International Journal of Economic Plants 2022, 9(3):174-178

Full Research

Doi: HTTPS://DOI.ORG/10.23910/2/2022.454c

Assessment of Nutrient Availability and Microbial Soil Biomass under Different Level of Potassium Humate and Fertility in Mungbean (*Vigna radiata*)

Yogesh Kumar[1], Rajhans Verma[1], Kuldeep Singh[2*], Aakash[3] and Oma Shanker Bhukhar[2]

[1]Dept. of Soil Science, Sri Karan Narendra Agriculture University, Jobner, Rajasthan (303 329), India
[2]Dept. of Agronomy, Sri Karan Narendra Agriculture University, Jobner, Rajasthan (303 329), India
[3]Dept. of Agronomy, BHU, Varanasi, Uttar Pradesh (212 011), India

Corresponding Author

Kuldeep Singh
e-mail: kuldeeptamana4@gmail.com

Article History

Article ID: IJEP454c
Received on 02nd January, 2022
Received in revised form on 25th June, 2022
Accepted in final form on 14th July, 2022

Abstract

A field trial was conducted to study soil quality parameters influenced by different levels of potassium humate and fertility under mungbean cultivation at SKNAU, Jobner during *kharif* season of 2019. The experiment was carried out in a factorial randomized block design with three replications and sixteen treatment combinations. Along with nutrients status in the soil after harvest, soil microbial properties were assessed. The response of potassium humate and fertility levels on nutrient content and soil microbial properties were found to be significant. Application of potassium humate @ 4.5 kg ha^{-1} was recorded maximum OC (%), N, P_2O_5, K_2O (kg ha^{-1}), S, DTPA-Zn and Fe (mg kg^{-1}) (0.23, 158.22, 22.00, 178.00, 9.61, 4.21 and 0.64, respectively) followed by potassium humate @ 3 kg ha^{-1} over control. Among different fertility levels, 100% RDF recorded a significantly higher value of above available nutrients in soil over control but DTPA-Zn, Fe, S and OC% did not significantly affect by different fertility levels. Application of potassium humate @ 4.5 kg ha^{-1} and 100% RDF was recorded improved soil microbial biomass viz., microbial biomass C, N, P, dehydrogenase enzyme and alkaline phosphatase activity over control.

Keywords: Dehydrogenase enzyme, DTPA-Zn, potassium humate, soil microbial biomass and mungbean

1. Introduction

Pulses are the second most important crop grown in India after cereals. India is leader in pulse production despite it, India has import around 2 million tonne pulse per year (Kumar and Hiramath, 2018). Among pulse, mungbean plays a significant role in the economy as well as health sustainability of Indian people. Mungbean also knows as the golden bean, it is anannual crop thatcomes under fabaceae fabaceaefamily. In India, mungbean mainly cultivated during rainy season (Kumar et al., 2017). It has wider adapatability and grown in different season under varing climate condition in India (Nath et al., 2016). It has ahigh nutritive value containing 24-26% protein in which tryptophan and lysine amino acids are predominant (Kumar et al., 2013). Different types of minerals found in pulses are particularly iron, zinc and magnesium and vitamins like K and E. It is works as dual purpose crop which can be used for seeds as well as for forage (Davies and Stewart, 1987). Mungbean is a leading pulse crop with an area of 3.64 Mha and an annual production of 2.34 MT with the productivity of 8.72 q ha^{-1} (Anonymous, 2019).

So many factors affecting the yield and quality of soil, out of that one factor is imbalance nutrient use (Singh et al., 2018). Yield The yield potential of mungbean may be improved by mediating soil fertility and agronomic management practices. Addition The addition of organic substances during crop cultivation enhanced the soil microbial population and diversity (Rani et al., 2017). Humic substances are naturally occurring ligands create in soils predominantly which played life supporting multiple functions in the soil environment (Olaetxea et al., 2018). Potassium humate is the concentrated form of humus having the composition of 50–60% humic and N (3.71%), K (6.25%) and sulphur (0.55%). It enhanced proteins, sugars and fibres content in the plants and directly increasing the yield and quality of crops (Sharma et al., 2018). It also improves the physical properties of soil, i.e. soil aeration, soil structure, water infiltration rate, aggregation, soil tilth and hydraulic conductivity. Use The use of potassium humate as an modification for improving soil health and soil properties in such Indian soils are are viable option in low organic C soils (Tripura et al., 2017).

