www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(5): 742-751
© 2022 TPI
www.thepharmajournal.com
Received: 05-02-2022
Accepted: 13-03-2022

Arpita Dey
Doon (P.G) College of Agriculture Science and Technology, Camp Road, Selaqui, Dehradun, Uttarakhand, India

Anurag Kumar
Doon (P.G) College of Agriculture Science and Technology, Camp Road, Selaqui, Dehradun, Uttarakhand, India

Akash Samanta
Doon (P.G) College of Agriculture Science and Technology, Camp Road, Selaqui, Dehradun, Uttarakhand, India

Sameer Ahmad Dar
Doon Valley College of Education, Doon Group of Colleges, Chakrata Road, Dehradun, Uttarakhand, India

Corresponding Author:
Arpita Dey
Doon (P.G) College of Agriculture Science and Technology, Camp Road, Selaqui, Dehradun, Uttarakhand, India

Effect of integrated nutrient management on plant growth and yield attributes: A case of lentil crop (*Lens culineris* Medik)

Arpita Dey, Anurag Kumar, Akash Samanta and Sameer Ahmad Dar

Abstract
The study was intended to observe the Effect of Integrated Nutrient Management on Plant Growth and Yield Attributes in lentil crop containing various integration of Farm yard manures, Vermicompost, Bio-fertilizers and inorganic fertilizers. Among various treatments, "N, P, K, S" ("20:17:20:20 kg/ha"), Farm Yard Manure execute better concerning days to"50% flowering, "plant height(cm), days to maturity, Branches number of each plants, pods number of each plant and seeds/pod." Combined infuse of N, P, K, S (20:17:20:20) with Farm Yard Manure execute most effective" for producing "higher seed yield (805.25 kg/ha) as compared to control (502.16 kg/ha)."Optimum use of "organic manure, bio-fertilizers, and inorganic fertilizers together resulted in increased high productivity of lentil crop.

Keywords: Nutrient management, rhizobium, yield attributes, bio-fertilizer, farm yard manure, vermicompost

1. Introduction
Among overall all pulses lentil (*Lens culineris* Medik) with 2n =14 is one of the most essential grain legume crops in India. Lentils are one of the most nutritious food in India. It is mostly eaten as 'Pulses'. It is easy to cook and so easily digestible with high biological value. Lentil is also called as Masur and known as 'Poor man's meat.

In India, Lentil crop extensively grown during Rabi season. Lentil. "Being a leguminous crop, it utilizes the atmospheric nitrogen to meet its fragmental nitrogen requirement and thus captures an important place in crop rotation in different regions in country". "In the country lentil is cultivated in an area of about 1.38 million hectares with production average 0.94 million tones and average yield 685 kg/hac." Customary consumption of nutrients resources of soil has cause emergence of nutrient deficiencies. This often results in higher yields, higher and faster soil nutrient emissions. The amount of nitrogen in the soil of India is insufficient. Currently, phosphorus deficiency has affected about 65 to 70 percent of the soil in India.

India was rank 1st position in area and 2nd position in terms of production with "39.79% and 22.79%" of"global area and production respectively. The absolute best productivity was recorded in Croatia average (2861 kg/ha) followed by New Zealand (2468 kg/ha). Canada rank first in production (41.15%) due to very high level of productivity (1632 kg/ha) as contrast to India (610 kg/ha)."

In India, Among all pulses growing states, Madhya Pradesh ranks 1st in area 39.56% (5.85 lakh /ha) followed by UP 34.36% and Bihar 12.40%. While in phrases of production UP ranks 1st at 36.64% (3.81 lakh tones) followed by Madhya Pradesh (28.81%) and Bihar (18.47%). The best yield was recorded by the state of Bihar (1124 kg/ha) followed by W.B. (960 kg/ha) and Jharkhand (954 kg/ha). The National yield average was (752 kg/ha). The lowest yield was observed in the state of Maharashtra (378 kg/ha), C.G. (409 kg/ha followed by M.P. (633 kg/ha).

Valuable effects of farm yard manure application on crop yield and soil productivity are the result of its effectiveness as a nutrient repository of plants, enhanced soil air circulation and root progression.

The main components of individual organic fertilizers like Rhizobium, Azotobacter, PSB, VAM etc. have been incorporated in the conservative nutrients of different crops. In addition to these microorganisms emit the Phyto-hormones & increment natural status of the soil due to which the accessibility of other supplements moreover increments. The country's growing demand for fertilizers and rising fertilizer prices have emphasized the use of organic fertilizers

in Indian agriculture. Phosphate soluble bacteria (PSB) accumulate phosphorus which is not available in the soil and make it accessible to crops. There is a lack of research work on bio fertilizers combining farm yard manure and major primary nutrients.

Integrated Nutrient Management (INM) has taken centre stage in recent times. Work on INM very little overall. Also the prohibitive price of chemical fertilizers often compels the use of organic fertilizers. INM therefore has the capability to enhance soil fertility on a sustainable basis, based on inorganic, organic and natural sources, as it provides almost all nutrients, enhances bedside high nutrient utilization efficiency and improves soil physio-chemical properties. Therefore, the effect of combined use of inorganic, organic and bio -fertilizers on the productivity of lentil pulses needs to be studied.

2. Materials and Methods

The display examination entitled as impact of Farm Yard Manure, Vermicompost, Bio -fertilizer on plant growth and yield attributes of lentil crop was dispensed throughout during Rabi season 2021-2022 at the experimental farm of Department of Agronomy, Doon (P.G) college of Agriculture science and Technology, Dehradun to standardize the optimal dose of Farm Yard Manure, Vermicompost, Bio-fertilizer for obtaining best growth, flowering and production. The experiment was perfomed get in randomized block design (RBD) with 3 replications. For this purpose of experiment The VL Masoor 148 variety was choosen by the researcher. The trial consists 14 treatments, which are: T1 (Control), T2"(N, P, K, S""(20:17:20:20),""T3 (50% N, P, K, S)," T4"(FYM @ 5 t/ha),"T5"(Vermicompost @ 2 t/ha),"T6"(N, P, K, S 20:17:20:20 kg/ha + FYM @5 t/ha),"T7"(N, P, K, S 20:17:20:20 kg/ha + Vermicompost @ 2t / ha),"T8"(50% N, P, K, S + FYM @5 t/ha)),"T9"(50% N, P, K, S + Vermicompost @ 2 t/ha),"T10"(Rhizobium culture + PSB),"T11"(N, P, K, S 20:17:20:20 kg/ha + Rhizobium culture + PSB),"T12"(50% N, P, K, S + Rhizobium culture + PSB),"T13"(FYM@ 5t/ha + Rhizobium culture + PSB),"T14"(Vermicompost@ 2 t/ha + Rhizobium culture +PSB)"variety VL Masoor 148 used to be "was shown on 25th of November, 2021 at the seed rate of 40-45kg/ha. The seeds have been planted 3-4 cm deep within the open furrow distance of 30 cm (row to row) and 8 to 10 cm (plant to plant), after that it covered with a skinny layer of soil. The pods of lentil were harvested in three pickings at weekly intervals. At 30 DAS, a light grooving was done with a khurpi to get rid of weeds with a thin operation maintaining a spacing of 8 to 10 cm. A 2nd weeding was done at 60 DAS and each and every one cultural practices have been followed. Three life saving irrigations were given during crop growth to avoid dry spell conditions and to avoid wastage of crop plants. In Different treatments, characteristics of different growth parameters and yield characteristics, nodule and pod yield information were recorded. Information were collected from 5 plants of each plot (one replication). The organic carbon, pH, available N, P and K were completely analysed according to the method described by Titration Method (Walkley and Black Method, 1934) Jackson (1973), Alkali potassium permanganate method (Subbiah and Asija; 1956), 0.5 M $NaHCO_3$(Olsen et. Al., 1954), 1N CH_3COONH_4 (Hanway and Heidel, 1952). The RBD design was applied to determine the overall performance of the diversity on the treatment. Overall Performance of variety over treatment was determined by applied one- factor ANOVA.

