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Response of phosphorus levels and varieties on growth, yield and quality of lentil (*Lens culinaris* Medikus.)

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Abstract
A field experiment was carried out during Rabi Season of 2021-22, at the instructional farm, AKS University, Sherganj, Satna, Madhya Pradesh to assess the response of Phosphorus levels and Varieties on growth, yield, and quality of Lentil (*Lens culinaris* Medikus.). The experiment consisted of twelve treatment combinations comprising three varieties of Lentil *viz*., IPL-316, RVL3, JL3 and four levels of phosphorus i.e., 0, 20, 40 and 60kg phosphorus ha. The experiment was laid out in randomized block design having factorial concept (FRBD) with three replication. Growth parameters like plant height, number of branches per plant and number of root nodules per plant were noted significantly highest in IPL-316. Yield attributing characters like number of pods per plant, number of seed per pod, length of pods, seed yield per plot, seed yields (q/ha), 1000 grain weight were found maximum in IPL-316 and all the parameters were increased with increasing phosphorus levels of 60kg ha. Varieties of lentil did not cause significant variation in 1000 grain weight. Highest seed yield (9.92 q/ha) of lentil was obtained from IPL-316. The increasing phosphorus level up to 60kg ha increased seed yield (9.92 q/ha) of lentil. Highest protein content (24.12%) was noted from IPL-316. Protein content in seed increased with increasing phosphorus level up to 60kg ha (24.12%).

Keywords: Phosphorus, varieties, lentil, root, *Lens culinaris* Medikus

Introduction
Lentil (*Lens culinaris* Medikus) is an important cool season grain legume crop in India, which is second major winter sown legume after chickpea. Lentil belongs to the sub-family Papilionaceae under the family Fabaceae (Leguminosae). Being a legume, it fixes nitrogen from atmosphere through root nodules by Rhizobium bacteria, which helps in reducing the pressure of nitrogenous fertilizers application. Nutrient management especially phosphorus application in pulses assume a significant role in increasing the productivity. Low soil fertility, particularly phosphorus deficiency is one of the major constraints to increase lentil productivity. Successful production of pulses always depend upon phosphorus application because in the absence of phosphorus development of root strength of stem, flower and seed formulation along with maturity of the crop affected adversely. Besides seed quality and resistance and plant disease also become poor. Phosphorus play and important role and it stimulate biological activities like nodulation, nitrogen fixation and nutrient uptake in soil and rhizosphere environment which further in courage higher yield of pulse. Varieties play an important role in the production of pulses. Selection of proper variety for a set of agro-climatic conditions is very important to achieve maximum potential, because of differential growth and development behavior due to different genetic characters of varieties. Many improved varieties have been developed in India but their performance varies in different regions. Replacement of traditional varieties with high yielding varieties contributes about 25-30% enhancement in productivity. Critical evaluation and selection of the superior varieties with high yield potential and good quality for particular region is, therefore always has a good promise. Presently several high yielding lentil varieties are available for Madhya Pradesh, but there is a need to test such varieties suitable to the region of Kymore Plateau and Satpura Hill Zone. The root growth as well as plant development may differ in new plant types of lentil cultivars.

Material and Methods
The present experiment was conducted during the *rabi* season of 2021-22 at the Student Instructional field, Department of Agronomy, Faculty of Agriculture, AKS University,

