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RESPONSE OF COWPEA (*VIGNA UNGUICULATA* L.) GENOTYPES TO NATIVE SOIL RHIZOBIA FOR NODULATION, YIELD AND SOIL PROPERTIES

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ABSTRACT

A field experiment was conducted on sandy loam soil, on comparision of both the check varieties, COCP-702 performed significantly better than RC-101 in most of the characters under study. The highest soil microbial biomass carbon, *i.e.,* 234.70 $\mu g\ g^{-1}$, soil available N, *i.e.,* 256.56 kg ha^{-1} and K, *i.e.,* 205.00 kg ha^{-1} was shown by check variety COCP-702. PGCP-4 recorded significantly more number of nodules $plant^{-1}$, *i.e.,* 74.33, N concentration in grain, *i.e.,* 4.76%. PGCP-6 gave significantly more grain yield, *i.e.,* 1893.75 kg ha^{-1}, plant N, *i.e.,* 2.15 %, plant protein content, *i.e.,* 13.43 %. This variety also recorded highest N uptake by grain, *i.e.,* 81.81 kg ha^{-1} and total plant uptake, *i.e.,* 97.64 kg ha^{-1}. Response of COCP-702, PGCP-4 and PGCP-6 to native soil rhizobia were found to be significantly more than the other cowpea genotypes.

INTRODUCTION

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).

In India, cowpea (*Vigna unguiculate* (L.) Walp) is a popular pulse legume component of intercropping farming systems. Often, however, potential production is compromised, particularly in high fertilizer input systems, because legume component competes with the non-legume component of the system for nitrogen (N) in the soil.

Cowpea was selected as the scavenger for the study of rhizobia diversity because it is a known broad host-range leguminous plant. In the study, the nodulation pattern of native soil rhizobia in different cowpea genotypes, evaluation of nutrient content and nutrient uptake of different cowpea genotypes were studied.

MATERIALS AND METHODS

A field experiment was conducted on cowpea at Seed Production Centre of G. B. Pant University of Agric. and Technology, Pantnagar, Uttarakhand in the year 2010 to study the response of cowpea (*Vigna unguiculata L.)* genotypes to native soil rhizobia for nodulation, yield and soil properties. The soil was sandy loam having pH 7.4, organic C 0.70%, available N, P, K was 241, 22.3, 141 kg ha^{-1}, respectively. The experiment was conducted in RBD with four replications having six entries of national varietal trial (NVT) namely, PGCP-1, PGCP-3, PGCP-4, PGCP-5, PGCP-6, CPD-78 and two checks viz. RC-101 and COCP-702. 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 separately and divided into two parts before processing for initial analysis. One part was stored at 0-4°C for microbial analysis. The other part of samples were air dried under shade and sieved using 2mm sieve and analysed for various soil properties.

The microbial biomass carbon was determined by fumigation-extraction method (Jenkinson, 1988). For expressing the microbial biomass carbon on oven dry weight basis of soil the moisture content was determined by gravimetric method.

Available nitrogen in soil was determined by alkaline $KMnO_4$ method (Subbiah and Asija, 1956) and expressed in terms of kg ha^{-1}.

Available potassium in soil was extracted by neutral normal ammonium acetate method (Pratt, 1965) and potassium concentration in aliquot was determined by flame photometer and expressed in terms of kg ha^{-1}. Three plants per plot were uprooted carefully and nodules from the washed plant roots were separated and counted.

After removing the nodules, plants were dried in the hot air oven at 70°C for 72 hours and their dry weights were recorded and reported as g plant^{-1}.

For chemical analysis the dried plant samples were finely grind in powder form.

The nitrogen in plant sample was determined by Micro-kjeldahl method (Jackson, 1967).

Digestion of plant samples was done with 4:1 mixture of nitric acid and perchloric acid. Digested sample were analysed for P and K.

The uptake of N is computed as kg ha^{-1}.

At maturity, the crop was harvested, dried in sun for 2-3 days. After threshing and proper cleaning, the grain yield of individual plot was recorded with single pan balance and converted into kg ha^{-1}.

RESULTS AND DISCUSSION

Soil microbial biomass carbon

As shown in Fig. 1.1 the highest 234.70 μg g^{-1} soil biomass carbon was given by check variety COCP-702 and lowest 73.66 μg g^{-1} soil was recorded by PGCP-1. COCP-702 gave 41.78% significantly higher microbial biomass carbon in soil over another check variety RC-101. All the varieties were significantly poor than check variety COCP-702. PGCP-3, PGCP-5 and PGCP-6 varieties were at par with check variety RC-101.

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.