3. Results and Discussion

"This Experiment relates to the results obtained during the current results entitled Effect of organic, inorganic manure and bio fertilizer on growth, yield attributes and yield of lentil (*Lens culinaris* Medik.) under rainfed condition. Records of the number of observations recorded periodically were subjected to statistical calculations in a randomized block design (RBD) to discover the importance of different treatments usage of differentiation technique analysis. The experimental findings on extraordinary components are integrated and presented in tables."

3.1 Pre-harvest studies

3.1.1 Plant population

"Statistical analysis of plant population data per meter row length at 30 days stage" and maturity has been summarized in Table no.1, Where it is appraise that the experimental variable did not altogether influence the plant population. In Table No. 1 showed that the plant populations were identical for all practical purposes under different nutritional management treatments. At"30 DAS," it row length ranged varies from"10.68/m to 10.95/"in definite control ("N, P, K, S 20:17:20:20 kg/ha + FYM@ 5 t/ha") treatment. "From the calculations of these plants it is clear that sowing was done properly and evenly using healthy and effective seeds of VL Masur 148 variety for good seed germination and emergence." Secondly, plant count at maturity stage indicated that climatic conditions such as maximum and minimum temperatures, relative humidity, and rainfall have no unfavorable impact on crops. Plant population were ranged from"10.45 to 10.61/m" row length at maturity stages.

Table 1: Nutrient management effect on plant population of lentil at 30 days after sowing (DAS) and maturity

"Treatment"		"Plant population/m row length at"	
		"30 DAS"	"Maturity"
Control (no fertilizers)	T_1	10.68	10.45
"N, P, K, S (20:17:20:20 kg/ha)"	T_2	10.86	10.68
50% N, P, K, S	T_3	10.78	10.45
FYM @ 5 t/ha	T_4	10.89	10.47
Vermicompost @ 2 t/ha	T_5	10.84	10.11
"N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5 t/ha"	T_6	10.95	10.61
"N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @5 t/ha"	T_7	10.92	10.60
50% N, P, K, S + FYM @ 5 t/ha	T_8	10.89	10.51
"50% N, P, K, S + Vermicompost @ 2 t/ha"	T_9	10.87	10.16
"Rhizobium culture + PSB"	T_{10}	10.80	10.46

"N, P, K, S (20:17:20:20 kg/ha)" + Rhizobium culture+ PSB	T_{11}	10.89	10.50
50% N, P, K, S + Rhizobium culture + PSB	T_{12}	10.88	10.45
"FYM @ 5 t/ha + Rhizobium culture + PSB"	T_{13}	10.85	10.52
"Vermicompost @ 2 t/ha + Rhizobium culture + PSB"	T_{14}	10.83	10.18
"S.Em ±"		0.55	0.47
"C.D. (at 5%)"		NS	NS

3.1.2 Plant height (cm)

The effect of organic, inorganic and bio fertilizers on the growth of lentils at different stages of growth is summarized in Table 2. Plant height from"30 days" after sowing (DAS) to maturity was recorded. In Table 2 presents the data and states that plant height, in general, was multiplied by the progress of plant growth up to the stage of maturity under all the treatments.

"Different treatments of nutrient management significantly" affected the plant height at all growth stages (Appendix II). (Table no.2) data show that treatment "N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5 t/ha" has achieved considerably more height"(8.81, 14.12, 22.21 and 32.35 cm)"in all treatments at"30, 45, 60 DAS" and maturity, respectively. However, it has been found to be equal with "N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha" at all crop growth stages; "50% N, P, K, S + FYM @ 5 t/ha, 50% N, P, K, S + Vermicompost @ 2 t/ha" and "N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB at 30, 45 DAS and maturity;" "FYM @ 5 t/ha + Rhizobium culture + PSB at 30 DAS and maturity; "and with"50% N, P, K, S + Rhizobium culture + PSB at maturity." Minimum plant height was recorded in control closely followed by "50% N, P, K, S, Rhizobium culture + PSB, Vermicompost @ 2 t/ha," "Vermicompost @ 2 t/ha + Rhizobium culture + PSB," "FYM @ 5 t/ha, N, P, K, S (20:17:20:20 kg/ha)"and"50% N, P, K, S + Rhizobium culture + PSB."

Table 2: Nutrient management effect on plant height at"35 DAS, 45 DAS, 60 DAS,"& maturity stage of lentil

Treatment		Plant height (cm) at			
		"30 DAS"	"45 DAS"	"60 DAS"	"Maturity"
Control (no fertilizers)	T_1	6.68	11.41	16.72	28.72
"N, P, K, S (20:17:20:20 kg/ha)"	T_2	7.66	12.39	19.54	30.71
50% N, P, K, S	T_3	7.06	11.54	1 8.99	29.12
FYM @ 5 t/ha	T_4	7.21	12.22	19.41	30.68
Vermicompost @ 2 t/ha	T_5	7.46	12.14	19.26	29.98
"N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5 t/ha"	T_6	8.81	14.12	22.21	32.35
"N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha"	T_7	8.12	13.74	20.79	31.99
50% N, P, K, S + FYM @ 5 t/ha	T_8	7.94	13.59	20.28	31.74
50% N, P, K, S + Vermicompost @ 2 t/ha	T_9	7.86	13.08	19.98	31.52
Rhizobium culture + PSB	T_{10}	6.88	12.06	18.73	29.48
"N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB"	T_{11}	7.82	12.94	19.94	31.46
50% N, P, K, S + Rhizobium culture + PSB	T_{12}	7.78	12.59	19.59	30.74
FYM @ 5 t/ha + Rhizobium culture + PSB	T_{13}	7.81	12.74	19.81	31.06
Vermicompost @ 2 t/ha + Rhizobium culture + PSB	T_{14}	7.42	12.19	19.29	30.08
"S.Em ±"		0.36	0.45	0.60	0.72
"C.D. (at 5%)"		1.04	1.31	1.76	2.08

3.1.3 Branches number of each plant

Branches number of each plant was recorded at distinctive development interims and the information have been displayed in Table 3. Branch formation, in general, was rapid until maturity, resulted that, the number of branches of each plant increase four times more. Investigation of variance (Appendix III) showed that nutrient management have a significant effect on the character of this growth at all stages of the observation in different treatments."

