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Research Article

EFFECT OF POTASSIUM HUMATE AND BIO-INOCULANTS ON COWPEA [*Vigna unguiculata* L. WALP] INFLUENCE OF SOIL FERTILITY, ENZYMATIC ACTIVITY AND MICROBIAL POPULATION IN SOIL

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Abstract- To study the effect of potassium humate and Bio-inoculants on soil fertility, Enzymatic activity and microbial population in soil of cowpea, a pot experiment was laid out during *kharif*, 2014 on loamy sand soil, at S.K.N. College of Agriculture, Jobner according to completely randomized block design with three replications. The treatments consisting of three levels of potassium humate (control, 5 and 10 mg kg^{-1}) and five bio-inoculants (no inoculation, Rhizobium + VAM, Rhizobium + PSB, VAM+PSB and Rhizobium + VAM + PSB) were applied. The application of potassium humate @ 10 mg kg^{-1} and seed inoculation with Rhizobium+VAM, Rhizobium+ PSB, VAM+PSB and Rhizobium+VAM+ PSB significantly increased the organic carbon, available nitrogen, phosphorus and potassium, microbial population (bacteria, fungi, actinomycetes), enzymatic activities (alkaline phosphatase and dehydrogenase activity) in soil at harvest stage of the crop than control, while, pH and EC of soil decreased non significantly at harvest.

Keywords- Potassium humate, Bio-inoculants, Soil fertility, Enzymatic activity, Microbial population.

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Introduction

Cowpea [*Vigna unguiculata* L. Walp] commonly known in India as *lobia* is one of the important *kharif* pulse crops grown for vegetable, grain, forage and green manuring. Green tender pods are used as vegetable, the vegetable cowpea pods contain moisture 84.6%, protein 4.3%, carbohydrate 8.0% and fat 0.2% it is also rich a source of calcium, phosphorus and iron. In India, cowpea was grown over an area of 25.43 m ha with production of 19.27 mt [1]. In Rajasthan, cowpea covers an area of 0.61 lakh ha with a production of 0.33 lakh tonnes [2]. Soil is a living biological system containing billion of microorganism. These microorganisms feed on soil organic matter and break it down into humus. Potassium humate is the potassium salt of humic acid having 50 % humic and 12 % potassium. It is used in agriculture as a fertilizer additive to in agriculture increase the use efficiency of fertilizers especially nitrogen and phosphorus based fertilizer inputs. The losses of soil and releasing elements as available nutrients and providing the stimulus environment for microbial activity. It is substantially increasing proteins, fibers, and sugars which help improve quality and yields [3]. Bio fertilizers are microbial inoculants or carrier based preparations containing living or latent cells of efficient strains of nitrogen fixing, phosphate is solubilizing and cellulose decomposing microorganisms intended for seed or soil application and designed to improve soil fertility and plant growth by increasing the number and biological activity of beneficial microorganisms in the soil. Bio fertilizers produced from P and K rocks and elemental sulfur inoculated with oxidizing bacteria produces sulfuric acid and release nutrients [4]. However, to provide N for plants and to control the effects of the low pH, the rock bio fertilizers need to be mixed with organic matter with a high pH [5]. The incorporation of organic matter in the soil and the addition of arbuscular mycorrhizal fungi are methods that promotes oil fertility and plant growth by increasing the nutrient availability and nutrient absorption, especially in reference to P a nutrient that is found in low levels in tropical soils [6, 7]. They are composting the area with the objective of increasing the number of such microorganisms and accelerate microbial process to augment to extent of the availability of the nutrient in a form, which can easily assimilated by plant [8]. The *Rhizobium* as fertilizer in pulses could fix 50-200 kg of N/ha/season and is able to meet 80-90% of the crop requirement for nitrogen. It includes mainly the nitrogen fixing, phosphate solubilizing and plant growth-promoting microorganisms [9].

