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Effect of phosphorus, zinc and their liquid biofertilizers on growth, yield attributes and yield of lentil (*Lens culinaris* Medik.)

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Abstract

A Field experiment was conducted in *Rabi* season 2019 at Instructional farm, College of Agriculture Kota, Rajasthan using lentil as a test crop to studies on effect of phosphorus, zinc and their liquid bio fertilizers on growth, yield attributes and yield of lentil. The experiment was laid out in randomized block design with 10 treatments *viz.* T_1 - Absolute control, T_2 - Recommended phosphorus dose (40 kg ha^{-1}), T_3 - $ZnSO_4$ 25 kg ha^{-1} soil application, T_4 - Biophos @ 5 ml kg^{-1}, T_5 - Biozinc @ 5 ml kg^{-1}, T_6 - Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}, T_7 - 50% RD phosphorus + Biophos @ 5ml kg^{-1}, T_8 - 12.50 kg $ZnSO_4$ + Biophos @ 5ml kg^{-1}, T_9 - 50% RD phosphorus + Biophos @ 5ml kg^{-1}+ Biozinc @ 5ml kg^{-1}, T_{10} - 50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1} and three replications with lentil variety Kota Masoor-3.

The result of field trial on response of lentil to application of phosphorus, zinc and their liquid biofertilizers showed synergistic effect on growth, yield attributes and yield of lentil. The results emerged out clearly indicated that use of 50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1} was found to be effective and significantly increase the growth and yield attributes of lentil crop *viz.* Plant height (25.97 cm), Chlorophyll content (3.05 mg g^{-1}), number of nodules $plant^{-1}$ (30.62), Fresh weight of nodules (37.04 mg $plant^{-1}$), number of pods $plant^{-1}$ (199.11), and number of seed pod^{-1} (1.71), seed yield (2337 kg ha^{-1}) and stover yield (4630 kg ha^{-1}), biological yield (6967 kg ha^{-1}) were also obtained. Among the treatments, application of Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1} combination along with 50% RD phosphorus + 12.5 kg $ZnSO_4$ inoculation showed superiority over all the treatments for improving growth, yield attributes and yield of lentil. Thus, it can be concluded that the application of Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1} combination along with 50% RD phosphorus + 12.5 kg $ZnSO_4$ recorded statistically superior in growth, yield attributes and yield of lentil as compared to alone application of recommended dose of phosphorus.

Keywords: Lentil, Biophos, Biozinc, growth, yield

Introduction

Agriculture began more than ten thousand years ago when gatherers and hunters turned into farmers, since then, pulses have been part of the human diet. Lentils (*Lens culinaris* Medik.), chickpeas (*Cicer arietinum* L.), peas (*Pisum sativum* L.) and bitter vetch (*Vicia ervilia* [L.] Willd.) are Neolithic founder crops, as they were among the plant species that were domesticated by early farming communities in the Fertile Crescent region and have since accompanied humankind. Pulses are nutrient-rich crops. They are an excellent source of plant-based protein and micronutrients and low in fat and high in dietary fibre. Eating pulses as part of a healthy diet can contribute to addressing the multiple facets of malnutrition, ranging from undernutrition and micronutrient deficiency to overweight and obesity. Furthermore, pulses and legumes in general, play an equally important role in soil health maintenance and improvement. These crops should not only be planted for an immediate return, namely high yields, but because they will also enrich the soil for subsequent crops. The United Nations General Assembly (UNGA) declared 2016 as the International Year of Pulses (IYP) to raise awareness about the importance of these plants and highlight their role in healthy diets and family farmers' livelihoods as well as their contribution to soil health and the environment. Additional benefits of pulses include helping to eradicate hunger, increase agricultural productivity, improve human health and reduce soil degradation (FAO, 2019) [8].

Lentil (*Lens culinaris* L. Medik.), locally known as masoor, is one of the most important *Rabi* season legume grown in India.