Table 3: Nutrient management effect on number of branches of lentil at different growth stages

"Treatment"		"Number of branches of each plants at"			
		"30 DAS"	"45 DAS"	"60 DAS"	Maturity
Control (no fertilizers)	T_1	1.02	1.35	3.46	3.46
"N, P, K, S (20:17:20:20 kg/ha)"	T_2	1.41	2.12	4.14	4.14
50% N, P, K, S	T_3	1.06	1.62	3.66	3.66
FYM @ 5 t/ha	T_4	1.34	1.88	4.08	4.08
Vermicompost @ 2 t/ha	T_5	1.41	2.06	3.72	3.72
"N, P, K, S (20:17:20:20 kg/ha) +FYM@5 t/ha"	T_6	1.79	3.08	4.81	4.81
"N, P, K, S (20:17:20:20 kg/ha)"+ Vermicompost @ 2 t/ha	T_7	1.76	2.92	4.72	4.72
50% N, P, K, S + FYM @ 5 t/ha	T_8	1.72	2.64	4.54	4.54
50% N, P, K, S + Vermicompost @ 2 t/ha	T_9	1.71	2.66	4.41	4.41
Rhizobium culture + PSB	T_{10}	1.26	1.68	3.68	3.68
"N, P, K, S (20:17:20:20 kg/ha)" + Rhizobium culture + PSB"	T_{11}	1.68	2.61	4.34	4.34
50% N, P, K, S + Rhizobium culture + PSB	T_{12}	1.46	2.31	4.16	4.16
FYM @ 5 t/ha + Rhizobium culture + PSB	T_{13}	1.52	2.61	4.28	4.28
Vermicompost @ 2 t/ha + Rhizobium culture	T_{14}	1.36	1.92	3.92	3.92

+ PSB					
"S.Em ±"		0.10	0.18	0.20	0.20
"C.D. (at 5%)"		0.30	0.52	0.62	0.62

Application of 100% of the recommended dose of "N, P, K, S (20:17:20:20 kg/ha) in combination with 5 t FYM/ha (T_6)" brought "about maximum branches starting from 1.79 at" "30 DAS to 4.81" "per plant at maturity." This treatment proved significantly superior to rest of the treatments except the treatment "N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha, 50% N, P, K, S + FYM @ 5 t/ha, 50% N, P, K, S + Vermicompost @ 2 t/ha, N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB and FYM @ 5 t/ha + Rhizobium culture + PSB" at growth stages of all crop." The minimum number of branches i.e., 1.02, 1.35 and 3.46 of each plant was recorded in control"at"30, 45, 60 DAS" and maturity, respectively.

3.1.4 Root nodules number of each plant

In each treatment, root nodules number per plant was checked in and the information gotten were factually calculated. The mean value is highlighted in Table 4. The different fertility treatments has a significant affects upon this parameter at both the stages of observations.

Table 4: "Nutrient management" effect "on number of root nodules of each plant of lentil at 45 and 60 days after sowing (DAS)"

"Treatment"		"Number of roots nodules of each plant at"	
		45 DAS	60 DAS
Control (no fertilizers)	T_1	9.38	10.72
"N, P, K, S (20:17:20:20 kg/ha)"	T_2	10.40	12.07
50% N, P, K, S	T_3	10.07	11.47
FYM @ 5 t/ha	T_4	9.93	11.07
Vermicompost @ 2 t/ha	T_5	9.81	11.87
"N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5 t/ha"	T_6	10.67	16.07
"N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha"	T_7	10.47	14.60
50% N, P, K, S + FYM @ 5 t/ha	T_8	10.43	13.30
"50% N, P, K, S +"Vermicompost @ 2 t/ha""	T_9	10.40	13.20
"Rhizobium culture + PSB"	T_{10}	10.87	16.13
"N, P, K, S (20:17:20:20 kg/ha)"+ Rhizobium culture + PSB"	T_{11}	11.93	17.10
50% N, P, K, S + Rhizobium culture + PSB	T_{12}	11.77	16.95
"FYM @ 5 t/ha + Rhizobium culture + PSB"	T_{13}	11.71	16.27
"Vermicompost @ 2 t/ha + Rhizobium culture + PSB"	T_{14}	11.63	16.13
"S.Em ±"		0.39	0.38
"C.D. (at 5%)"		1.12	1.11

In both observations, the number of root nodules per plant increased noteworthy higher in all the fertility treatments over control recorded at"45 and 60"days after sowing stages. Maximum root nodules of each plant 11.93 and 17.10 were recorded with the application of"N, P, K, S @ 20:17:20:20 kg/ha + FYM @ 5 t/ha"at both stages of crop growth. However, this treatment was found statistically identical influence upon the formation of root nodules to further treatments. At 45 DAS and 60 DAS, root nodules were recorded significantly lowest 9.38 and 10.72 in control treatment.

3.1.5 Root nodules (dry weight of each plant) (mg)

In recorded treatment, the root nodules dry weight per plant and hence the data obtained were statistically analyzed. The average values are presented in Table 5.

Table 5: "Nutrient management" effect on "dry weight of root nodules of lentil at 45 and 60 days after sowing (DAS)."

"Treatment"		"Dry weight of root nodules of each plant (mg) at"	
		"45 DAS"	"60 DAS"
Control (no fertilizers)	T_1	2.27	4.12
"N, P, K, S (20:17:20:20 kg/ha)"	T_2	3.07	6.98
50% N, P, K, S	T_3	2.89	6.80
FYM @ 5 t/ha	T_4	2.73	6.01
Vermicompost @ 2 t/ha	T_5	2.60	5.58
"N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5 t/ha"	T_6	3.63	7.86
"N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha"	T_7	3.59	7.85
50% N, P, K, S + FYM @ 5 t/ha	T_8	3.36	7.61
50% N, P, K, S + Vermicompost @ 2 t/ha	T_9	3.23	7.10
Rhizobium culture + PSB	T_{10}	3.63	7.76
"N, P, K, S (20:17:20:20 kg/ha)"+ Rhizobium culture + PSB	T_{11}	4.49	8.12
50% N, P, K, S + Rhizobium culture + PSB	T_{12}	4.43	8.03
"FYM @ 5 t/ha + Rhizobium culture + PSB"	T_{13}	4.23	7.96
"Vermicompost @ 2 t/ha + Rhizobium culture + PSB"	T_{14}	3.90	7.79
"S.Em ±"		0.32	0.34
"C.D. (at 5%)"		0.95	1.00

In both stages, the various integrated nutrient management treatments brought about noteworthy affect upon this parameter of observation recorded at 45 and 60 days after sowing. Higher dry weight of root nodules per plant as compared to control treatment. The application of "N, P, K, S @ 20:17:20:20 kg/ha"+"FYM @ 5 t/ha" resulted maximum dry weight of root nodules is 3.63 and 7.86. It has been found to coincide with the rest of the treatment.