MaterialsandMethods

The pot experiment was conducted in cage house of Department of Plant Physiology and laboratory analysis of plant and soil samples were analysed in Department of Soil Science and Agricultural Chemistry, S.K.N. College of Agriculture, Jobner (Rajasthan) during the *kharif* season, 2014. Entire dose of potassium humate was thoroughly mixed in soil before sowing of the crop. The cowpea variety RC-19 was treated with Rhizobium+ VAM, Rhizobium + PSB, VAM + PSB and Rhizobium + VAM + PSB seed followed by *Rhizobium* inoculation. 10 treated seed per pot were sown on 25^{th} July, 2014 and after germination, only five plants per pot were maintained. The crop was harvested on 29^{th} September, 2014. Measured volume (1.25 litres) of water was applied to each pot according to plan of experiment. Besides one pre sowing irrigation six subsequent irrigations were given on field capacity of 11.5 per cent. The soils were collected from experimental pots and left for air dry in processing laboratory. After dried samples were ground and sieved through 2 mm sieve and stored in plastic bags. The chemical and biological properties of the processed soil samples were determined by following the standard procedure. A soil water suspension

Table-1 *Effect of potassium humate and bio-inoculants on soil properties after harvest of cowpea*

Treatments	pH_2	EC_2 (dsm^{-1})	Organic carbon (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
Potassium humate						
Control (KH_0)	8.44	2.41	0.239	119.34	16.09	148.46
5 mg/kg (KH_1)	8.30	2.33	0.258	135.11	20.70	172.21
10 mg/kg (KH_2)	8.19	2.25	0.273	144.62	21.63	190.03
SEm±	0.16	0.04	0.005	2.64	0.38	3.36
CD (p= 0.05)	NS	NS	0.014	7.66	1.09	9.73
Bio-inoculants						
Control (B_0)	8.45	2.44	0.242	118.56	15.84	151.23
Rhizobium + VAM (B_1)	8.34	2.35	0.259	134.42	19.64	174.24
Rhizobium + PSB (B_2)	8.32	2.33	0.262	136.22	19.92	175.92
VAM + PSB (B_3)	8.28	2.29	0.253	129.24	20.31	169.22
Rhizobium + VAM + PSB (B_4)	8.18	2.24	0.268	146.68	21.66	180.56
SEm±	0.20	0.06	0.006	3.41	0.49	4.34
CD (p= 0.05)	NS	NS	0.018	9.88	1.41	12.57

Table -2 *Effect of potassium humate and bio-inoculants on Enzymatic activity and Microbial population in soil at harvest of cowpea.*

Treatments	Dehyrogenase enzyme activity (P kat kg^{-1} soil))	Alkaline phosphatage enzyme activity (µml PNP produced g^{-1} soil hr^{-1})	Microbial population		
			Bacteria (x 10^{-7} g^{-1})	Fungi (x 10^{-4} g^{-1})	Actinomycetes (x 10^{-4} g^{-1})
Potassium humate					
Control (KH_0)	5.82	8.79	0.68	0.47	0.73
5 mg/kg (KH_1)	6.15	9.84	0.79	0.58	0.88
10 mg/kg (KH_2)	6.34	10.73	0.82	0.64	0.92
SEm±	0.13	0.20	0.02	0.01	0.02
CD (p= 0.05)	0.37	0.57	0.05	0.04	0.05
Bio-inoculants					
Control (B_0)	5.81	8.54	0.66	0.46	0.72
Rhizobium + VAM (B_1)	6.14	9.96	0.79	0.58	0.87
Rhizobium + PSB (B_2)	6.21	10.12	0.80	0.60	0.89
VAM + PSB (B_3)	6.03	9.58	0.76	0.55	0.83
Rhizobium + VAM + PSB (B_4)	6.33	10.75	0.82	0.65	0.93
SEm±	0.17	0.26	0.02	0.02	0.02
CD (p= 0.05)	0.48	0.74	0.06	0.05	0.07

was prepared in the ratio of 1: 2.5 (10 g soil and 25 ml of distilled water) and pH_2 (1:2 soil water suspension) was recorded with the help of glass electrode pH meter and EC_2 was measured with the help of EC meter and expressed as dS m^{-1} [10], Organic Carbon [11], Available N [12], Available P [13], Available K [10], Dehydrogenase activity [14], Alkaline phosphatase activity [15] and Total bacteria, fungi and actinomycetes were estimated by following the serial dilution and plating technique as described by [16].