It is one of the most nutritious cool season and drought tolerant legumes. It contains about protein (24% - 26%), fat (1.3%), minerals (2.1%), fibre (3.2%) and carbohydrate (57%) (Ali *et al.*, 2017 and Singh *et al.*, 2013) [1]. Lentil makes use of atmospheric N_2 to fulfil its N requirements through biological nitrogen fixation (Badarneh and Ghawi 1994) [4]. Nitrogen fixation in legumes is governed by several factors like rhizobial strains as well N and P availability in the soil. Phosphorus (P) and nitrogen (N) play specific roles in symbiotic N_2-fixation process. Symbiotic nitrogen fixation has a high P demand indirectly because the process consumes large amounts of energy (Schulze *et al.*, 2006) [20] and energy generating metabolism strongly depends upon the availability of energy (Israel, 1987) [10].

The total pulses production in India is 24.42 million tonnes, lentil ranks next only to Chickpea in India, Lentil occupies 1.59 mha area and contributes 1.6 million tonnes in pulse production and productivity 1.01 ton ha^{-1} in the country, (Anonymous, 2020) [3].

Low productivity of lentil may be associated with many reasons such as inadequate and imbalanced fertilization and prevalence of suboptimum soil moisture condition. The lentil crop shows good response to phosphorus fertilization (Hussain *et al.*, 2002) [9]. *Rhizobium* and phosphate solubilizing bacteria are known to enhance the productivity of the crop as they increase the availability of soil nitrogen and phosphorus (El Sayed, 1999) [7]. Among the major nutrients phosphorus is considered to be one of the major limiting nutrient elements in pulse production in India. Phosphorus is one of the macronutrients required for biological growth and development. Bio-fertilizers are the products containing one or more carrier-based (Solid and Liquid) living species of microorganisms which have the ability to mobilize nutritionally important elements from non-usable to usable forms through biological process such as nitrogen-fixation, phosphate solubilisation or mobilization, excretion of plant growth promoting substances or cellulose and lignin biodegradation, to enhance the productivity of crop and soil. In brief, biofertilizers refer to living organisms which augment plant nutrient supplies in one way or the other, they are environment-friendly and cost-effective supplement to fertilizers and organic manures. Biofertilizers play a significant role in improving nutrient availability to crop plants. They are recognized as one of the components of (IPNS) integrated plant nutrient system (Rattan *et al.*, 2015) [19].

Materials and Methods

The experiment was conducted during *Rabi* season of 2019-20 at Agricultural Research Station, Ummedganj-Kota, Rajasthan. Geographically, The Kota situated at 25.21º N latitude and 75.86º E longitudes at an altitude of 271 meters above mean sea level. The experimental area falls under Agro-climatic Zone V (Humid South Eastern Plains) of Rajasthan. Kota is characterized by sub-tropical conditions having hot and dry summer months (April to June) followed by hot and humid month from July to September and cold winter during December to January. The average annual rainfall 575mm, about three fourth contribute from south-west monsoon during July to September. Winter rain receive during the months of December, January and February are scanty and occasionally. The experiment was laid out on Vertisols with ten treatment combination, replicated three times in randomized block. Test crop of field trial was lentil of variety Kota Masoor-3. 50 kg ha^{-1} seed was sowned manually with a spacing of 30 cm x 10 cm row to row and plant to plant. Observation was recorded at 30, 45, 60 DAS at harvesting of crop. The following observation were taken on growth and yield attributes of lentil are plant population (m^{-2}), plant height (cm), chlorophyll content mg g^{-1}, number of nodules $plant^{-1}$, fresh weight of nodules, dry weight of nodules, number of pods $plant^{-1}$, number of seeds pod^{-1}, seed yield (kg ha^{-1}), stover yield (kg ha^{-1}) and biological yield (kg ha^{-1}), Five place was randomly selected from each plot for counting the plant population (m^{-2}) with the help of one-meter scale. Mean value was taken. Randomly five plant were selected for measuring height (cm) with the help of meter scale, number of nodules $plant^{-1}$, number of pods $plant^{-1}$, and mean value was calculated. For counting the number of nodules $plant^{-1}$. The selected plant sample was uprooted carefully and wash with water for removing the soil mass adhered in roots and counted the pink coloured nodules. Mean value was recorded. To evaluate the best treatment for lentil, economics evaluation was done. Several economic indices are used to evaluate the profitability of plots *viz.* cost of cultivation, gross return, net return and benefit cost ratio.