3.1.7 Root/plant Length (cm) at 45 DAS

Root length / plant (cm) was recorded at 45 DAS and 60 DAS. The measurably investigation of information at both the stages given in Table no.6, appeared that treatment impact on root / plant length was noteworthy at 45 DAS treatment "N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5 t/ha," "recorded the significantly longer root length per plant than Control" (no fertilizers) 50% N, P, K, S + Rhizobium culture + PSB, 50% N, P, K, S + Rhizobium culture + PSB and was at per with "N, P, K, S (20:17:20:20 kg/ha), FYM @ 5 t/ha," "Vermicompost @ 2 t/ha, N, P, K, S (20:17:20:20 kg/ha)"+"Vermicompost @ 2 t/ha,"50% "N, P, K, S + FYM @ 5 t/ha,"50% N, P, K, S +"Vermicompost @ 2 t/ha," "N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB,"50% N, P, K, S + Rhizobium culture + PSB, "Vermicompost @ 2 t/ha + Rhizobium culture + PSB. At 60 DAS treatment N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5 t/ha," recorded significantly longer root per plant than Control (no fertilizers),"N, P, K, S (20:17:20:20 kg/ha),"50% N, P, K, S, Rhizobium culture + PSB, 50% N, P, K, S +"Rhizobium culture + PSB, FYM @ 5 t/ha + Rhizobium culture + PSB," "Vermicompost @ 2 t/ha + Rhizobium culture + PSB," and was at per with "FYM @ 5 t/ha," "Vermicompost @ 2 t/ha," N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha, 50% N, P, K, S + FYM @ 5 t/h, 50% N, P, K, S + Vermicompost @ 2 t/ha, and "N, P, K, S" "(20:17:20:20 kg/ha) + Rhizobium culture + PSB." "In both phases the minimum length of root of each plant was recorded in the control treatment.

Table 6: Nutrient management effect on length of root of lentil ("45 DAS & 60 DAS")

Treatment		Length of root of each plant (cm)	
		45 DAS	60 DAS
Control (no fertilizers)	T_1	11.75	15.27
"N, P, K, S (20:17:20:20 kg/ha)"	T_2	12.85	17.09
50% N, P, K, S	T_3	11.85	16.01
FYM @ 5 t/ha	T_4	12.98	17.25
Vermicompost @ 2 t/ha	T_5	12.68	17.20
"N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5 t/ha"	T_6	13.47	18.22
"N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha"	T_7	13.37	17.99
50% N, P, K, S + FYM @ 5 t/ha	T_8	13.33	17.88
50% N, P, K, S + Vermicompost @ 2 t/ha	T_9	13.10	17.74
Rhizobium culture + PSB	T_{10}	11.98	16.51
"N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB"	T_{11}	13.10	17.64
50% N, P, K, S + Rhizobium culture + PSB	T_{12}	12.86	17.10
"FYM @ 5 t/ha + Rhizobium culture + PSB"	T_{13}	12.80	17.00
"Vermicompost @ 2 t/ha + Rhizobium culture + PSB"	T_{14}	12.10	16.95
"S.Em ±"		0.29	0.36
"C.D. (at 5%)"		0.87	1.07

3.1.8 Root bio-mass/plant (g) 45 DAS

The data on root bio-mass was recorded at 45 DAS and 60 DAS given in table 7. Data related to root biomass at 45 DAS appeared that treatment impact was not critical but the higher esteem of root biomass was recorded in "N, P, K, S (20:17:20:20 kg/ha), N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB and FYM @ 5 t/ha + Rhizobium culture + PSB." At 60 DAS treatment effect was significant and treatment "N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5 t/ha" recorded the significantly higher root bio-mass than Control (no fertilizers)"50% N, P, K, S, Vermicompost @ 2 t/ha, Rhizobium culture + PSB, FYM @ 5 t/ha + Rhizobium culture + PSB, Vermicompost @ 2 t/ha + Rhizobium culture + PSB and was at per with N, P, K, S (20:17:20:20 kg/ha), FYM @ 5 t/ha, N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha, 50% N, P, K, S + FYM @ 5 t/ha, 50% N, P, K, S + Vermicompost @ 2 t/ha, N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB and 50% N, P, K, S + Rhizobium culture + PSB." At both the stage 45 DAS and 60 DAS minimum and maximum root biomass was recorded in control treatment

Table 7: Nutrient management effect on root bio-mass of lentil (45 DAS & 60 DAS)

Treatment		Root bio mass/plant (g)	
		45 DAS	60 DAS
Control (no fertilizers)	T_1	0.16	0.19
"N, P, K, S (20:17:20:20 kg/ha)"	T_2	0.20	0.22
50% N, P, K, S	T_3	0.17	0.20
FYM @ 5 t/ha	T_4	0.18	0.22
Vermicompost @ 2 t/ha	T_5	0.19	0.21
"N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5 t/ha"	T_6	0.23	0.25
"N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha"	T_7	0.17	0.24
50% N, P, K, S + FYM @ 5 t/ha	T_8	0.18	0.24
50% N, P, K, S + Vermicompost @ 2 t/ha	T_9	0.17	0.23

Rhizobium culture + PSB	T_{10}	0.18	0.20
"N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB"	T_{11}	0.20	0.23
50% N, P, K, S + Rhizobium culture + PSB	T_{12}	0.19	0.22
"FYM @ 5 t/ha + Rhizobium culture + PSB"	T_{13}	0.20	0.21
"Vermicompost @ 2 t/ha + Rhizobium culture + PSB"	T_{14}	0.18	0.21
"S.Em ±"		0.008	0.009
"C.D. (at 5%)"		NS	0.028

3.1.9 Pods number of each plant:

At Table no. 8 shows that the number of pods in each plant has been found to be veer off due to various richness treatments. Each Plant's pod is a very important yield characteristic parameter, which is essentially influenced by different integrated nutrient management treatments. Given application of "N, P, K, S @ 20: 17: 20: 20 kg / ha + FYM @ 5 t / ha," Maximum number of pods of each plant was recorded (66.67). This treatment has been found to be completely superior to the application of "Rhizobium culture + PSB, Vermicompost @ 2 t/ha + Rhizobium culture + PSB, Vermicompost @ 2 t/ha, FYM @ 5 t/ha, 50% N, P, K, S, N, P, K, S (20:17:20:20 kg/ha)" and control treatments and found at par with "N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha, 50% N, P, K, S + FYM @ 5 t/ha, 50% N, P, K, S + Vermicompost @ 2 t/ha, N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB, 50% N, P, K, S + Rhizobium culture + PSB, FYM @ 5 t/ha + Rhizobium culture + PSB treatment. Only N, P, K, S @ 20: 17: 20: 20 kg / ha" application was found to be crucial in increasing the pods number of each plant then 50% N, P, K,S and control treatment. The application of chemical fertilizer alone or in combinations with organic manures and bio-fertilizers crucially affected the pods number of each plant.

