SOIL MICROBIAL PROPERTIES AS INFLUENCED BY APPLICATION OF PHOSPHATE AND POTASH SOLUBILIZING BACTERIA TO WHEAT (*Triticum aestivum* L.)

***SAVALIYA, NAYANA V.; BHADU, VIPEN; GODHANI, M. R. AND DAKI, R. N.**

DEPARTMENT OF AGRONOMY
COLLEGE OF AGRICULTURE
JUNAGADH AGRICULTURAL UNIVERSITY
JUNAGADH – 362 001, GUJARAT, INDIA

****E-MAIL: nayanasavaliya608@gmail.com***

ABSTRACT

An investigation conducted on calcareous clayey soil of Junagadh (Gujarat) during rabi season of 2014-15 to study the effect of phosphate and potash solubilizing bacterial inoculations on soil microbial properties. The results showed that application of 45 kg P_2O_5/ha + PSB seed inoculation + PSB soil application (P_3) recorded significantly the highest PSB count at 30 DAS (6.72×10^6), 60 DAS (7.30×10^6) and at harvest (9.48×10^6). Similarly, application of 45 kg K_2O/ha + KSB seed inoculation + KSB soil application (K_3) recorded significantly the highest KSB count at 30 DAS (6.58×10^6), 60 DAS (7.48×10^6) and harvest (9.53×10^6). The treatment combination P_2K_2 (45 kg P_2O_5/ha + PSB seed inoculation and 45 kg K_2O/ha + KSB seed inoculation) recorded significantly the highest PSB count (7.57×10^6) at 30 DAS.

KEY WORDS: KSB, PSB, Soil Microbial Properties, Wheat

INTRODUCTION

Wheat is the second most important crop in India next to rice. Which occupies an area of 31.47 million hectares with production 86.53 million tonnes and productivity of 2749 kg/ha in India (Anonymous, 2015). The important irrigated wheat growing districts are Junagadh, Sabarkantha, Ahmedabad, Rajkot, Banaskantha, Kheda, Mehsana, Anand and Jamnagar. Among these, Junagadh district ranks first in area (1.52 lakh hectares), production (5.86 lakh tonnes) and productivity (3844 kg/ha) of irrigated wheat in the state.

The fertilizer is essential as well as expensive input in agricultural production. Fertilizer plays a leading role in increasing crop production by almost 41 per cent. Of the agronomic factors known to augment wheat yield, the true rate and status of the plant nutrients mainly nitrogen, phosphorus and potassium are more widely understood today with micronutrients as trace element than they were a decade ago. There is a correlation between fertilizer use and agricultural production, its effect being manifested quickly on the plant growth and ultimately on crop yields. Some of the estimates on the uptake of nutrients have shown that, a healthy wheat crop of one hectare removes 140 kg nitrogen, 50 kg phosphorus and 10 kg potassium (Takkar and Nayer, 1983). These figures clearly illustrated the high demand of this crop for nutrient elements. The fertilizer

recommendations need to be matched to genetic materials and agro-climatic situations to exploit potential yield of wheat.

An adequate supply of phosphorus and potassium during growing phases of plant development is important for laying down the primordia of plant reproductive parts. It plays significant role in increasing root ramification and strength thereby imparting vitality and disease resistance capacity to plant. It also helps in seed formation and in early maturation of crop like cereals and legumes. Poor availability or deficiency of phosphorus and potassium markedly reduces plant size and growth and ultimately in low yield.

In recent years, the deterioration in soil health associated with global predicament of energy along with escalation in the prices of chemical fertilizers leads to emphasize on supplementation of chemical fertilizers with low priced nutrient sources such as organics and bio-sources (Kumar and Dhar, 2010). Thus, application of P and K solubilizing bacteria as biofertilizer for agriculture improvement can reduce the use of agrochemicals and support eco-friendly crop production. Soil micro-organisms influence the availability of soil minerals, playing a central role in ion cycling and soil fertility. At Coimbatore (Tamil Nadu) *Frateuria aurantia* belonging to the family Pseudomonaceae obtained from the agricultural soils was found to solubilize K considerably and promoted the crop yield have been reported by Ramarethinam and Chandra (2006). This solubilization effect is generally due to the production of certain organic acids and enzymes by P and K solubilizing bacteria. So, bacterial inoculation to solubilize phosphate and potash seem very important and essential to be studied for wheat crop.