Sherganj, Satna (M.P.). Geographically, Satna district lies in the Kymore Plateau and Satpura Hill Zone, MP-4 (Agro-climatic Zone-VIII). It is situated in the north-eastern part of Madhya Pradesh the latitude of $23^0$58' to $25^0$12' N and longitude of $80^0$21' to $81^0$23' east in Rewa division of M.P. State of India at an elevation of 315 m above mean sea level. The experiment consisted of twelve treatment combinations comprising three varieties of Lentil *viz*., IPL-316, RVL3, JL3 and four levels of phosphorus i.e., 0, 20, 40 and 60kg phosphorus ha. The experiment was laid out in randomized block design having factorial concept (FRBD) with three replication were tested at Agricultural Research Farm of AKS University, Sherganj, Satna, MP. In order to determine the textural class and fertility status of the field soil, to study the mechanical composition and chemical properties of the soil, representative soil samples were taken at four randomly selected places in the experimental field from 0-30 cm depth were collected prior to fertilizer application before sowing of crop. The composite soil samples were analyzed for the various physico-chemical properties of soil. The soil was well drained, sandy loam in texture having pH 7.5, EC 0.16 DSM, organic carbon 0.30 g kg, 2726 available nitrogen 176.6 kg ha, available phosphorus 12.5 kg ha and available potassium 200 kg ha. The crop was sown in spacing (30x5 cm apart) on 25 October, 2021 and harvested on 05 March 2022 at maturity.

Result and Discussion

The significantly highest values under phosphorus @ 60 kg/ha with the variety IPL-316 was verified significantly superior to rest of the treatments for the characters and their respective value such as plant height(9.09, 11.56 and 19.71 cm), Number of branches per plant (4.40 and 4.87), number of root nodules per plant (6.80 at the growth stage), number of pods per plant (74.60), number of grains per pod (2.20), highest test weight (30.72 g), grain yield per plant (3.24 g), grain yield per plot (1.19 kg), highest grain yield per hectare (9.92 q/ha), Stover yield per hectare (17.97 q/ha), The harvest index of lentil under the treatment @ 60 kg/ha was found to be non- significant. Highest protein content under the treatment @ 60 kg/ha was found to be 24.12%. The highest cost of cultivation of lentil was recorded under the treatment combination consisting that application of phosphorus @ 60 kg/ha with all the three lentil varieties of IPL-316, RVL-3 & JL-3 with the respective value of 17094.00 Rs/ha. The significantly highest gross monetary return of lentil was recorded under the treatment combination consisting that application of phosphorus @ 60 kg/ha with the lentil variety of IPL-316 with the respective value of ₹ 66233.67 Rs/ha which are proved significantly superior to rest of the treatments. The significantly highest net monetary return of lentil was recorded under the treatment combination consisting that application of phosphorus @ 60 kg/ha with the lentil variety of IPL-316 with the respective value of ₹ 49139.67 Rs/ha which are proved significantly superior to rest of the treatments. The significantly highest B:C ratio of lentil was recorded under the treatment combination consisting that application of phosphorus @ 60 kg/ha with the lentil variety of IPL-316 with the respective value of 2.87 which are proved significantly superior to rest of the treatments.

Table 1: Plant height (cm) of lentil at 60 DAS as influenced by different levels of phosphorus, varieties and their interaction

Varieties	Phosphorus levels				
	P_0 (0 kg/ha)	**P_1 (20 kg/ha)**	**P_2 (40 kg/ha)**	**P_3 (60 kg/ha)**	**Mean**
V_1 (IPL-316)	13.34	17.21	17.68	19.71	16.99
V_2 (RVL-3)	11.37	16.42	17.21	17.81	15.70
V_3 (JL-3)	12.83	16.89	17.82	18.08	16.40
Mean	12.51	16.84	17.57	18.53	
		S. Em±		C.D. (P= 0.05)	
Phosphorus (P)		0.50		1.48	
Varieties (V)		0.58		1.70	
Interaction (P x V)		0.29		0.60	

Table 2: Number of branches per plant of lentil at 60 DAS as influenced by different levels of phosphorus, varieties and their interaction