Results and Discussion

Growth parameters

Application of different treatments of phosphorus, zinc and their liquid bio fertilizer significantly increased the plant height, chlorophyll content, number of nodules per plant, Fresh and dry weight of nodules of lentil (table 1 and 2). The application of (50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}) attained maximum value of these parameters. This may be attributed primarily to the beneficial effect of fertility on overall physical condition of the soil. The reason for better growth and development in the above treatment might be due to increased availability of zinc and phosphours to the plant initially through fertilizers, microbial inoculants then through phosphorus, zinc and their liquid bio fertilizer in the cropping season. The increase in growth attributes due to phosphorus helps in early root development and formation of lateral fibrous, healthy roots and root proliferation. P increases the metabolic activities and amount of naturally occurring phytohormones. PSB strains released greater amounts of available Phosphorus and this enable the plant to absorb more Phosphorus resulting in improved growth attributes. Similar results were reported by Kachave *et al.*, (2018) [12]. The better growth in terms of plant height, chlorophyll content, number of nodules $plant^{-1}$, fresh and dry weight of nodules per plant of lentil, due to application of (50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}) as compared to other treatments. The plant height was recorded at 30, 60 DAS, and at harvest. The result revealed that plant height was minimum upto 30 DAS but it was increased during 60 and at harvest due to increase in the age of crop. The plant height value ranges from 18.63cm at 30 DAS, 21.41cm at 60 DAS, and 25.97cm at harvest under different treatment. Significantly, maximum plant height value was 21.41cm recorded at 60 DAS and 25.97 at harvest under 50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1} and found superior among the treatments. This finding was confirmed by Anant *et al.*, (2021) [2], Kant *et al.*, (2016) [13] and Chauhan and Raghav, (2017) [5]. In our observation plants treated with zinc application show significant increase in total chlorophyll content as compare to absolute control plants (table 1 and 2). The maximum amount of chlorophyll was recorded at 45 DAS (3.05 mg g^{-1}) of the application of 50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}. These application finding are more closely related with those of Purushottam *et al.*, (2018) [18] and Kachave *et al.*, (2018) [12] while the result confirmed that the findings of Mishra and Prasad (2010) [16]. Almost similar trend was also noted with PSB inoculation which might be due to more availability of Phosphorus to plant that may stimulate formation of more nodules. Favourable effect on nodulation appears due to increased Phosphorus supply. The number of nodules decreased at absolute control with advancement of crop age and was significantly affected by different treatments (table 1 and 2). The maximum number of nodules at 45 DAS was recorded *i.e.* 30.62 in treatment T_{10} 50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}, which were superior to rest of the treatments, while minimum number of nodules was recorded in T_1 (Absolute control). Number of nodules at pertinent stage was increased by 68.42 percent in treatment T_{10} 50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1} over absolute control and this result is supported by Kant *et al*., (2016) [13]. Inoculation of T_{10} 50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1} individually increased the number of nodules and fresh and dry weight of root nodules significantly, Results clearly indicates that treatment T_{10} (50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}) attained the maximum fresh and dry weight of nodules of 37.04 mg $plant^{-1}$, 6.61 mg $plant^{-1}$, were reported by Kumar and Chandra (2008) [14], Navsare *et al.,* (2018) [17] and Kachave *et al.,* (2018) [12].