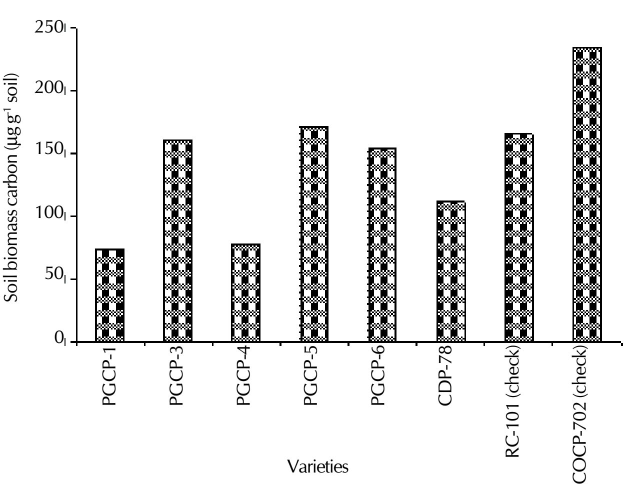

Figure 1.1: Effect of native soil rhizobia on soil microbial biomass carbon of cowpea varieties

Available nitrogen

The highest amount 256.56 kg ha^{-1} of available nitrogen in soil was recorded in the treatment with check variety COCP-702 and lowest 215.08 kg ha^{-1} with PGCP-5. Both the check varieties COCP-702 and RC-101 were comparable with each other. None of the variety showed significantly higher available soil nitrogen than RC-101 and COCP-702 both. All the varieties were at par with check variety RC-101 except PGCP-5. The treatment consisting varieties PGCP-1, PGCP-3 and PGCP-5 showed significantly low amount of available nitrogen in soil. Remaining varieties were comparable with COCP-702. Legumes are unique in their ability to establish symbiotic interaction with rhizobacteria from Rhizobium genus, which provide them with available nitrogen (Smadar *et al.,* 2009).

Available potassium

The available K content of soil also varied significantly with variety. The highest amount 205.00 kg ha^{-1} of available K in soil was found with CPD-78 and check variety COCP-702 both and lowest 147.92 kg ha^{-1} with PGCP-6. The check varieties RC-101 and COCP-702 did not differ significantly with each other for soil available K. CPD-78 and COCP-702 both showed 11.63% more available K in soil than RC-101. None of the variety was significantly better than both the check varieties, however, PGCP-6 was significantly poor than RC-101. The check variety COCP-702 showed 24.39% and 38.58% significantly higher available K in soil respectively over PGCP-3 and PGCP-6.

The amount of available potassium in soil depends on the microbial activity in soil which differs with the variety of crop. Therefore, significant variation in the available potassium in soil was found.

Nodule number

In Fig. 1.2 cowpea genotypes showed significant variation with each other for nodulation with native soil rhizobia. Maximum number 74.33 of nodules plant^{-1} was recorded in PGCP-4 and minimum number 11.99 nodules plant^{-1} in check variety COCP-702. Both the check varieties were parallel to each other; however, check variety RC-101 formed 47.28 % more nodules than another check variety COCP-702. PGCP-

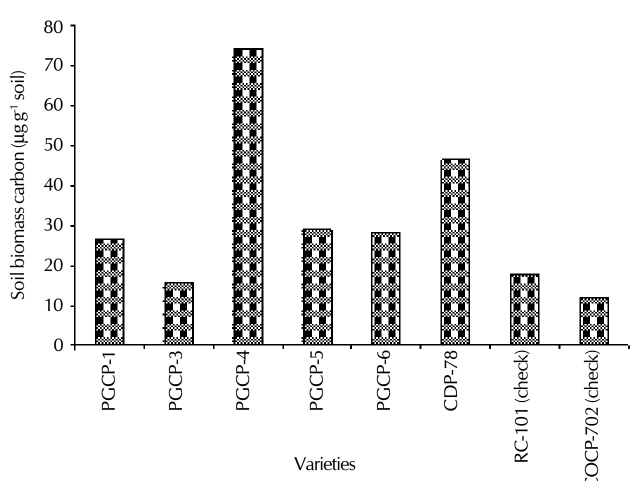

Figure 1.2: Effect of native soil rhizobia on nodule number per plant of cowpea varieties.

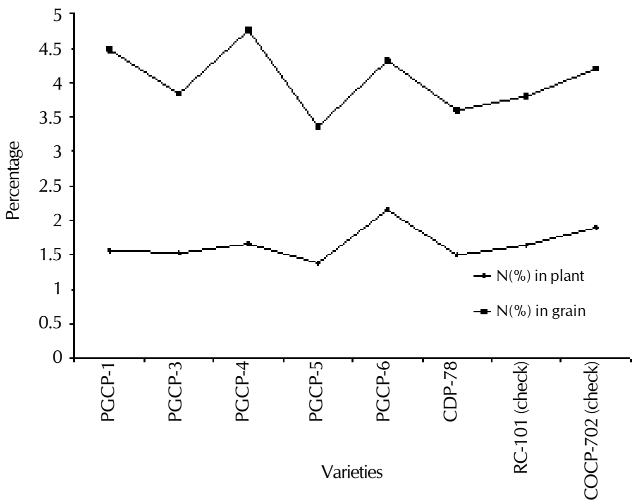

Figure 1.3: Effect of native soil rhizobia on nitrogen concentration in plant and grain of cowpea varieties.