Table 8: "Nutrient management" effect "on yield attributing characters of lentil."

"Treatment"		"No. of pods/ plant"	"No. of seeds/pod"	"Seed yield/ plant (g)"	"Seed index (g)"
Control (no fertilizers)	T_1	41.33	1.21	1.72	2.26
"N, P, K, S (20:17:20:20 kg/ha)"	T_2	54.67	1.29	2.48	2.49
50% N, P, K, S	T_3	46.33	1.22	1.78	2.29
FYM @ 5 t/ha	T_4	58.33	1.25	2.44	2.46
Vermicompost @ 2 t/ha	T_5	56.67	1.28	2.40	2.41
"N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5t/ha"	T_6	66.67	1.44	3.07	2.92
"N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha"	T_7	66.00	1.36	2.88	2.72
50% N, P, K, S + FYM @ 5 t/ha	T_8	65.67	1.32	2.76	2.71
50% N, P, K, S + Vermicompost @ 2 t/ha	T_9	62.67	1.35	2.67	2.62
Rhizobium culture + PSB	T_{10}	59.00	1.24	2.34	2.32
"N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB"	T_{11}	63.67	1.32	2.65	2.61
50% N, P, K, S + Rhizobium culture + PSB	T_{12}	61.33	1.29	2.51	2.52
FYM @5 t/ha + Rhizobium culture + PSB	T_{13}	62.67	1.31	2.55	2.56
Vermicompost @ 2 t/ha + Rhizobium culture + PSB	T_{14}	56.67	1.26	2.43	2.42
S.Em ±		1.65	0.06	0.18	0.11
C.D. (at 5%)		4.80	NS	0.53	0.32

3.2 Seeds Number of each pod

Seeds number of each pod did not vary altogether due to distinctive nutrient management treatments as uncovered from Table 9.n In Control (no fertilizers) showed 1.21/pod and "N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5 t/ha)"treatment showed 1.44/pod.

3.2.1 Seed yield of each plant

The "data on seed yield of each plant are displayed in Table 9."The seed yield of each plant was crucially affected by different integrated nutrient management treatments. The application of "N, P, K, S @ 20:17:20:20 kg/ha + FYM @ 5 t/ha was brought 3.07 g seed yield of each plant." It was found significantly superior than "FYM @ 5 t/ha + Rhizobium culture + PSB, 50% N, P, K, S + Rhizobium culture + PSB, Rhizobium culture + PSB, Vermicompost @ 2 t/ha, FYM @ 5 t/ha, 50% N, P, K, S, N, P, K, S (20:17:20:20 kg/ha) and control treatments, whereas at par with N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha, 50% N, P, K, S + FYM @ 5 t/ha, 50% N, P, K, S + Vermicompost @ 2 t/ha, N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB, FYM @ 5 t/ha + Rhizobium culture + PSB, N, P, K, S @ 20:17:20:20 kg/ha" alone affected that increased seed yield of each plant found significant than T3 and control treatments. However, it has been found to be equivalent with "Vermicompost @ 2 t/ha + Rhizobium culture + PSB, FYM @ 5 t/ha + Rhizobium culture + PSB, Vermicompost @ 2 t/ha, Rhizobium culture + PSB." The application of organic manures i.e., vermicompost @ 2 t/ha and bio-fertilizers were also increased seed yield of each plant significantly then control treatment.

3.2.2 Seed Index (g)

The seed weight of 100 seeds was also deviated significantly due to applied fertility treatments as revealed from data in Table 9. The result indicated from the data that the 100 seeds weights were essentially "affected by different integrated nutrient management" treatments. The maximum weight of 100 seeds (2.92 gm) was recorded with application of "N, P, K, S @ 20:17:20:20 kg/ha + FYM @ 5 t/ha," this treatment was found significantly superior to "N, P, K, S (20:17:20:20 kg/ha), 50% N, P, K, S, FYM @ 5 t/ha, Vermicompost @ 2 t/ha, Rhizobium culture + PSB, 50% N, P, K, S + Rhizobium culture + PSB, FYM @ 5 t/ha + Rhizobium culture + PSB, Vermicompost @ 2 t/ha + Rhizobium culture + PSB and control treatments and at par with N, P, K, S (20:17:20:20

kg/ha) + Vermicompost @ 2 t/ha, 50% N, P, K, S + FYM @ 5 t/ha, 50% N, P, K, S + Vermicompost @ 2 t/ha, N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB treatments. The application of N, P, K, S @ 20:17:20:20 kg/ha alone was found significantly superior than 50% N,P,K,S FYM @ 5 t/ha, Vermicompost @ 2 t/ha, Rhizobium culture + PSB, Vermicompost @ 2 t/ha + Rhizobium culture + PSB control treatments." The effect of organic manures applied separately or in combinations with Rhizobium + PSB were found significant than control. Wherever the application of Rhizobium + PSB alone was found significantly superior then control and 50% N, P, K, S.

Table 9: "Nutrient management" effect "on yield attributing characters of lentil."

"Treatment"		No. of pods of each plant	No. of Seeds of each pod	Seed Yield of each plant (g)	"Seed index" (g)
Control (no fertilizers)	T_1	41.33	1.21	1.72	2.26
"N, P, K, S (20:17:20:20 kg/ha)"	T_2	54.67	1.29	2.48	2.49
50% N, P, K, S	T_3	46.33	1.22	1.78	2.29
FYM @ 5 t/ha	T_4	58.33	1.25	2.44	2.46
Vermicompost @ 2 t/ha	T_5	56.67	1.28	2.40	2.41
"N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5t/ha"	T_6	66.67	1.44	3.07	2.92
"N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha"	T_7	66.00	1.36	2.88	2.72
50% N, P, K, S + FYM @ 5 t/ha	T_8	65.67	1.32	2.76	2.71
50% N, P, K, S + Vermicompost @ 2 t/ha	T_9	62.67	1.35	2.67	2.62
Rhizobium culture + PSB	T_{10}	59.00	1.24	2.34	2.32
"N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB"	T_{11}	63.67	1.32	2.65	2.61
50% N, P, K, S + Rhizobium culture + PSB	T_{12}	61.33	1.29	2.51	2.52
FYM @5 t/ha+ Rhizobium culture + PSB	T_{13}	62.67	1.31	2.55	2.56
Vermicompost @ 2 t/ha + Rhizobium culture + PSB	T_{14}	56.67	1.26	2.43	2.42
S.Em ±		1.65	0.06	0.18	0.11
C.D. (at 5%)		4.80	NS	0.53	0.32

3.2.3 Seed yield (kg/ha)

Application of Farm Yard Manure, vermicompost and biofertilizer alone or N, P, K, S combine control affected the seed yield noteworthy in Table no.10."N, P, K, S""(20: 17: 20: 20 kg / ha)" + "FYM @ 5 t" / ha showed that maximum seed yield of lentils (805.25kg / ha) which was affected outstanding higher in control (502.16kg / ha) than other treatments. Application of "N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha was found second best treatment which was at par with 50% N, P, K, S + FYM @ 5 t/ha, 50% N, P, K, S + Vermicompost @ 2 t/ha, N, P, K, S (20:17:20:20 kg/ha) + Rhizobium culture + PSB, and significantly superior than FYM @ 5 t/ha, 50% N, P, K, S + Rhizobium culture + PSB, N, P, K, S (20:17:20:20 kg/ha), FYM @ 5 t/ha + Rhizobium culture + PSB, Vermicompost @ 2 t/ha, Vermicompost @ 2 t/ha + Rhizobium culture + PSB, Rhizobium culture + PSB, 50% N, P, K, S, Control (no fertilizers)."