Varieties	Phosphorus levels				
	P_0 (0 kg/ha)	**P_1 (20 kg/ha)**	**P_2 (40 kg/ha)**	**P_3 (60 kg/ha)**	**Mean**
V_1 (IPL-316)	3.13	3.27	4.40	4.87	3.92
V_2 (RVL-3)	2.93	3.20	3.33	3.40	3.22
V_3 (JL-3)	3.07	3.27	4.13	4.53	3.75
Mean	3.04	3.24	3.96	4.27	
		S. Em±		C.D. (P= 0.05)	
Phosphorus (P)		0.36		1.07	
Varieties (V)		0.42		1.23	
Interaction (P x V)		0.21		0.44	

Table 3: Seed yield per hectare (q/ha) of lentil as influenced by different levels of phosphorus, varieties and their interaction

Varieties	Phosphorus levels				
	P_0 (0 kg/ha)	**P_1 (20 kg/ha)**	**P_2 (40 kg/ha)**	**P_3 (60 kg/ha)**	**Mean**
V_1 (IPL-316)	5.64	8.11	9.31	9.92	8.24
V_2 (RVL-3)	5.08	6.58	8.50	8.56	7.18
V_3 (JL-3)	5.28	7.33	8.75	9.64	7.75
Mean	5.33	7.34	8.85	9.37	
		S.Em±		C.D. (P= 0.05)	
Phosphorus (P)		0.28		0.83	
Varieties (V)		0.33		0.96	
Interaction (P x V)		0.16		0.34	

Table 4: Stover yield per hectare (q/ha) of lentil as influenced by different levels of phosphorus, varieties and their interaction

Varieties	Phosphorus levels				
	P_0 (0 kg/ha)	**P_1 (20 kg/ha)**	**P_2 (40 kg/ha)**	**P_3 (60 kg/ha)**	**Mean**
V_1 (IPL-316)	11.29	15.66	17.15	17.97	15.52
V_2 (RVL-3)	11.02	13.42	15.72	16.33	14.12
V_3 (JL 3)	11.23	13.91	16.51	17.51	14.79
Mean	11.18	14.33	16.46	17.27	
		S.Em±		C.D. (P= 0.05)	
Phosphorus (P)		0.51		1.51	
Varieties (V)		0.59		1.74	
Interaction (P x V)		0.30		0.61	

Table 5: Test weight (g) of lentil as influenced by different levels of phosphorus, varieties and their interaction

Varieties	Phosphorus levels				
	P_0 (0 kg/ha)	**P_1 (20 kg/ha)**	**P_2 (40 kg/ha)**	**P_3 (60 kg/ha)**	**Mean**
V_1 (IPL-316)	27.65	28.89	30.05	30.72	29.33
V_2 (RVL-3)	27.58	28.25	29.05	29.21	28.52
V_3 (JL-3)	27.63	28.52	29.92	30.27	29.09
Mean	27.62	28.55	29.67	30.07	
		S.Em±		C.D. (P= 0.05)	
Phosphorus (P)		0.22		0.66	
Varieties (V)		0.26		0.76	
Interaction (P x V)		0.13		0.27	

Table 6: Protein content (%) of lentil as affected by phosphorus, varieties and their interaction

Varieties	Phosphorus levels				
	P_0 (0 kg/ha)	**P_1 (20 kg/ha)**	**P_2 (40 kg/ha)**	**P_3 (60 kg/ha)**	**Mean**
V_1 (IPL-316)	20.37	21.67	22.92	24.12	22.27
V_2 (RVL-3)	19.44	20.65	21.69	22.07	20.96
V_3 (JL-3)	20.28	21.52	22.42	23.89	22.03
Mean	20.03	21.28	22.34	23.36	
		S.Em±		C.D. (P= 0.05)	
Phosphorus (P)		0.32		0.92	
Varieties (V)		0.36		1.07	
Interaction (P x V)		0.18		0.38	