Results

Effect on soil chemical properties

It is evident from the data summarized in [Table-1] that with the application of potassium humate, there was a significant increase available nitrogen, phosphorus and potassium in soil under treatments KH_1 and KH_2 as compared to control(KH_0) after harvest. An examination of data in [Table-1] revealed that after of the crop due to inoculation of cowpea seed with *Rhizobium* + VAM, *Rhizobium* + PSB, VAM + PSB and *Rhizobium* + VAM + PSB, there was a significant increase in available nitrogen, phosphorus and potassium in soil in comparison to no inoculation. The increase in available nitrogen, phosphorus and potassium in soil of cowpea with *Rhizobium* + VAM + PSB was significantly higher over *Rhizobium* + VAM, *Rhizobium* + PSB as well as VAM + PSB inoculations.

Effect on Soil microbial population and enzyme activity

It is evident from the data summarized in [Table-2] with the application of potassium humate there was a significant increase microbial population (bacteria, fungi and actinomycetes) and enzymatic activity (Alkaline phosphatase and Dehydrogenase activity) in soil under treatments KH_1 and KH_2 as compared to control (KH_0) after harvest. An examination of data in [Table-2] revealed that after of the crop due to inoculation of cowpea seed with *Rhizobium* + VAM, *Rhizobium* + PSB, VAM + PSB and *Rhizobium* + VAM + PSB, there was a significant increase microbial population (bacteria, fungi and actinomycetes) and enzymatic activity (Alkaline phosphatase and Dehydrogenase activity) in soil in comparison to no inoculation. The increase in microbial population (bacteria, fungi and actinomycetes) and enzymatic activity (Alkaline phosphatase and Dehydrogenase activity) in soil of cowpea with *Rhizobium* + VAM + PSB was significantly higher over *Rhizobium* + VAM, *Rhizobium* + PSB as well as VAM + PSB inoculations and no inoculation. Inoculation of *Rhizobium*+PSB+VAM significantly increased soil microbial population compared to no inoculation. Data presented in [Table-2] show that inoculation of biofertilizer viz. *Rhizobium*+ PSB+VAM significantly increased the dehydrogenase activity in soil. The application of Rhizobium +PSB+VAM significantly enhanced the alkaline phosphatase activity in soil at harvest of cowpea over no inoculation of bio fertilizer. Increased microbial and root activity in the rhizosphere may generally account for higher activity including phoshpatase [17] and [18].

Discussion

Effect on soil chemical properties

One of the most striking characteristics of humic acids in soils and other environments is their ability to interact with metal ions and soil minerals to form complexes of varying properties and increasing chemical stability [19]. [20] also found that application of humic acid increased the mineralization of organic P which enhance plant available P in soil. The results corroborate the finding of [21-23] who also observed increase in organic carbon, available nitrogen, phosphorus and potassium by the use of potassium humate. The bio fertilizers have important role in improving nutrient supplies to soil and also have long term impact without any adverse effects [24]. Inoculation of seed with nitrogen fixers might have increased the concentration of an efficient and healthy strain of *Rhizobium* bacteria in the root nodules which in turn might have resulted in greater fixation of atmosphere N consequently having higher accumulation of nitrogen in the soil. The microorganism is also responsible for providing favorable physical properties, which help in the mineralization of soil nutrient leading to higher available phosphorus and potassium. The beneficial effect of micro-organism on potassium availability includes minimization of the losses from leaching through the action of organic acids, released during decomposition and also minimizing losses due to fixation [25]

Effect on Soil microbial population and enzyme activity

The increase in microbial population and enzymatic activities were expected since any form of organic matter applied to soil would serve as a “food” source for microorganisms. This was confirmed by [26] who reported increased bacterial and actinomycete growth and activity in soil on account of humic acid application. The results find support from the work of [27-29] who also observed an increase in the soil microbial population (bacteria, fungi and actinomycetes) and enzyme activities with application of potassium humate. Use of bio fertilizer significantly increased the crop productivity and thereby provided substrate essential for microbial growth and activity, which probably responsible for this increase in soil microbial population. The low content in control could be due to no addition of any external input into the soil and over by poor crop productivity. Similar result was also reported by [30].

Conflict of Interest: None declared

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