24

FYM (tha^{-1})	L0($N_0P_0K_0$)			L1($N_{120}p_{80}k_{60}$)			L2($N_{240}p_{160}k_{120}$)		
	2022-23	2023-24	Mean	2022-23	2023-24	Mean	2022-23	2023-24	Mean
0	1126	1248	1187	1302	1337	1320	1433	1483	1458
5	1158	1264	1211	1343	1367	1355	1541	1587	1564
10	1231	1297	1264	1442	1388	1415	1614	1649	1632
N (kgha^{-1})									
0	833	923	878	909	965	937	976	1041	1009
10	1128	1301	1215	1253	1395	1324	1374	1688	1531
20	1252	1340	1296	1523	1461	1492	1763	1690	1727
30	1230	1302	1266	1478	1432	1455	1634	1661	1648
P_2O_5 (kgha^{-1})									
0	882	943	913	953	1020	987	1049	1078	1064
30	1185	1280	1233	1376	1411	1394	1462	1636	1549
60	1245	1351	1298	1488	1433	1461	1697	1691	1694
90	1276	1395	1336	1489	1499	1494	1763	1719	1741
K_2O (kg ha^{-1})									
0	857	976	917	1009	1020	1015	1081	1159	1120
10	1241	1294	1268	1455	1390	1423	1593	1602	1598
20	1253	1326	1290	1503	1421	1462	1611	1621	1616
30	1324	1395	1360	1562	1537	1550	1812	1780	1796

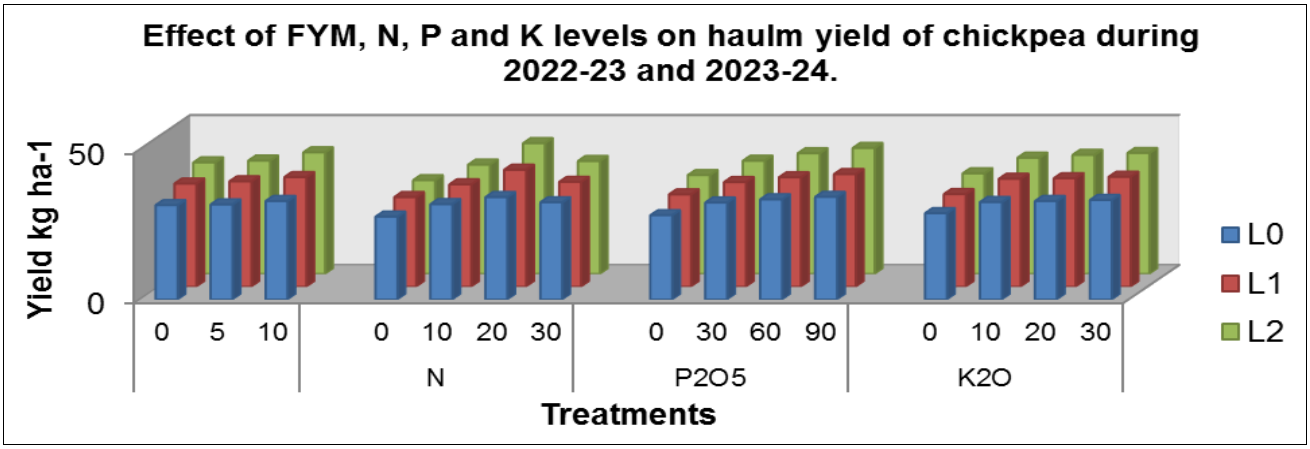


6.5 Effect of FYM, N, P and K levels on Haulm yield

Data present in Table-5 indicated that the application of 5 and 10 t-ha^{-1} FYM increased the mean Haulm yield by 4.2% and 7.3%; 3.3% and 5.9% and 6.4% and 11.00% over control in L0 ($N_0P_0K_0$), L1 (N-120, P_2O_5-80, and K_2O-60) and L2 (N-240, P_2O_5-160, K_2O-120) strip respectively. The maximum mean of haulm yield 2759, 3086 and 3611 kg ha^{-1} was observed in L0, L1 and L2 strip respectively. The application of N @ 10, 20, and 30 kg ha^{-1} increased the mean haulm yield by 50.36%, 66.20% and 74.02%; 39%, 53.8% and 55.7% and 40.30%, 48.70% and 52.50% in L_0, L_1 and L_2 strip respectively. The maximum mean haulm yield 2938, 3272 and 3844 kg ha^{-1} was observed @ 30 kg N ha^{-1} in L0, L1 and L2 strip respectively. The application of P_2O_5 @ 30, 60, and 90 kg ha^{-1} increased the mean haulm yield by 28.60%, 37.30% and 40.80%, 36.30%, 45.50% and 48.70% and 43.80%, 58.80% and 60.40% over control in L_0, L_1 and L_2 strip respectively. The maximum mean haulm yield 2916, 3289 and 3812 ha^{-1} was observed @ 90 kg P_2O_5 ha^{-1} in L0, L1 and L2 strips respectively. The application of K_2O @ 10, 20, and 30 kg ha^{-1} increased the mean haulm yield by 36%, 38.3%and 42.30%; 35.6%, 38.2% and 47.4% and 41.8%, 42.60% and 62.30% over control in L_0, L_1 and L_2 strip respectively. The maximum mean haulm yield 2883, 3363 and 4038 kg ha^{-1} was observed @ 30 kg K_2O ha^{-1} in L_0, L_1 and L_2 strip respectively. The maximum haulm yield with the highest fertility level might by due to in the more vegetative growth. The similar results were also obtained by Tiwari *et al.*, (2023) [14].

Table 5: Effect of FYM, N, P and K levels on haulm yield of chickpea during 2022-23 and 2023-24

FYM t-ha^{-1}	L0($N_0P_0K_0$)			L1($N_{120}p_{80}k_{60}$)			L2($N_{240}p_{160}k_{120}$)		
	2022-23	2023-24	Mean	2022-23	2023-24	Mean	2022-23	2023-24	Mean
0	2455	2690	2572	2770	3058	2914	3174	3330	3252
5	2513	2847	2680	2929	3092	3010	3367	3555	3461
10	2653	2865	2759	3052	3120	3086	3611	3611	3611
N (kg ha^{-1})									
0	1815	2040	1927	1962	2242	2102	2125	2294	2209
10	2420	2989	2704	2708	3137	2922	3028	3625	3326
20	2804	2927	2865	3174	3292	3233	3641	3702	3671
30	2864	3012	2938	3223	3321	3272	3902	3786	3844
P_2O_5(kgha^{-1})									
0	1991	2151	2071	2096	2328	2212	2331	2424	2377
30	2507	2820	2663	2820	3213	3016	3212	3624	3418
60	2695	2992	2843	3195	3243	3219	3792	3759	3775
90	2817	3016	2916	3218	3361	3289	3841	3783	3812
K_2O (kg ha^{-1})									
0	1890	2162	2026	2226	2339	2282	2402	2574	2488
10	2652	2859	2755	3056	3135	3095	3477	3577	3527
20	2672	2933	2802	3091	3217	3154	3510	3584	3547
30	2750	3016	2883	3249	3477	3363	4045	4032	4038



7. Conclusion

The highest plant height and no of branches and pods plant^{-1} and haulm yield were observed with 10 t FYM, 30 kg N, 90 kg P_2O_5 and 30 kg k_2O ha^{-1} while the maximum grain yield were observed with 20 kg N, 90 kg P_2O_5 and 30 kg k_2O ha^{-1}.

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