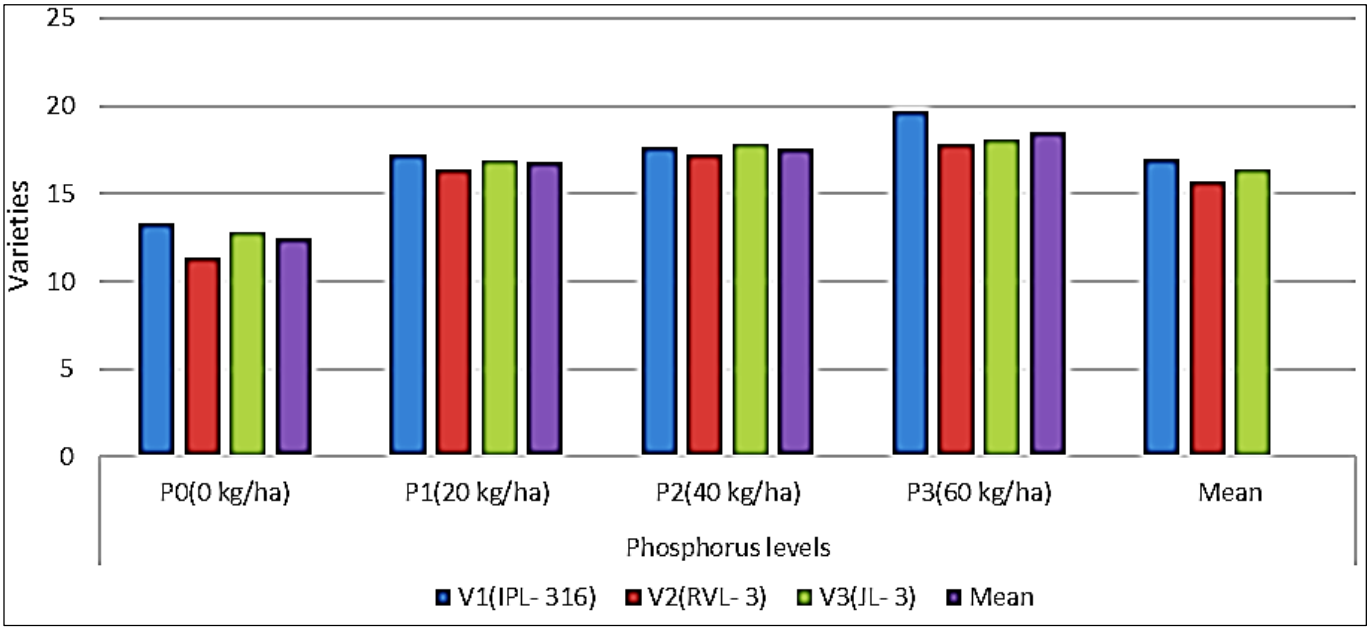

Fig 1: Plant height (cm) of lentil at 60 DAS as influenced by different levels of phosphorus, varieties and their interaction