Soil fertility is the ability of soil to provide all essential plant nutrients in the available form in a balanced amount. Optimum nitrogen fertilizer application enhanced the crop yield of mungbean (Mondal et al., 2011). Different growth stages of mungbean responds in adifferent ways with nitrogen application rates. From the young stage to the nodule stage, the requirement of nitrogen in the mungbean is fulfilled by the nitrogen fixation in the mungbean. After the nodule stage accumulated nitrogen content sharply declines to fulfill the nitrogen requirement of a crop may be through the application of chemical N fertilizer. Application of optimum amount of nitrogen resultedin higher dry matter production by increasing in vegetative growth and photosynthetic rate.

Being a macronutrient potassium has a vital role in protein synthesis, photosynthesis, a resistantresistanceto pests and diseases, activation of a number of enzymes. Stomatal regulation is controlled by potassium through cell expansion and cell growth mechanisms. Potassium humate playes a great role in improving plant nutrient dynamics (Burhan et al., 2018). Potassium humate is an organic fertilizer and ishighly active in the soil system. It is a rich source of phenolic and carboxylic groups which influcence plant growth directly and indirectly by improving soil fertility. It acts as a chelating agent, which binds the metals and micronutrients and prevents to to leaching. Thus, maintain soil fertility levels and it also playing playinga important role in anion uptake kinetics, i.e. nitrate, phosphate etc (Lodi et al., 2013). It reduces the use of chemical fertilizers by improving fertilizers use efficiency. Potassium humate is an organic fertilizer and ishighly active in the soil system (Waqas et al., 2014). It increases the level of available potassium in soil and improves potassium uptake by the plant. It also reduced the losses and fixation of potassium in soil (Kumar *et al.,* 2013).

Therefore, keeping mentioned facts in view, the present study was undertaken to evaluate the efficacy of potassium humate and RDF on summer mungbean for better soil health and fertility of the soil.

2. Materials Methods

This field experiment was conducted at the agronomy farm, S.K.N. College of Agriculture Jobner located at 26°05” North latitude, 75°28″ East longitude and altitude of 427 metres above mean sea level during the *kharif* season of 2019 (3 months). The experiment was carried out in afactorial randomized block design with three replications and 16 treatment combinations. The experiment was comprised of four treatments of potassium humate (control, 1.5 kg ha^{-1}, 3.0 kg ha^{-1}, 4.5 kg ha^{-1}) and four treatments of fertility levels (Control, 50% RDF, 75% RDF and 100% RDF) were applied to the mungbean. The soil of theexperiment field was loamy sand in texture having alkaline ph (8.11), low in organic carbon (0.20%), available nitrogen (127.23 kg ha^{-1}), medium in available phosphorus (18.21 kg ha^{-1}) and potassium (192.15 kg ha^{-1}). Fertilizers were applied as per treatment through diammonium phosphate (DAP) containing 46% P_2O_5 and 18% N and urea containing 46% N at the time of sowing as per treatment and the entire dose of potassium humate was thoroughly mixed in the soil before sowing of the crop. Potassium humate was applied in the soil as per treatment. The required quantity of seeds (25 kg ha^{-1}) was treated with rhizobium culture and phosphorus solubilising bacterial (PSB) before sowing @ 20 g kg^{-1} of seed. The seeds were sown in arow drawn 30 cm apart. Plant to plant spacing was maintained at 10cm with 5cm deep of variety RMG- 492. Irrigation wasapplied in thefield only one time at 34 DAS.

Walkley and Black method, alkaline permanganate method, 0.5 M sodium bicarbonate method, ammonium acetate extraction method and 0.15% $CaCl_2$ method is used for soil organic carbon, available N, P, K and S estimation, respectively. DTPA-$CaCl_2$-TEA method is used for micronutrients estimation. Soil microbial biomass carbon estimate by $CHCl_3$ method (Jenkinson and powlson, 1976), microbial nitrogen and phosphorus by $CHCl_3$ fumigated method (Brookes et al., 1982). Dehydrogenase and alkaline phosphatase activity wereestimated by using themethod given by (Casida et al., 1964 and Tabatabai and Bremner, 1970, respectively). Experimental data were analyzed using analysis of variance (ANOVA) as per Factorial Randomized Block Design (Gomez and Gomez, 1984). Significa the significance of the treatments weretested using theF test with a 5% level of significance (p< 0.05) and the means were compared using the least significant difference (LSD) test at α=0.05.