MATERIALS AND METHODS

A field experiment was conducted on a clayey soil at Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat) in *rabi* 2014-15 to study the effect of phosphate and potash solubilizing bacterial inoculations on growth and yield of wheat. The experimental soil was medium black calcareous clayey and slightly alkaline in reaction with pH 7.9 and EC 0.33 dS/m, medium in available nitrogen (254-269 kg/ha), available phosphorus (28.4-30.7 kg/ha) and available potash (183-185 kg/ha). The experiment comprise of 16 treatment combinations consisting of four levels of PSB (P_0: Control, P_1: 60 kg P_2O_5/ha, P_2: 45 kg P_2O_5/ha + PSB seed inoculation, P_3: 45 kg P_2O_5/ha + PSB seed inoculation + PSB soil application) and four levels of KSB (K_0: Control, K_1: 60 kg K_2O/ha, K_2: 45 kg K_2O/ha + KSB seed inoculation, K_3: 45 kg K_2O/ha + KSB seed inoculation + KSB soil application). These treatments were replicated thrice in a randomized block design. Dose of nitrogen *i.e.*120 kg N/ha was applied uniformly to all the plots in two equal splits at sowing and 25 DAS. Entire dose of phosphorus and potash as per treatments was applied in form of diammonium phosphate and muriate of potash, respectively at sowing. Liquid formulation of PSB (*Bacillus coagulans*) and KSB (*Frateuria aurantia*) were used for seed treatment as well as for soil application. For seed treatment, seeds were spreaded and PSB/KSB culture (108 viable cells/g) @ 30 ml/kg of seed was sprinkled on the seeds and then dried in shade. For soil application, PSB/KSB culture (108 viable cells/g) @ 3000 ml/ha was applied in furrows just after sowing before irrigation. The crop was raised as per the recommended package of practices. The soil microbial analysis was carried out for total PSB count and total KSB count by serial dilution method (Aneja, 2008). The microbial study was carried out for initial soil sample as well at 30, 60 DAS and at harvest. Microbial count of soil was

done by general Colony Formation Unit (CFU) count per gram.

RESULTS AND DISCUSSION

Effect of different treatments on periodical PSB count

The results showed (Table 1) that different treatments of PSB manifested significant influence on PSB count at different stages of crop growth as well as at harvest. Among different levels of PSB, application of 45 kg P_2O_5/ha + PSB seed inoculation + PSB soil application (P_3) recorded significantly the highest PSB count at 30 DAS (6.72×10^6), 60 DAS (7.30×10^6) and at harvest (9.48×10^6) followed by application of 45 kg P_2O_5/ha + PSB seed inoculation (P_2). PSB count in soil at 30 DAS, 60 DAS and harvest remained unaffected due to various KSB levels.

Interaction effect of PSB and KSB on PSB count at 30 DAS

The interaction effect of different levels of PSB and KSB on PSB count in soil was found significant at 30 DAS. At 30 DAS (Table 2), the treatment combination P_2K_2 (45 kg P_2O_5/ha + PSB seed inoculation and 45 kg K_2O/ha + KSB seed inoculation) recorded significantly the highest PSB count (7.57×10^6), however it remained statistically at par with the treatment combinations P_3K_1 (45 kg P_2O_5/ha + PSB seed inoculation + PSB soil application and 60 kg K_2O/ha), P_3K_3 (45 kg P_2O_5/ha + PSB seed inoculation + PSB soil application and 45 kg K_2O/ha + KSB seed inoculation + KSB soil application) and P_3K_2 (45 kg P_2O_5/ha + PSB seed inoculation + PSB soil application and 45 kg K_2O/ha + KSB seed inoculation).