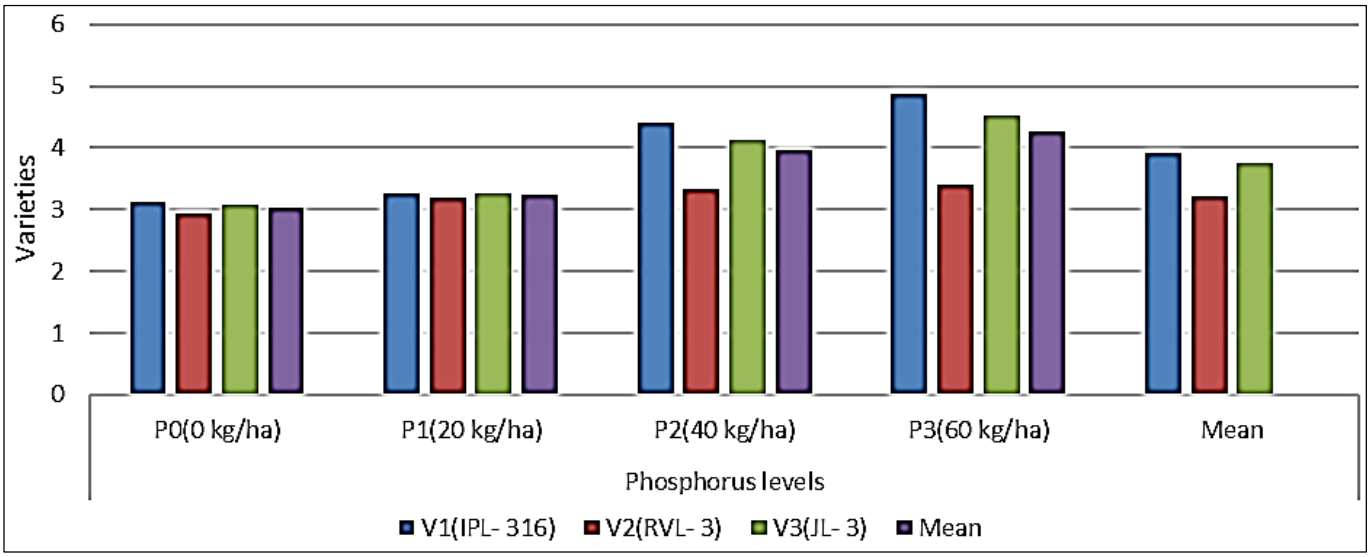

Fig 2: Number of branches per plant of lentil at 60 DAS as influenced by different levels of phosphorus, varieties and their interaction

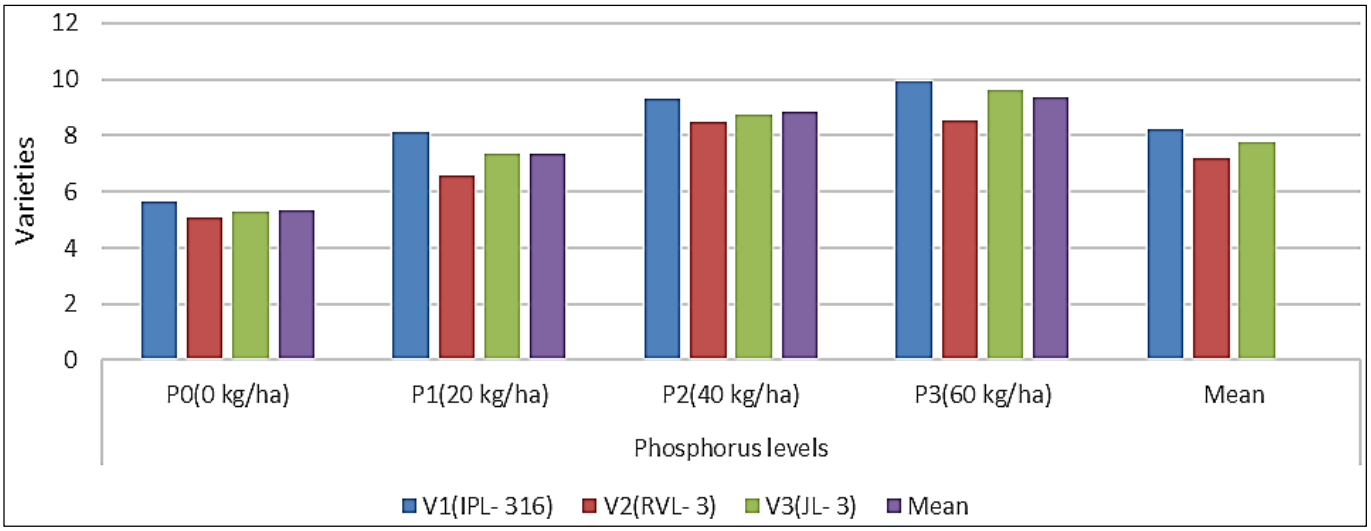

Fig 3: Seed yield per hectare (q/ha) of lentil as influenced by different levels of phosphorus, varieties and their interaction