3.2.4 Straw yield (kg/ha): The trend of results in the case of lentil straw yield has been found to be similar to that observed in the case of lentil grain yield. "The data clearly showed that the effect of different integrated nutrient management treatments on" straw yields has been found extraordinary (Table 10). "N, P, K, S"@"20:17:20:20 kg/ha" + "FYM @ 5 t/ha" application affected increased straw yield "1447 kg/ha" and found noteworthy higher than "Vermicompost @ 2 t/ha, Rhizobium culture + PSB, Vermicompost @ 2 t/ha + Rhizobium culture + PSB, 50% N, P, K, S and control." "Further it was observed that this treatment was found statistically at par with" "N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha, N,P,K,S(20:17:20:20 kg/ha), 50% N, P, K, S + Vermicompost @ 2 t/ha N,P,K,S(20:17:20:20 kg/ha) + Rhizobium culture + PSB, 50% N,P,K,S+ Rhizobium culture + PSB, 50% N, P, K, S + FYM @ 5 t/ha, FYM @ 5 t/ha + Rhizobium culture + PSB. Only chemical fertilizers application of N, P, K, S @ 20:17:20:20 kg/ha increased straw yield significantly after the control."

Table 10: "Nutrient management effect on Lentil yields and harvest index."

"Treatment"		"Seed yield (kg/ha)"	"Straw yield (kg/ha)"	"Harvest index (%)"
Control (no fertilizers)	T_1	502.16	939.20	34.85
"N,P,K,S(20:17:20:20 kg/ha)"	T_2	662.35	1387.34	34.40
50% N,P,K,S	T_3	565.43	1027.78	35.52
FYM @ 5 t/ha	T_4	688.89	1306.48	34.49
Vermicompost @ 2 t/ha	T_5	582.41	1173.46	33.20
"N,P,K,S(20:17:20:20 kg/ha) + FYM @ 5 t/ha"	T_6	805.25	1447.53	35.92
"N,P,K,S(20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha"	T_7	773.15	1419.44	35.29
50% N,P,K,S+ FYM @ 5 t/ha	T_8	771.91	1353.70	38.63
50% N,P,K,S+ Vermicompost @ 2 t/ha	T_9	749.69	1364.50	35.66
Rhizobium culture + PSB	T_{10}	568.21	1147.53	33.11
"N,P,K,S(20:17:20:20 kg/ha) + *Rhizobium* culture + PSB"	T_{11}	735.18	1312.96	36.19
50% N, P, K, S + Rhizobium culture+ PSB	T_{12}	670.37	1258.64	35.26
"FYM @ 5 t/ha + Rhizobium culture + PSB"	T_{13}	649.38	1218.52	34.77
"Vermicompost @ 2 t/ha + Rhizobium culture + PSB"	T_{14}	575.31	1163.58	33.01
S.Em ±		24.17	80.56	1.81
C.D. (at 5%)		70.26	234.23	NS

4. Summary

The display examination entitled as impact of Farm Yard Manure, Vermicompost, Bio -fertilizer on plant growth and yield attributes of lentil crop was dispensed throughout during Rabi season (2021-2022) at the experimental farm of Department of Agronomy, Doon (P.G) college of Agriculture science and Technology, Dehradun. The soil of the test plot was sandy loam soil with pH 8.3, natural carbon 0.45%, accessible N, P and K, 213.0, 15.0 and "184.0 kg / ha" separately. "The experiment was performed in randomized block design having 14 treatments of nutrient management with 3 replications." Treatments includes of Control, "N,P,K,S" "(20:17:20:20 kg/ha)," 50% "N, P, K, S," "FYM @ 5 t/ha," "Vermicompost @ 2 t/ha," "N, P, K, S""(20:17:20:20 kg/ha)"+"FYM @ 5 t/ha," "N, P, K, S""(20:17:20:20 kg/ha)"+"Vermicompost @ 2 t/ha,"50% "N, P, K, S"+"FYM @ 5 t/ha,""50% N, P, K, S + Vermicompost @ 2 t/ha," Rhizobium culture + PSB,""N, P, K, S (20:17:20:20 kg/ha)"+ "Rhizobium culture + PSB," "50% N, P, K, S"+"Rhizobium culture + PSB," "FYM @ 5 t/ha + Rhizobium culture + PSB"and"Vermicompost @ 2 t/ha + Rhizobium culture + PSB." The plot size for this particular experiment was"(4m × 3m)"gross and net size"(3.5m × 2.4m)"along spacing of "(30cm × 10cm)."The dosages of NPK and S were work in applied within the form of urea, DAP fertilizer, MOP and "gypsum individually." FYM "and vermicompost" was applied evenly in soil before sowing. We have done "seed treatment @ 5 g/kg" seed with the application of Rhizobium culture + PSB. Lentil var VL Masoor 148 was sown on 25th November 2021. The crop was raised under rainfed conditions and harvested on 20thmarch; 2022 The main results of the current test are summarized below.

4.1.1 Growth parameters

Different "nutrient management treatments had a crucial impact on development characteristic of lentil *viz*.," plant height, branches number of each plant, etc. The aforementioned characters were crucially improved under treatment "N, P, K, S (20: 17: 20: 20 kg / ha) + FYM @ 5 t / ha compared to the rest of the treatment. Although, application of N, P, K, S (20:17:20:20 kg/ha) + Vermicompost @ 2 t/ha, 50% N, P, K, S + FYM @ 5 t/ha and 50% N, P, K, S+ Vermicompost @ 2 t / ha" was found to be comparable to the previous treatment in all growth characteristic. The least value of all these parameters was recorded within the control.

4.1.2 Root nodulation

Different nutrient management treatments had a crucial effect on "observations recorded on both the number of root nodules of each plant and the sowing stage recorded at 45 and 60 days showed a significant increase" in all fertility treatments on control. By application of"N,P,K,S"@"20:17:20:20 kg/ha"+ "FYM @ 5 t/ha," the maximum root nodules per plant 11.93 and 17.10"were recorded at both crop growth stages and all the treatments recorded altogether "higher root nodules of each plant's dry weight as compared to control treatment." By application of "N, P, K, S @ 20: 17: 20: 20 kg / ha + FYM @ 5 t / ha," the maximum "root nodules dry weight at both stages of crop growth is 3.63 and 7.86. It has been found to coincide with the rest of the treatment."