Yield attributes and yield

Application of different treatments significantly increased the yield attributes such as number of pods $plants^{-1}$, seeds pod^{-1} and test weight (table 3). The same trend was also observed in seed, straw and biological yield (table 3). The application of (50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}) attained maximum value of these parameters than rest of the treatments. The result showed that inoculation of phosphate and zinc solubilizing microbes significantly increase the number of pods $plant^{-1}$ in lentil and the result also indicates the positive effect of phosphate and zinc solubilizing microbes on number of pods $plant^{-1}$ ranges from 10 to 200 among different treatment. The result revealed significantly maximum number of pods $plant^{-1}$ 199.11 was recorded under T_{10} 50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}. This finding was confirmed by Anant *et al.,* (2021) [2] and Navsare *et al.,* (2018) [17]. The increased seed yield was obtained in organic manure combination with biofertilizers application (*Rhizobium* and PSB) could be attributed to the effect of growth hormones like IAA and cytokinin produced by *Rhizobium* which stimulated root morphology. Data pertaining to the efficacy of Phosphorus and inoculation of PSB on straw yield and grain yield of lentil presented in (table 3). The straw and grain yield of lentil was significantly increased by the application of different levels of Phosphorus alone while the maximum increased in straw and grain yield were reported under the treatment T_{10}-(50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}) (2337 and 4630 kg ha^{-1}) followed by T_2- Recommended phosphorus dose (40 kg ha^{-1}) (2219 and 4427 kg ha^{-1}) over absolute control. The increased in straw yield might be due to vigorous start to plant and strength straw yield by Phosphorus application. Similar results were reported by Kachave *et al.,* (2018) [12]. The increase in yield might have resulted from the growth regulating substances produced by biofertilizers besides fixation of additional nitrogen from atmosphere there by increasing nitrogen availability in the soil throughout the crop growth and this result was reported by Singh and Singh (2017) [21]. The beneficial effect of sulphur and zinc application on yield attributing characteristics have also been recorded by Choudhary *et al.,* (2014) [6] but combination of sulphur and zinc was not found to have significant effect on yield attributes. The maximum increased biological yield was reported under the treatment T_{10}-(50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}) with value of 6967 kg ha^{-1} compared to other treatments and it was revealed by Kant *et al*., (2016) [13].

Table 1: Effect of phosphorus, zinc and their liquid bio fertilizers on plant stand and plant height.

Treatment		Plant population (mrl^{-1})		Plant height (cm)		
		30 DAS	At harvest	30 DAS	60 DAS	At harvest
T_1	Absolute control	30.13	28.80	11.06	12.71	15.42
T_2	Recommended phosphorus dose (40 kg ha^{-1})	38.95	37.23	17.81	20.47	24.83
T_3	- $ZnSO_4$ 25 kg ha^{-1} soil application	35.32	33.76	14.27	16.40	19.90
T_4	Biophos @ 5 ml kg^{-1}	33.88	32.38	13.79	15.85	19.22
T_5	Biozinc @ 5 ml kg^{-1}	35.04	33.49	14.18	16.30	19.77
T_6-	Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}	34.70	33.16	14.34	16.48	19.99
T_7^1	50% RD phosphorus + Biophos @ 5ml kg-	36.88	35.25	15.92	18.30	22.19
T_8	12.50 kg $ZnSO_4$ + Biophos @ 5ml kg^{-1}	35.50	33.93	14.38	16.53	20.05
T_9	50% RD phosphorus + Biophos @ 5ml kg^{-1}+ Biozinc @ 5ml kg^{-1}	37.29	35.64	16.06	18.45	22.39
T_{10}-	50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}	39.32	37.58	18.63	21.41	25.97
S.Em. ±		2.10	1.79	0.71	1.11	0.98
CD at 0.05%		NS	NS	2.10	3.31	2.92

Table 2: Effect of phosphorus, zinc and their liquid bio fertilizers on chlorophyll content (mg g^{-1}), number of nodules per plant, fresh and weight of nodules mg $plant^{-1}$ at 45 DAS.

