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Response of cowpea (*Vigna unguiculata* L.) genotypes to native soil rhizobia on biological properties of soil

Sonam Binjola* and Narendra Kumar*

ABSTRACT: *Biological health of soil was assessed to understand response of cowpea genotypes to native soil rhizobia. Ten treatments comprised eight cultivars and two control varieties were used under the study. The microbial biomass carbon was found significantly more in the plots having varieties PGCP-3, PGCP-11 and PGCP-13 than both the check varieties Pant lobia-1 and Pusa komal. No significant effect was seen on total bacterial, rhizobial, actinomycetes and fungal population in the soil whereas for soil dehydrogenase activity, no variety was found significantly better than both the check varieties.*

Key words: *Cowpea, genotypes, microbial biomass carbon, microbial population, dehydrogenase activity*

Cowpea is an annual legume. The amount of nitrogen fixed in legumes is controlled by available nitrogen, genetic determination of compatibility in both symbiotic partners and lack of other yield limiting factors. The host plant provides carbon substrate as a source of energy and the bacteria reduce atmospheric nitrogen to NH_3 which is exported to plant the tissues for essential protein synthesis. The efficiency of biological nitrogen fixation is markedly dependent on the mutual compatibility of both partners, and is influenced by a number of environmental factors (Sprent and Minchin, 1983; Vincent, 1980).

The major factors which affect the symbiotic nitrogen fixation are macrosymbiont (i.e. variety, nodulation, photosynthetate stability, tolerance of stress), microsymbiont (i.e. ineffectiveness, effectiveness, competitive ability, saprophytic competence) and environment (i.e. combined nitrogen, light, temperature, water and aeration, salinity and biotic agent). These factors affect nodulation, nitrogen fixing efficiency, plant growth, nitrogenase activity, *Rhizobium* viability and infection, symbiosis establishment. Our present study was conducted on the response of cowpea genotypes to native soil rhizobia for biological properties of soil.

MATERIALS AND METHODS

A field experiment was conducted on sandy loam soil in a narrow belt under the foothills of the Shivalik range of Himalayas, known as *Tarai* at G. B. Pant University of Agric. & Technology, Pantnagar, Uttarakhand in the year 2010. The soil was sandy loam having pH 7.4, organic C 0.70%, available N, P, K, 241, 22.3, 141 kg ha^{-1}, respectively. The experiment was conducted in RBD with four replications having eight entries of state varietal trial (SVT) namely, PGCP-3, PGCP-4, PGCP-5, PGCP-6, PGCP-11, PGCP-12, PGCP-13 ,PGCP-14 and two checks viz. Pant Lobia -1 and Pusa Komal. The basal application of 100 kg ha^{-1} N P K fertilizer (12:36:16) was done at sowing. Soil samples from the individual plots at 0-15 cm depth were collected and were stored at 0-4^{0}C for microbial analysis.

The biological properties like total microbial count (bacteria, fungi, actinomycetes and rhizobial population) was carried out by using serial dilution spread plate method (Wollum, 1982). Thorton's medium (for bacteria), Martin's Rose Bengal (for fungi), ken knight and munaier's medium (for actinomycetes), Rhizobium medium (for rhizobial population) were used for enumeration of colony forming units in soil samples. Soil microbial biomass carbon was estimated by chloroform fumigation and extraction technique (Jenkinson, 1988). Enzyme dehydrogenase activity was determined by the method given by Casida *et al.* (1964). The intensity of pink coloured tri phenyl formazan (TPF) formed due

* Department of Soil Science, G. B. Pant University of Agri. & Tech., Pantnagar, Udham Singh Nagar District, Uttarakhand- 263145, *E-mail: nk5278@rediffmail.com*

to the reduction of 2, 3, 5-triphenyl tetrazolium chloride (TTC) under anaerobic conditions was measured using spectrophotometer at a wavelength of 485 nm against methanol as a blank. The amount of Tri phenyl formazan (TPF) formed was calculated from the standard curve drawn in the range of 10 mg to 90 TPF mL^{-1}.

The different treatments laid out in the experiment are as follows:

T1	PGCP-3
T2	PGCP-4
T3	PGCP-5
T4	PGCP-6
T5	PGCP-11
T6	PGCP-12
T7	PGCP-13
T8	PGCP-14
T9	Pant Lobia-1
T10	Pusa Komal

RESULTS AND DISCUSSIONS

Soil microbial biomass carbon

Cowpea variety PGCP-11 registered highest soil microbial biomass carbon of 497.07 µg g^{-1} while lowest 120.08 µg g^{-1} soil microbial biomass carbon was found with PGCP-6 (Table 1). Check varieties did not vary significantly with each other. Soil microbial biomass carbon was significantly higher with varieties PGCP-3, PGCP-11 and PGCP-13 than both the check varieties. PGCP-11 registered 23.38% and 20.73% significantly more soil microbial biomass carbon, respectively over Pant lobia-1 and Pusa komal check varieties.

Soil microbial biomass carbon is directly related with the number of microorganisms in soil which largely depends on the chemicals released by the plant roots in the form of root exudates and it is the genetical and physiological characters of the plant which determine the composition of root exudates Badri *et al.* (2009). Hence the results showed significant variation in soil microbial biomass carbon with cowpea varieties.