4.1.3 Root length and bio-mass of each plant

In Lentil different nutrient management treatments had noteworthy affect on root length and bio-mass. Root length of each plant was significant at 45 DAS, treatment "N, P, K, S (20:17:20:20 kg/ha) + FYM @ 5 t/ha, recorded the significantly longer root length per plant than Control (no fertilizers), 50% N,P,K,S + Rhizobium culture + PSB 50% N,P,K,S+ Rhizobium culture + PSB and the higher value of root biomass was recorded in N,P,K,S (20:17:20:20 kg/ha) + FYM @ 5 t/ha, N,P,K,S (20:17:20:20 kg/ha) + Rhizobium culture + PSB and FYM @ 5 t/ha + Rhizobium culture + PSB."

4.1.4 Yield attributing parameters

"Pods number of each plant, seeds number per unit, seed yield of each plant, and seed index were increased altogether due to expanded supply of nutrients from integrated nutrient management treatment" having "N, P, K, S @ 20:17:20:20 kg/ha + FYM @ 5 t/ha," Fertility remaining without this treatment was found to be significantly higher than the treatment having "N, P, K, S @ 20:17:20:20 kg/ha + vermicompost @ 2 t/ha and then N, P, K, S @ 20:17:20:20 kg/ha + Rhizobium + PSB. Thus, the treatment of nutrient management is N, P, K, S @ 20: 17: 20: 20 kg / ha + vermicompost @ 2 t / ha and then N, P, K, S @ 20: 17: 20: 20 kg / ha + Rhizobium + PSB" ranked second and third best, respectively, for encouraging yield trait parameters. The best treatment "N, P, K, S @ 20:17:20:20 kg/ha + FYM @ 5 t/ha" resulted in "maximum yield attributes" *viz*. 66.67 pods of each plant, 1.44 seeds of each pod, 3.07 g seed yield of each plant and 2.92 g seeds weight. The corresponding values in case of control treatment were significantly lowest i.e., 41.33 pods, 1.21 seeds per pod, 1.72 g seed yield of each plant and 2.26 seed index.

5. Conclusion

From recent research it has been concluded that integrated nutrient management having "N, P, K, S @ 20:17:20:20 kg/ha + FYM @ 5 t/ha" "increased the plant height," branches and "root length," root biomass of lentil up to maximum, this was closely followed by "N,P,K,S @ 20:17:20:20 kg/ha + vermicompost @ 2 t/ha and then N,P,K,S @ 20:40:20:20 kg/ha + Rhizobium + PSB."

In the treatment of integrated nutrition management, "N, P, K, S"@"20: 17: 20: 20 kg / ha"+ "FYM @ 5 t / ha" results in root-nodulation (number & weight of root nodules) as well as "N, P, K, S @ 20: 17: 20: 20 kg / ha"+ Physiological parameters of lentil pulses (leaf area, dry weight per plant, LAI, CGR and NAR) are significantly higher / ha and N, P, K than other treatments except "vermicompost @ 2 t., S @ 20: 17: 20: 20 kg / ha + Rhizobium + PSB." "The yield attributing parameters and yield of lentil var. VL Masoor 148 was found highest from the integrated nutrient management treatments" with "the application" of "N,P,K,S@ 20:17:20:20 kg/ha +FYM @ 5 t/ha," being noteworthy superior to the remaining treatment, except "N,P,K,S@ 20:17:20:20 kg/ha + vermicompost @ 2 t/ha and N,P,K,S@ 20:17:20:20 kg/ha + Rhizobium + PSB."

Amongst the integrated nutrient management treatment, "N, P, K, S"("20:17:20:20 kg/ha") + "FYM @ 5 t/ha" gave the maximum net profit up to Rs. 17787 per hectares and B: C ratio 2.30 followed by "N,P,K,S"("20:17:20:20 kg/ha") + "Vermicompost"@"2 t/ha", 50% "N,P,K,S + Vermicompost

@ 2 t/ha," "N,P,K,S"("20:17:20:20 kg/ha") + Rhizobium culture + PSB, 50% N,P,K,S+ FYM @ 5 t/ha, 50% N,P,K,S+ Rhizobium culture + PSB which gave Rs. 17763, 17572, 17252, 17103, and15859 /ha net return and 2.62, 2.83, 2.86, 2.39, 2.91 B: C ratio."