3. Result and Discussion

3.1. Nutrient availability in the soil after harvest

Potassium humate: Data mentioned in Table 1 indicated that available OC, N, P_2O_5, K_2O, S, DTPA-Zn and Fe were significantly

Table 1: Effect of potassium humate and fertility levels on organic carbon (%), available N, P_2O_5, K_2O content (kg ha^{-1}) and S (mg kg^{-1}) in soil at harvest of the mungbean

Treatments	Organic carbon	Available N	Available P_2O_5	Available K_2O	Available S
Potassium humate					
K0 (control)	0.205	129.19	8.56	144.15	8.11
K_1 (1.5 kg ha^{-1})	0.215	139.25	19.55	156.44	8.65
K_2 (3.0 kg ha^{-1})	0.223	148.98	20.81	167.31	9.15
K_3 (4.5 kg ha^{-1})	0.231	158.22	22.00	178.00	9.61
SEm±	0.002	3.06	0.39	3.54	0.15
CD (p=0.05)	0.007	8.83	1.14	10.21	0.43
Fertility levels					
F_0 (Control)	0.203	129.51	9.34	143.48	8.12
F_1 (50% RDF)	0.214	139.34	19.57	156.06	8.66
F_2 (75% RDF)	0.224	148.82	20.76	167.72	9.14
F_3 (100% RDF)	0.232	157.96	21.91	178.64	9.60
SEm±	0.002	3.06	0.39	3.54	0.15
CD (p=0.05)	NS	8.83	1.14	10.21	NS

affected due to potassium humate. Application of potassium humate @ 4.5 kg ha^{-1} was recorded maximum OC (%), N, P_2O_5, K_2O (kg ha^{-1}), S, DTPA-Zn and Fe (mg kg^{-1}) (0.23, 158.22, 22.00, 178.00, 9.61, 4.21 and 0.64, respectively) followed by potassium humate @ 3 kg ha^{-1} over control. Potassium humate acts as achelating agent which binds the metals and micronutrients to itself and prevents from leaching of essential nutrients. Application of potassium humate significantly increased the mineralization of organic P which increased plant available P in soil. The results were also corroborated with the finding of Hemida (2017).

Fertility level: DTPA-Zn, Fe, S and OC% were did not significantly affected due to potassium humate. Application of 100% RDF was found maximum maximum N, P_2O_5 and K_2O (kg ha^{-1}) (157.96. 21.91 and 178.64, respectively) followed by 75% RDF over control. Initial application of nitrogen and phosphorus improves root growth and nodulation of mungbean, this leads to more nitrogen fixation and phosphorus availability to the soil. The application of 100 per cent RDF significantly increased the organic carbon, available N, P_2O_5 and K_2O content in thesoil. The results were also in agreement with those of Hemida (2017) (Table 2).

Table 2: Effect of potassium humate and fertility levels on DTPA- Zn and Fe (mg kg^{-1}) content in soil at harvest of the mungbean

Treatments	DTPA-Fe	DTPA-Zn
Potassium humate		
K_0 (control)	3.31	0.44
K_1 (1.5 kg ha^{-1})	3.72	0.53
K_2 (3.0 kg ha^{-1})	3.99	0.59
K_3 (4.5 kg ha^{-1})	4.21	0.64
SEm±	0.07	0.01
CD (p=0.05)	0.21	0.04
Fertility levels		
F_0 (Control)	3.28	0.43
F_1 (50% RDF)	3.71	0.52
F_2 (75% RDF)	4.00	0.60
F_3 (100% RDF)	4.24	0.65
SEm±	0.07	0.01
CD (p=0.05)	NS	NS

Nitrogen budgeting: the data pertaining to N budgeting are given in Figure 1. Among potassium humate levels, higher actual gain (35.72 kg ha^{-1}) N over initial soil available nitrogen was recorded in potassium humate @ 4.5 kg ha^{-1}. However, the apparent gain was recorded also higher in potassium humate @ 4.5 kg ha^{-1} (101.56 kg ha^{-1}). Under different fertility levels, application of 100% RDF was recorded higher actual and apparent gain (30.63 and 96.81 kg ha^{-1}) followed by 75% RDF (21.49 and 85.14 kg ha^{-1}).