Effect of different treatments on periodical KSB count

A glance at data (Table 3) revealed that different levels of KSB exerted significant impact on KSB count in soil at 30 DAS, 60 DAS and harvest. Application of 45 kg K_2O/ha + KSB seed inoculation + KSB soil application (K_3) recorded significantly the highest KSB count at 30 DAS (6.58×10^6), 60 DAS (7.48×10^6) and harvest (9.53×10^6) followed by application of 45 kg K_2O/ha + KSB seed inoculation (K_2). Various levels of PSB did not exhibit significant influence on KSB count at 30 DAS, 60 DAS and harvest.

The improvement in population of Phosphate and Potash Solubilizing Bacteria in soil might be due to application of phosphate and potassium minerals co inoculated with PSB and KSB have synergistic effect and found better environment and food supply. These results are in line with the results found by Han and Lee (2005), Bharti *et al.* (2007), Dadhich and Somani (2007), Khan and Zaidi (2007) and Kaur and Reddy (2014).

CONCLUSION

From the results and discussion, It can be concluded that application of 45 kg P_2O_5/ha along with PSB and KSB as seed treatment [(108 viable cells/g) @ 30 ml/kg of seed] and soil application [(108 viable cells/g) @ 3000 ml/ha] increased the count of PSB and SSB in the soil, increased the yield of wheat.

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Table 1: Effect of different treatments on periodical PSB count

Treatments	PSB Count (1×10^6) at		
	30 DAS	**60 DAS**	**At Harvest**
PSB			
P_0 : Control	2.78	3.52	4.49
P_1 : 60 kg P_2O_5/ha	1.88	2.38	3.77
P_2 : 45 kg P_2O_5/ha + PSB seed inoculation	5.42	6.24	7.43
P_3 : 45 kg P_2O_5/ha + PSB seed inoculation + PSB soil application	6.72	7.30	9.48
S.Em.±	0.18	0.23	0.26
C.D. at 5%	0.51	0.67	0.74
KSB			
K_0 : Control	4.21	4.58	6.23
K_1 : 60 kg K_2O/ha	3.78	4.49	5.93
K_2 : 45 kg K_2O/ha + KSB seed inoculation	4.38	5.06	6.35
K_3 : 45 kg K_2O/ha + KSB seed inoculation + KSB soil application	4.43	5.32	6.66
S.Em.±	0.18	0.23	0.26
C.D. at 5%	NS	NS	NS
P x K			
S.Em.±	0.36	0.47	0.51
C.D. at 5%	1.03	NS	NS

Table 2: Interaction effect of PSB and KSB on PSB count at 30 DAS

Treatments	PSB Count(1×10^6)			
	K_0	**K_1**	**K_2**	**K_3**
P_0	3.47	1.93	2.00	3.73
P_1	3.40	1.70	1.37	1.07
P_2	4.07	4.13	7.57	5.90
P_3	5.90	7.37	6.57	7.03
S.Em.±	0.36			
C.D. at 5 %	1.03			

Table 3: Effect of different treatments on periodical KSB count

Treatments	KSB Count (1×10^6) at		
	30 DAS	**60 DAS**	**At Harvest**
PSB			
P_0 : Control	3.35	4.60	5.83
P_1 : 60 kg P_2O_5/ha	3.20	4.29	5.54
P_2 : 45 kg P_2O_5/ha + PSB seed inoculation	3.33	4.69	6.00
P_3 : 45 kg P_2O_5/ha + PSB seed inoculation + PSB soil application	3.56	5.38	6.58
S.Em.±	0.15	0.29	0.27
C.D. at 5%	NS	NS	NS
KSB			
K_0 : Control	1.00	2.76	3.35
K_1 : 60 kg K_2O/ha	0.63	2.41	2.79
K_2 : 45 kg K_2O/ha + KSB seed inoculation	5.23	6.32	8.28
K_3 : 45 kg K_2O/ha + KSB seed inoculation + KSB soil application	6.58	7.48	9.53
S.Em.±	0.15	0.29	0.27
C.D. at 5%	0.44	0.85	0.78
PxK			
S.Em.±	0.30	0.59	0.54
C.D. at 5%	NS	NS	NS

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