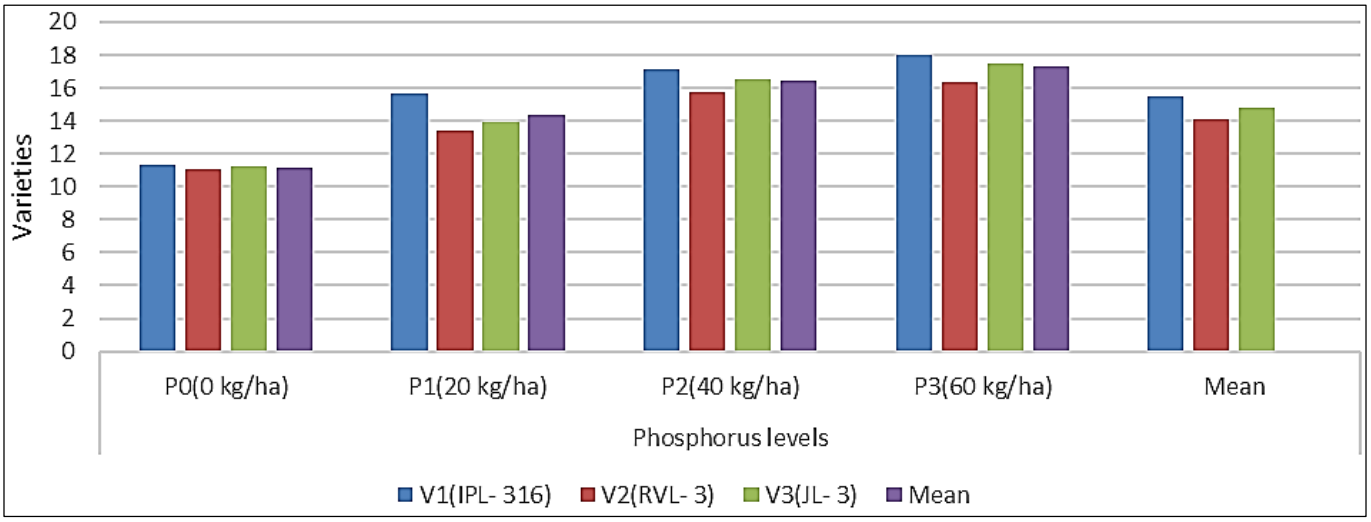

Fig 4: Stover yield per hectare (q/ha) of lentil as influenced by different levels of phosphorus, varieties and their interaction