6. References

1. Alam MN, MS, Jahan MK, Ali MS, Islam Khandaker SMAT. Effect of vermicompost and N,P,K,S fertilizers on growth yield and yield components of red amaranth. Australian-Journal-of-Basic-and-Applied-Sciences. 2007;1(4):45-53.
2. Anonymous. Annual Report of All India Co-ordinate Research Project on MULLaRP Indian Institute of Pulse Research, Kanpur, 2001, Pp-66-67.
3. Anonymous. Effect of phosphorus and Seeds rate on growth and yield of bold seeded Kabuli chick pea (Annual Report 2001-2002). All India Co-ordinate Research project on chickpea, 2002, Pp-126.
4. Anonymous. Hand book of Agriculture. ICAR Publication, New Delhi India, 2007.
5. Arya RL, Varshney JG, Kumar Lalit. Effect of integrated nutrient applicationin chickpea+mustard intercropping system in the semi-arid tropics of North India. *Comm.* 2007.
6. Balyan JK, Singh Mahak. Effect of seed inoculation, different levels of irrigation and phosphorus on nodulation and root growth development of lentil. *Res. Crops*. 2005;6(1):32-34.
7. Bandyopadhyay S, Puste AM. Effect of integrated nutrient management on productivity and residual soil fertility status under different rice (*Oryza sativa*)-pulse cropping systems in rained lateritic belt of West Bengal. Indian Journal of Agronomy. 2002;47(1):33-40.
8. Chakraborty A. Growth and yield of lentil (*Lens culinaris* L.) as affected by boron and molybdenum application in lateritic soil. Journal of Crop and Weed. 2009;5:96-99.
9. Chandra R, Pareek N. effect of inoculation of different strains of *Rhizobium leguminosarum Bv. vaciae* on nodulation and yield of lentil genotypes. Legume Research. 2003;26(4):292-295.
10. Huang HC, Erickson RS. Effect of seed treatment with *Rhizobium leguminosarum* on Pythium damping-off, seedling height, root nodulation, root biomass, shoot biomass, and seed yield of pea and lentil. J Phytopathol. 2007;155(1):31-37.
11. Kanase AA, Mendhe SN, Khawale VS, Jarande NN, Mendhe J. Effect of integrated nutrient management and weed biomass addition on growth and yield of soybean. *J. Soils Crops*. 2006;16(1):236-239.
12. Karmakar Rajib, Chandra, Ramesh, Pareek RP. Influence of inoculation method and PSB on survival, mobility, strain competition and symbiotic performance of inoculated *Rhizobium* leguminosarum in lentil. Indian J Pulses Res. 2006;19(2):204-207.
13. Khan, Hakim, Ahmad, Farhad, Ahmad SQ, Sherin M, Bari Abdul. Effect of phosphorus fertilizer on grain yield of lentil. *Sarhad J. Agric*. 2006;22(3):433-436.
14. Khanna Veena, Sharma Poonam, Sekhon HS. Effect of *Rhizobium* inoculation and PGPR on nodulation and grain yield in lentil (*Lens culinaris* L.). Environ. Ecol. 2006;24(1):224-226.
15. Koreish EA, El-Fayoumy ME, Ramadan HM, Mohamed WH. Interaction effect of organic and mineral fertilization on faba bean and wheat productivity in calcareous soils. Alexandria J Agril. Res. 2004;49(2):101-114.
16. Kumar RP, Singh ON, Singh Yogeshwar, Sachchidan, Dwivedi, Singh JP. Effect of integrated nutrient management on growth, yield, nutrient uptake and economics of French bean (*Phaseolus vulgaris*). Indian J Agril. Sci. 2009;79(2):122-128.
17. Kumar Ravinder, Chandra R. Influence of PGPR and PSB on *Rhizobium* leguminosarum bv. Viciae strain competition and symbiotic performance in lentil. World J. Agril. Sci. 2008;4(3):297-301.
18. Kumar SHA, Uppar DS. Influence of integrated nutrient management on seed yield and quality of moth bean [*Vigna aconitifolia* (Jacq.) Marchel]. Karnataka J Agril. Sci. 2007;20(2):394-396.
19. Kumar Satish, Kumar Rakesh. Effect of FYM, phosphorus levels and biofertilizer on productivity of lentil. Crop-Research-Hisar. 2006;31(3):370-372.
20. Malik R. Genetic divergence analysis in lentil (*Lens culinaris* Medik). M.Sc. Thesis, Department of Agricultural Botany, Ch. Charan Singh University, Meerut (U.P.), India, 2005, 1pp.
21. Meena LK, Singh RK, Houtum RC. Effect of moisture conservation practice, phosphorus levels and bacterial inoculation on growth, yield and economics of chickpea (*Cicer arietinum* L.). Legume Research. 2006;29(1):68-72.
22. Nasser RR, Fuller MP, Jelling's AJ. Effect of elevated and nitrogen levels on lentil growth and nodulation. Agronomy for Sustainable Development. 2008;28(2):175-180.
23. Pathak Satyajit, Namdeo KN, Chakravarty VK, Tiwari RK. Effect of bio-fertilizers, diammonium phosphate and zinc sulphate on growth and yield of chickpea. Crop Research. 2003;26(10):42-46.
24. Patil HM, Tuwar SS, Wani AG. Studies on integrated nutrient management for pigeon pea + pearl millet intercropping system under dryland conditions. International J Agril. Sci. 2008;4(1):335-339.
25. Qados AMSA, Hozayn M. Magnetic water technology, increase growth, yield and chemical constituents of lentil (*Lens esculenta*) under greenhouse condition. American-Eurasian Journal of Agricultural and Environmental Science. 2010;7:457-462.
26. Rajkhowa DJ, Sakia M, Rajkhowa KM. Effect of vermicompost and levels of fertilizer on green gram. *Legume Research.* 2003;26(1):63-65.
27. Rajput RL, Pandey RN. Effect of method of application of bio-fertilizer on yield of pea (*Pisum sativum*). Legume Research. 2004;25(1):75-76.
28. Rajput RL, Kushwaha SS. Effect of integrated nutrient management on yield of pea (*Pisum sativum*). Legume Research. 2005;28(3):231-232.
29. Reddy Krishna SV, Ahlawat IPS. Dry matter accumulation and nutrient uptake in lentil (*Lens culinaris* Medik*)* in relation to cultivars, phosphorus, Zinc and bio-fertilizers. Research on crops. 2001;2(1):21-24.
30. Satyajit, Nanwal RK. Productivity and quality of Indian mustard (*Brassica juncea*) as influenced by integrated nutrient management treatments in semi-arid environment. Environ. Ecol. 2007;25(4):956-958.

31. Sharma BC, Sharma SC. Integrated nutrient management in lentil. *Adv. Pl. Sci*. 2004;17(1):195-197.
32. Singh Guriqbal. Effects of wheat straw and farmyard manure mulches on overcoming crust effect, improving emergence, growth and yield of soybean and reducing dry matter of weeds. Intern. J Agril. Res. 2009;4(12):418-424.
33. Singh Guriqbal, Sekhon HS, Sharma Poonam. Effect of *Rhizobium*, vesicular arbuscular mycorrhiza and phosphorus on the growth and yield of lentil (*Lens culinaris*) and field pea (*Pisum sativum*). Environ. Ecol. 2001;19(1):40-42.
34. Singh KK, Srinivasa Rao C, Masood Ali. Root growth, nodulation, grain yield, and phosphorus use efficiency of lentil as influenced by phosphorus, irrigation, and inoculation. Comm. Soil Science Pl. Anal. 2005;36(13/14):19191929.
35. Singh ON, Sharma M, Dash R. Effect of seed rate, phosphorus and FYM application on growth and yield of bold seeded lentil. Indian J Pulses Res. 2003;16(2):116-118.
36. Singh SB, Singh ON, Singh SK, Yadav SS, Rajput PK. Effect of fertility levels, PSB and vermi-compost on growth, yield and quality of large seeded lentil. J Food Legumes. 2007;20(1):52-54.
37. Singh Teekam, Rana KS. Effect of moisture conservation and fertility on Indian mustard (*Brassica juncea*) and lentil (*Lens culinaris*) intercropping system under rainfed conditions. Indian J Argon. 2006;51(4):267-270.
38. Singh Ummed, Saad AA, Singh SR, Kamal Uddin. Influence of genotypes and inoculation method on productivity of lentil (*Lens culinaris*) under dryland temperate conditions of Kashmir valley. Indian J Agril. Sci. 2008;78(8):671-675.
39. Singh YP, Chauhan CPS. Effect of Sulphur, phosphorus and inoculation treatments on yield, nitrogen uptake and biological N fixation by lentil crop. Crop Res. Hisar. 2004;27(1):77-82.
40. Singh YP, Chauhan CPS, Gupta RK. Effect of Sulphur, phosphorus and inoculation on growth, yield and Sulphur utilization by lentil (*Lens culinaris*). Indian J Agric. Sci. 2000;70(7):491-493.
41. Soil Sci. Pl. Anal. 38(1/2):229-240.
42. Vasanthi D, Subramanian S. Effect of vermicompost on nutrient uptake and protein content in black gram (*Cicer arietinum*). Legume Research. 2004;27(4):293-295.
43. Zaiden MS. Effect of organic manure and phosphorus fertilizers on growth, yield and quality of lentil plants in sandy soil. Res. J Agri. Biological Sci. 2007;3(6):748-7.