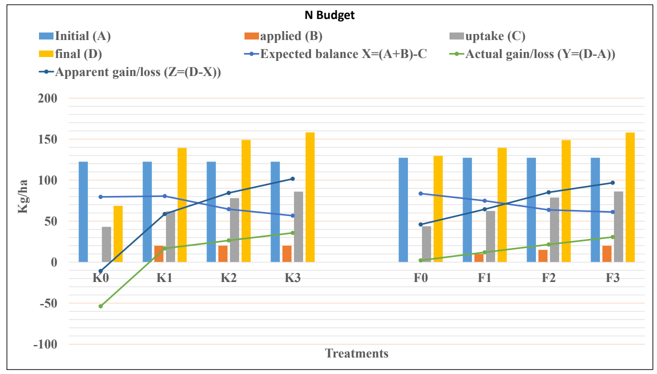

Figure 1: Effect of potassium humate and fertility level on nitrogen budgeting

Phosphorus budgeting: the data pertaining to P budgeting are given in Figure 2. Among potassium humate levels, higher actual gain (3.79 kg ha^{-1}) P over initial soil available phosphorus was recorded in potassium humate @ 4.5 kg ha^{-1} but actual phosphorus loss washigher under control. Minimum apparent loss under control but higher under potassium humate @ 1.5 kg ha^{-1}. Among different fertility levels, higher actual gain under 100% RDF but lowest actual gain under control.

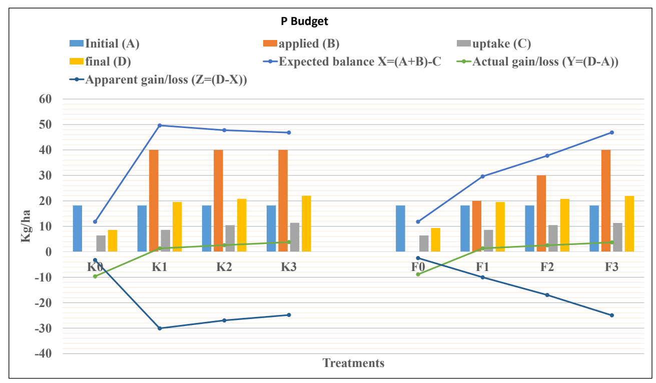

Figure 2: Effect of potassium humate and fertility level on phosphorus budgeting

3.2. Soil microbial properties

Potassium humate: The data presented in Table 3 showed that the microbial biomass carbon, nitrogen and phosphorus of the soil at harvest of the crop was increased with increasing level of potassium humate up to 4.5 kg ha^{-1}. Significantly highest microbial biomass carbon, nitrogen and phosphorus content (µg g^{-1} soil) (230.48, 49.40 and 36.76, respectively) in the soil at harvest of the crop was recorded under potassium humate@4.5 kg ha^{-1} followed by potassium humate@ 3.0 kg ha^{-1}.

Fertility level: Significantly highest microbial biomass carbon, nitrogen and phosphorus content (µg g^{-1} soil) (231.28, 49.75 and 36.89, respectively) in the soil at harvest of the crop was recorded under 100% RDF followed by 75% RDF over control.

3.3. Dehydrogenase enzyme and Alkaline phosphatase activity

Potassium hum ate: Data presented in Table 4 revealed that

Table 3: Effect of potassium humate and fertility levels on microbial biomass C, N and P (µg g^{-1} soil) at harvest of the mungbean

Treatments	Microbial biomass		
	C	N	P
Potassium humate			
K_0 (control)	177.88	36.61	28.69
K_1 (1.5 kg ha^{-1})	200.15	42.02	31.70
K_2 (3.0 kg ha^{-1})	215.69	45.97	34.69
K_3 (4.5 kg ha^{-1})	230.48	49.40	36.76
SEm±	4.95	1.18	0.68
CD (p=0.05)	14.29	3.41	1.97
Fertility levels			
F_0 (Control)	177.12	36.34	28.25
F_1 (50% RDF)	199.35	41.68	31.84
F_2 (75% RDF)	216.46	46.23	34.87
F_3 (100% RDF)	231.28	49.75	36.89
SEm±	4.95	1.18	0.68
CD (p=0.05)	14.29	3.41	1.97

Table 4: Effect of potassium humate and fertility levels on enzymetic activites of soil at harvest of the mungbean