Table 1
Response of cowpea genotypes to native soil rhizobia on soil biomass carbon

Treatments	*Soil Biomass Carbon (µg g^{-1} soil)*
T1	284.30
T2	175.49
T3	138.34
T4	120.08
T5	497.07
T6	461.93
T7	163.28
T8	138.42
T9 (check)	148.90
T10 (check)	161.74
CD AT 5%	27.68

Total microbial population

The data illustrated in figure no. 1 showed that the microbial population of soil was not affected significantly by the cowpea varieties. The maximum number of bacteria (9.18 x 10^6 cfu g^{-1} soil) in soil was found with PGCP-3 variety while minimum number (8.35 x 10^6 cfu g^{-1} soil) with PGCP-14. Rhizobial population in soil ranged maximum 8.43 x 10^5 cfu g^{-1} soil with PGCP-6 and minimum 7.70 x 10^5 cfu g^{-1} soil with PGCP-11. Treatment having PGCP-13 showed maximum actinomycetes population of 8.25 x 10^5 cfu g^{-1} soil while check variety Pusa komal showed minimum 7.66 x 10^5 cfu g^{-1} soil. Maximum fungal population of 7.61 x 10^4 cfu g^{-1} soil was recorded with PGCP-5 and Pant lobia-1 check variety while minimum 6.89 x 10^4 cfu g^{-1} soil with check variety Pusa komal.

The number of soil microorganisms largely depends on (i) the chemical released by the plant roots in the form of root exudates and it is genetical character and (ii) physiology of the plant which determines the composition of root exudates. Similar findings have been reported by Badri *et al.* (2009) who concluded that root exudates influence the surrounding soil microbial community.

Dehydrogenase activity

The data presented in table no. 2 show the effect of cowpea varieties and native soil rhizobia on dehydrogenase activity. Dehydrogenase activity in soil ranged from minimum 105.65 µg TPF 24 h^{-1} g^{-1} soil with PGCP-11 to maximum 196.55 µg TPF 24 h^{-1} g^{-1} soil with Pusa komal check variety. Both the check varieties were comparable but Pusa komal showed

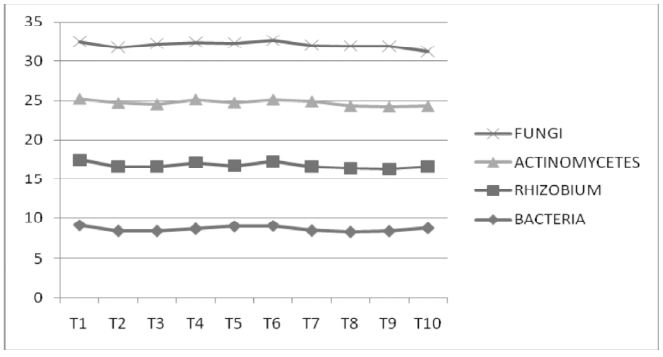

Figure 1: Response of cowpea genotypes to native soil rhizobia on total microbial population.

21.51 % higher dehydrogenase activity than Pant lobia-1. None of the variety was significantly better than check varieties for dehydrogenase activity of soil. Only one variety PGCP-11 was significantly poor than check variety Pant lobia-1. However, when compared with Pusa komal, the varieties PGCP-5, PGCP-12 and PGCP-14 were at par and remaining varieties were significantly poor.

The dehydrogenase activity in soil is an enzyme reaction, which are constitutive and found in living systems. The dehydrogenase activity is linked with the microbial activity which is related with the activity, population and physiology of soil microorganisms depending largely on the availability of nutrients and energy source in the form of root exudates as well as soil condition. Brzezinska *et al.* (1998) have reported that soil water content and temperature influence the dehydrogense activity by affecting the soil oxidation and reduction status.

Table 2
Response of cowpea genotypes to native soil rhizobia on dehydrogenase activity in soil

Treatments	*Dehydrogenase Activity (μg TPF 24 h^{-1} g^{-1} soil)*
T1	137.60
T2	122.67
T3	175.22
T4	141.15
T5	105.65
T6	166.70
T7	135.45
T8	153.92
T9 (check)	161.75
T10 (check)	196.55
CD AT 5%	43.40

CONCLUSION

On evaluating the performance of eight cowpea cultivars using two standard check varieties, the results showed that the varieties PGCP-3, PGCP-11 and PGCP-13 performed significantly better than both the check varieties Pant lobia-1 and Pusa Komal, in case of soil microbial biomass carbon. Cowpea varieties did not have significant effect on total bacterial, rhizobial, actinomycetes and fungal population in the soil. No variety was found to be significantly better than both the check varieties for soil dehydrogenase activity.

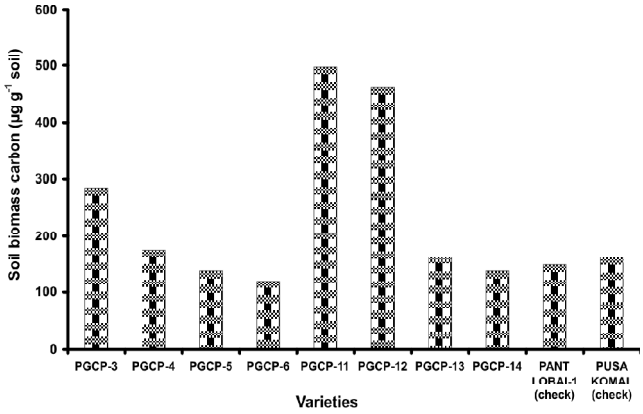

Figure 1.1: Interactive effect of cowpea varieties and native soil rhizobia on soil microbial biomass carbon

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