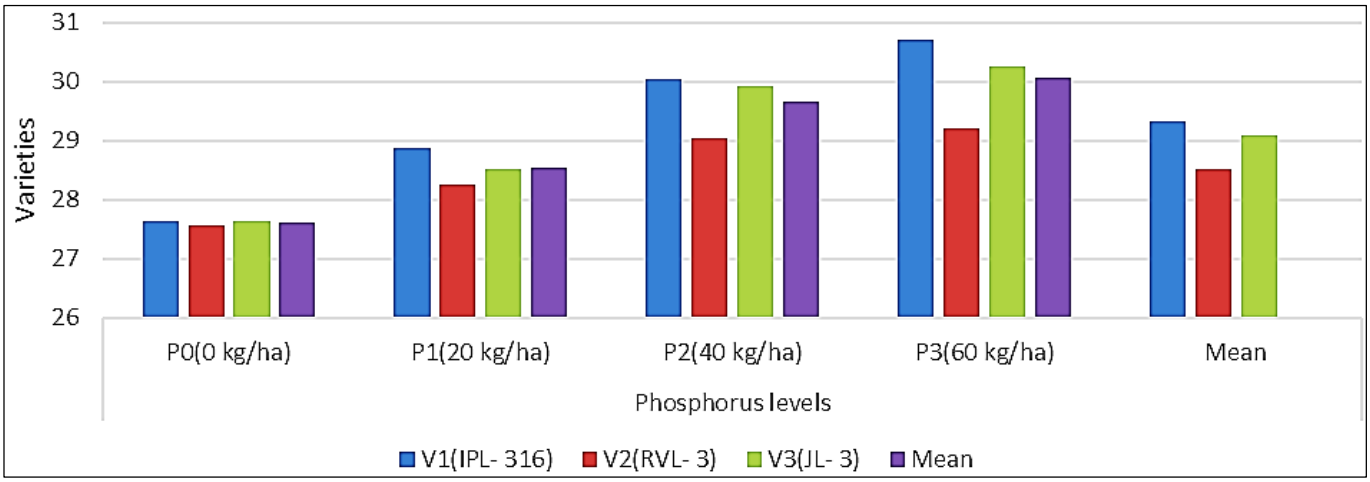

Fig 5: Test weight (g) of lentil as influenced by different levels of phosphorus, varieties and their interaction

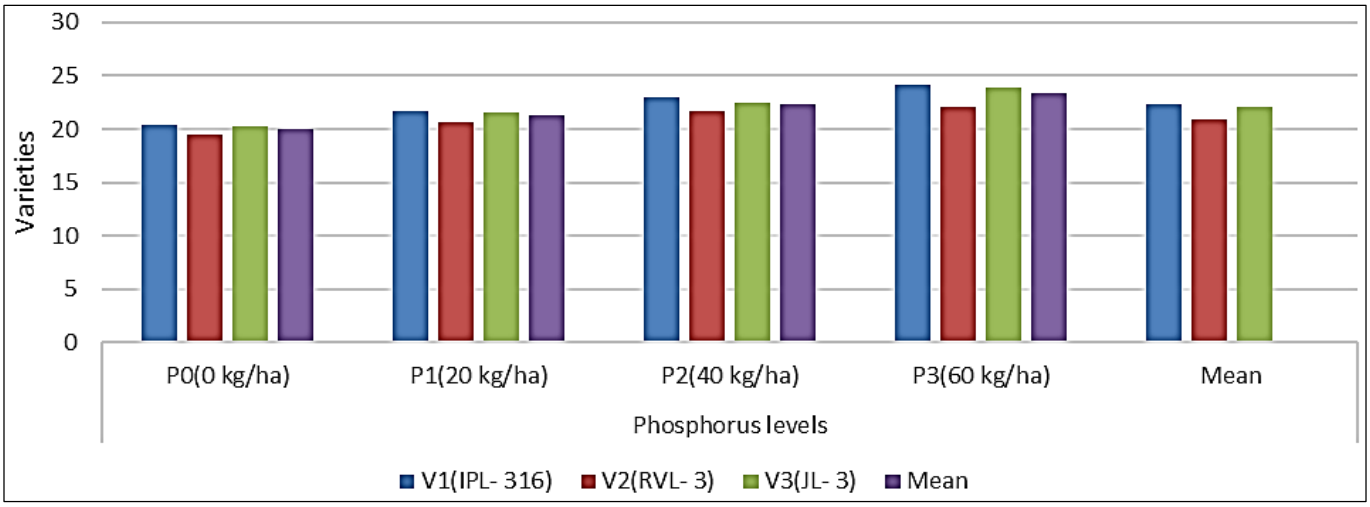

Fig 6: Protein content (%) of lentil as affected by phosphorus, varieties and their interaction

Summary and Conclusion

Based upon this experiment it is concluded that application of phosphorus @ 60 kg/ha with lentil variety of IPL-316 (P_3V_3) recorded the maximum and significantly higher grain yield (9.92q/ha), net returns (₹ 49139.67 Rs/ha) and highest B:C ratio of 2.87:1. Hence, it can be concluded that application of phosphorus @ 60 kg/ha with lentil variety of IPL-316 obtained B:C ratio >2.80.0, can be used as an remunerative strategies.

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