Treatments	Dehydrogenase	Alkaline phosphatase
	(µg TPF g^{-1} soil 24 h^{-1})	(µg PNP produced g^{-1} soil 24 h^{-1})
Potassium humate		
K_0 (control)	116.14	10.15
K_1 (1.5 kg ha^{-1})	124.96	10.79
K_2 (3.0 kg ha^{-1})	132.97	11.32
K_3 (4.5 kg ha^{-1})	139.64	11.79
SEm±	2.29	0.16
CD (p=0.05)	6.61	0.46
Fertility levels		
F_0 (Control)	115.77	10.13
F_1 (50% RDF)	125.16	10.77
F_2 (75% RDF)	133.01	11.32
F_3 (100% RDF)	139.77	11.83
SEm±	2.29	0.16
CD (p=0.05)	6.61	0.46

the Dehydrogenase enzyme and alkaline phosphatase activity was significantly increased due to the application of increasing levels of potassium humate over control. Application of potassium humate@4.5 kg ha^{-1} was recorded highest Dehydrogenase enzyme (µg TPF g $soil^{-1}$ $24hr^{-1}$) and alkaline phosphatase activity (µg PNP produced g^{-1} soil hr^{-1}) (139.64 and 11.79) followed by potassium humate @ 3.0 kg ha^{-1}. Application of potassium humate @ 4.5 kg ha^{-1} enhanced the dehydrogenase enzyme activity by 20.23, 11.75 and 5.02 per cent higher over control, potassium humate @1.5 kg ha^{-1} and 3.0 kg ha^{-1}, respectively. The increased in microbial biomass C, N, P and enzymatic activities were improved by theapplication of organic matter that applied to soil would serve as a "food" source for microorganisms and organic matter serves as two main functions for microorganisms, providing energy for growth and suppling carbon for the formation of thenew cell. It increased the soil microbial population and diversity in soil which is very help full for nutrient transformation during crop growth. This was confirmed by Vallini et al., 1993 These findings were also aggremetswith Tripura et al. (2017) and Hemida et al. (2017).

Fertility levels: Application of 100% RDF was recorded significantly highest Dehydrogenase enzyme (µg TPF g^{-1} soil 24 hr^{-1}) and alkaline phosphatase activity (µg PNP produced g^{-1} soil hr^{-1}) (139.77 and 11.83) followed by 75% RDF. 100% RDF registered an increase of 16.78, 9.84 and 4.51 per cent in alkaline phosphatase activity over control, 50% RDF and 75% RDF, respectively. Dehydrogenase activity and alkaline phosphatase activity in the soil after harvest of the crop were significantly increased with the application of SSP+PROM in green gram (Yadav et al., 2013). Application of P upto 40 kg P_2O_5 ha^{-1} significantly increases microbial biomass carbon The amount of microbial biomass P and phosphatase activity were found to be the highest under combined application of 100%RDF+FYM and declined with increased rates of fertilizer application (Santhy et al., 2004). Phosphate enzyme activity and community composition of P-solubilizing bacteria was wassignificantly higher in the N treatment than in the control across all soils has hasbeen reported by Widdiy et al. (2019).

4. Conclusion

Potassium humate enhanced nutrient contents in soil and had positive effects on soil microbial count. Based on the present finding of the experiment it may be concluded that application of potassium humate @ 4.5 kg ha^{-1} and 100% RDF may be recommended to improve nutrient availability, soil microbial biomass and soil health.

5. References

Anonymous, 2019. 3rd advance estimate, Ministry of Agriculture and Farmers Welfare, Government of India, Available at https://pib.gov.in/PressReleasePage.aspx?PRID=1624044

Brookes, P.C., Powlson, D.S., Jenkinson, D.S., 1982. Measurement of microbial biomass phosphorus in soil. Soil Biology and Biochemistry 14, 319–329.

Burhan, A.K., Duraid, K.A., Taey, A.L., 2018. Effect of potassium humate, humic acid, and compost of rice wastes in the growth and yield of two cultivars of Dill under salt stress conditions. Advances In Natural and Applied Sciences 12(11), 1–6.

Casida, L., Klein, D., Santoro, T., 1964. Soil dehydrogenase activity. Soil Science 98, 371–376.

Davies, S., Stewart, A., 1987. Nutritional Medicine, Richard clay Ltd., Bungay, Suffolk.

Gomez, K.A., Gomaz, A.A., 1984. Statistical Procedures for Agricultural Research. J. Wiley and Sons, Singapore.