Treatment		Chlorophyll content at 45 DAS mg g^{-1}	Number of nodules $plant^{-1}$ at 45 DAS	Fresh weight nodules (mg $plant^{-1}$)	Dry weight of nodules (mg $plant^{-1}$)
	T_1- Absolute control	1.82	18.18	21.99	3.93
T_2	Recommended phosphorus dose (40 kg ha^{-1})	2.90	29.27	35.42	6.32
T_3	$ZnSO_4$ 25 kg ha^{-1} soil application	2.33	23.46	28.38	5.07
T_4	Biophos @ 5 ml kg^{-1}	2.26	22.66	27.42	4.90
T_5	Biozinc @ 5 ml kg^{-1}	2.33	23.31	28.20	5.04
T_6	Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}	2.34	23.57	28.51	5.09
T_7	50% RD phosphorus + Biophos @ 5ml kg^{-1}	2.60	26.17	31.65	5.65
T_8	12.50 kg $ZnSO_4$ + Biophos @ 5ml kg^{-1}	2.37	23.64	28.60	5.11
T_9	50% RD phosphorus + Biophos @ 5ml kg^{-1}+ Biozinc @ 5ml kg^{-1}	2.63	26.39	31.93	5.70
T_{10}	50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}	3.05	30.62	37.04	6.61
	S.Em. ±	0.07	1.25	2.01	0.30
	CD at 0.05%	0.22	3.70	5.97	0.88

Table 3: Effect of phosphorus, zinc and their liquid bio fertilizers on pods per plant, seed per pod and test weight, seed yield, haulm yield, biological yield and harvest index at harvest.

Treatment	Pods $plant^{-1}$		Seeds pod^{-1}	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (%)
T_1	Absolute control	118.22	1.29	1.99	1384	2750	4134	33.73
T_2	Recommended phosphorus dose (40 kg ha^{-1})	190.39	1.69	2.21	2219	4427	6645	33.59
T_3	$ZnSO_4$ 25 kg ha^{-1} soil application	152.54	1.52	2.16	1776	3549	5326	33.54
T_4	Biophos @ 5 ml kg^{-1}	147.38	1.50	2.15	1716	3424	5140	33.43
T_5	Biozinc @ 5 ml kg^{-1}	151.60	1.53	2.17	1766	3528	5294	33.31
T_6	Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}	153.27	1.54	2.17	1770	3529	5299	33.37
T_7	50% RD phosphorus + Biophos @ 5ml kg^{-1}	170.17	1.62	2.20	1994	3949	5943	33.62
T_8	12.50 kg $ZnSO_4$ + Biophos @ 5ml kg^{-1}	153.76	1.53	2.16	1795	3577	5371	33.47
T_9	50% RD phosphorus + Biophos @ 5ml kg^{-1}+ Biozinc @ 5ml kg^{-1}	171.63	1.60	2.16	2001	3989	5989	33.39
T_{10}	50% RD phosphorus + 12.5 kg $ZnSO_4$ + Biophos @ 5 ml kg^{-1}+ Biozinc @ 5 ml kg^{-1}	199.11	1.71	2.21	2337	4630	6967	33.61
S.Em. ±		7.96	0.08	0.07	76	206	217	1.69
CD at 0.05%		23.64	NS	NS	226	612	643	NS