Hemida, K., Eloufey, A., Mohamed, A., Rady, M., 2017. Integrated effect of potassium humate and α- tocopherol applications on soil characteristics and performance of Phaseolus vulgaris plants grown on a saline soil. Archives of Agronomy and Soil Science 63, 1556–1571.

Jenkinson, D.S., Powlson, D.S., 1976. The effects of biocidal treatments on metabolism in soil. V. A method for measuring soil biomass. Soil Biology and Biochemistry 8, 209–213.

Kumar, D., Singh, A.P., Raha, P., Rakshit, A., Singh, C.M., Kishor, P., 2013. Potassium humate a potential soil conditioner and plant growth promoter. International Journal of Agriculture, Environment and Biotechnology 6, 441–446.

Kumar, M.R., Hiremath, S.M., 2018. Bio–efficacy of imazethapyr in rainfed greengram. Annals of Reviews and Research 4(1), 555-627.

Kumar, N., Hazra, K.K., Nadarajan, N., 2017. Efficacy of pre- and post-emergence herbicides in rainy season greengram *(Vigna radiata).* Indian Journal of Agricultural Science 87(9), 1219–1224

Lodhi, A., Tahir, S., Iqbal, Z., Mahmood, A., Akhtar, M., Qureshi, T.M., Naeem, A., 2013. Characterization of commercial humic acid samples and their impact on growth of fungi and plants. Soil Environment 32, 63–70.

Mondal, M.M.A., Rahman, M.A., Akter, M.B., Fakir, M.S.A., 2011. Effect of foliar application of nitrogen and micronutrients on growth and yield in mungbean. Legume Research 34(3), 166–171.

Nath, C.P., Das, T. K., Rana, K.S., 2016. Effects of herbicides and tillage practices on weeds and summer mungbean (*Vigna radiata*) in wheat (*Triticum aestivum*)-mungbean cropping sequence. Indian Journal of Agricultural Science 86(7), 860–864.

Olaetxea, M., Hita, D., Garcia, A., Fuentes, M., Baigorri, R., Mora, V., Garica, M., Urrutia, O., Erro, J., Zamarreno, A.M., Berbara, R.L., Garcia-Mina, J.M., 2018. Hypothetical framework integrating the main mechanisms involved in the promoting action of rhizospheric humic substances on plant root- and shoot growth. Applied Soil Ecology 123, 521–537.

Rani, Y.S., Triveni, U., Patro, T.S., 2017. Integrated Nutrient Management for Enhancing the Soil Health, Yield and Quality of Little Millet (*Panicum sumatrense*). International Journal of Bio-resource and Stress Management 8(1), 26–32.

Santhy, P., Vijila, K.D., Dhakshinamoorthy, M., 2004. Studies on soil microbial biomas, labile P and phophate activity under continuous intensive cultivation in an inceptisol. Annals of Agricultural Research 25, 38–42.

Sharma, P., Bhatt, A., Jyoti, B., 2018. Effect of seed bio-priming with microbial inoculants on plant growth, yield and yield contributing characters in soybean [*Glycine max* (L.) Merril]. International Journal of Economic Plants 5(2), 53–58.

Singh, S.P., Yadav, R.S., Kumawat, A., Jakhar, R.R., 2018. Productivity augmentation of greengram (*Vigna radiata*) through weed management. Legume Research 41(3), 410–415

Tabatabai, M.A., Bremner, J.M., 1970. An alkaline oxidation method for determination of total sulfur in soils. Soil Science Society of America Journal 34, 62–65.

Tripura, P., Kumar, S., Verma, R., 2017. Effect of potassium humate and bio-inoculants on nutrient content, uptake and quality of cowpea [*Vigna unguiculata* (L.) Walp]. Journal of Food Legumes 30(3), 195–197.

Vallini, G., Pera, A., Avio, L., Valdrighi, M., Giovannetti, M., 1993. Influence of humic acids on laurel growth, associated rhizospheric microorganisms, and mycorrhizal fungi. Biology and Fertility of Soils 16, 1–4.

Waqas, M., Ahmad, B., Arif, M., Munsif, F., Khan, A.L., Amin, M., Lee, I.J., 2014. Evaluation of humic acid application methods for yield and yield components of mungbean. American Journal of Plant Sciences 2(3), 203–208.

Yadav, K.R., 2013. Effect of phosphorus source and phosphorus solubilizing microorganism on performance of mungbean [*Vigna radiata* (L.) growth in entisol. M.sc. thesis, SKRAU.