References

1. Ali A, Ahmad B, Hussain I, Ali A, Shah FA. Effect of phosphorus and zinc on yield of lentil. Pure Appl. Biol. 2017;6(4):1397-1402.
2. Anant Sweety, Chandrakar DK, Das Debasis. Effect of phosphate and zinc solubilizing microbes on growth, yield and economics of fieldpea (*Pisum sativum* L.) under conditions of chhattisgarh. International Journal of Current Microbiology and Applied Sciences. 2021L10(03):635-642.
3. Anonymous, Agricultural Statistics at a Glance, Government of India, Ministry of Agriculture Cooperation and Farmers Welfare, Director of Economics and Statistics, 2020.
4. Badarneh DMD, Ghawi IO. Effectiveness of inoculation on biological nitrogen fixation and water consumption by lentil under rainfed conditions. Soil Biology and Biochemistry. 1994;26(1):1-5.
5. Chauhan and Raghav. Effect of phosphorus and phosphate solubilizing bacteria on growth, yield and quality of chickpea (*Cicer arietinum*) Annals of Plant and Soil Research. 2017;19(3):303-306.
6. Choudhary Pratibha, Jhajharia Arun, Kumar Rohit. Influence of sulphur and zinc fertilization on yield, yield components and quality traits of soybean (*Glycine Max* L.). An International Quarterly Journal of Life Sciences. 2014;9(1):137-142.
7. El-Sayed SAM. Influence of Rhizobium and phosphate-solubilizing bacteria on nutrient uptake and yield of lentil in the New Valley (Egypt). Egyptian Journal of Soil Sciences. 1999;39:175-186.
8. FAO. Final report of the international year of pulses. Food and Agriculture Organization of the United Nations, 2019.
9. Hussain M, Shah SH, Nazir MS. Differential genotypic response to phosphorus application in lentil (*Lens culinaris* Medic). Pakistan Journal of Agricultural Sciences. 2002;39:193-196.
10. Israel DW. Investigations of the role of phosphorus in symbiotic dinitrogen fixation. Plant Physiology. 1987;84:835-840.
11. Jones DL, Darrah PR. Amino-acid influx at the soil-root interface of Zea mays L. and its implications in the rhizosphere. Plant and Soil. 1994;163:1-12.
12. Kachave, *et al.* Effect of phosphorus and PSB on growth, yield and quality of blackgram [*Vigna mungo* (L.) in Inceptisol]. International Journal of Current Microbiology and Applied Sciences. 2018;7(7):3359-3365.
13. Kant S, Kumar A, Kumar S, Kumar V, Pal Y, Shukla AK. Effect of rhizobium, PSB and p-levels on growth, yield attributes and yield of Urdbean (Vigna Mungo L.). J Pure Appl Microbiol. 2016;10:3093-3099
14. Kumar Ravindra, Chandra R. Influence of PGPR and PSB on *Rhizobium leguminosarum* Bv. viciae strain competition and symbiotic performance in lentil, World Journal of Agricultural Sciences. 2008;4(3):297-301.
15. Maheswari NU, Elakkiya T. Effect of liquid bio fertilizers on growth and yield of urdbean (*Vigna mungo* L.). International Journal Pharmaceutical Sciences Review Research. 2014;29(2):42-45.
16. Mishra A, Prasad K. Synergism among Rhizobium,

phosphate solubilizing bacteria and plant growth promoting Rhizobacteria in field pea. International Journal of Applied Agriculture Research. 2010;5(1):25-30.

17. Navsare RI, Mane SS, Supekar SJ. Effect of potassium and zinc solubilizing microorganism on growth, yield and quality of mungbean. International Journal of Chemical Studies. 2018;6(1):1996-2000.
18. Purushottam, Saren BK, Puhup CS, Kumar Khirod, Sodi Bharti. Effect of irrigation scheduling and zinc application on chlorophyll content, zinc content, uptake and yield of chickpea (*Cicer arietinum* L.). Journal of Pharmacognosy and Phytochemistry. 2018;7(1):1834-1837.
19. Rattan RK, Katyal JC, Dwivedi BS, Sarkar AK, Bhattacharyya Tapas, Tarafdar JC, *et al*. Soil Science: An Introduction. Indian Society of Soil Science, 2015, 436-437.
20. Schulze J, Temple G, Temple SJ, Beschow H, Vance CP. Nitrogen fixation by white lupin under phosphorus deficiency. Annals of Botany. 2006;98(4):731-740.
21. Singh Ranjit, Singh AP. Effect of phosphorus, sulphur and biofertilizer on yield, quality and uptake of nutrients in cowpea (*Vigna unguiculata*). Annals of Plant and Soil Research. 2017;19(2):175-179.
22. Singh Dashrath, Singh RP. Effect of integrated nutrient management on growth, physiological parameters and productivity of lentil (*Lens culinaris* Medik.). International Journal of Agricultural Sciences. 2014;10(1):175-178.
23. Singh Y, Singh P, Sharma RD, Marko GS, Namdeo KN. Effect of organic sources of nutrients on growth, yield and quality of lentil genotypes. Annals of Plant and Soil Research. 2013;15(2):134-137.
24. Swarup A. Lessons from long term fertilizer experiments in improving fertilizer use efficiency and crop yields. Fertilizer news. 2002;47(12):59-73.