4, PGCP-5, CPD-78 and PGCP-6 showed significantly more number of nodules plant-1 than check variety RC-101. None of the variety was significantly poor than both the check varieties. When compared with another check variety COCP-702 all varieties were significantly better except PGCP-3. PGCP-4 gave 56.67% and 62.34% more nodules plant-1 over check varieties RC-101 and COCP-702. Carroll *et al.* (1985) reported that the nodule number and its distribution are largely dependent on host influence.

Grain yield

The highest grain yield of 1893.75 kg ha^{-1} was obtained from PGCP-6 followed by PGCP-4 while the lowest yield of 619.00 kg ha^{-1} was obtained from PGCP-5. Between the check varieties, COCP-702 significantly gave 31.18% more grain yield than RC-101. PGCP-4, PGCP-6 and CPD-78 produced significantly higher yield than check variety RC-101. Other varieties were comparable with RC-101 while comparing with COCP-702 both PGCP-4 and PGCP-6 gave 26.92% and 89.32% significantly higher grain yield, respectively. Kurdali *et al.*, (2005) also found that both dry matter yield and grain yield were affected by plant genotype and bacteria

Nutrient concentration in plant

Nitrogen

In Fig. 1.3 the nitrogen concentration in plant ranged from 1.38% to 2.51%. Highest N-concentration was recorded in PGCP-6 and lowest in PGCP-5. The check varieties RC-101 and COCP-702 did not differ significantly with each other for plant N concentration, however, COCP-702 check variety showed 15.85% more N concentration over RC-101. PGCP-6 registered 31.09% and 13.15% more plant N concentration, respectively over check varieties RC-101 and COCP-702. This variety was also significantly better than RC-101. None of the variety showed significantly higher N concentration than check variety COCP-702. Similarly, none of the variety was significantly poor than RC-101 check variety. The varieties PGCP-1, PGCP-3, PGCP-5 and CPD-78 showed significantly less amount of plant N concentration in comparision to COCP-702 check variety.

The nutrient concentration in plant differed significantly with variety. The nutrient concentration in plant is a physiological phenomenon which vary from species to species. It also depends upon the root growth and foliage of the plant. Garcia *et al*. (1988) reported that high nutrient concentration that exist with selected tillage systems can alter plant root growth.

Nutrient concentration in grain

Nitrogen

In Fig. 1.3 grain highest amount 4.76% N concentration was showed by PGCP-4 and lowest amount 3.60% by CPD-78. In check varieties, COCP-702 had 10.52% significantly higher grain N concentration over RC-101. PGCP-4 registered 25.26% and 13.33% significantly more grain N concentration over check varieties RC-101 and COCP-702, respectively. PGCP-1, PGCP-4 and PGCP-6 were significantly better than check variety RC-101. PGCP-1 and PGCP-4 also had significantly more grain N concentration in comparision to check variety COCP-702. None of the variety was significantly poor than check variety RC-101, however, PGCP-3, PGCP-5 and CPD-78 have significantly less amount of grain N concentration than COCP-702 check variety.

Nutrient uptake by grain

Nitrogen uptake

The highest 81.81 kg ha^{-1} uptake of nitrogen by grain was recorded in PGCP-6 and lowest 20.79 kg ha^{-1} by PGCP-5. Check varieties also differ significantly with each other. Check variety COCP-702 showed 45.01% significantly higher N uptake by grain than another check variety RC-101. PGCP-4 and PGCP-6 recorded significantly higher N uptake than check variety RC-101. All the variety was comparable with RC-101. Only PGCP-6 was significantly better than check variety COCP-702 and showed 94.73% higher N uptake. Only PGCP-5 was significantly poor than COCP-702.

Significant difference was found in the uptake of nutrients (N) in plant and grain. The nutrient uptake depends upon the growth of plant and concentration of nutrients in plant tissues. Higher the plant biomass, higher will be the nutrient uptake. This is also a genetical character of the plant along with physiology. Li *et al.* (2008) suggested that the reduction in plant growth may be related to impeded uptake of P by the plants.

Total N uptake

The result of data revealed that there was significant difference between varieties for total N uptake. Highest total N uptake of 97.64 kg ha^{-1} was shown by PGCP-6 and lowest 41.24 kg ha^{-1} by check variety RC-101. Both the check varieties also differ significantly with each other and COCP-702 had 56.32% total uptake of N over another check variety RC-101. All the varieties except PGCP-5 were significantly better than check variety RC-101 for total uptake of N. None of the variety was significantly poor than RC-101. Only PGCP-6 showed significantly higher 33.17 kg ha^{-1} uptake of N in comparision to COCP-702. CPD-78 and check variety RC-101 have significantly low N uptake than COCP-702.

Plant protein

The protein content in plant ranged from lowest 8.62% in PGCP-5 to highest 13.43% in PGCP-6. Both the check varieties were parallel to each other. PGCP-6 was significantly better than check variety RC-101 and recorded 31.02 % and 13.14% more protein content in plant as compared with check varieties RC-101 and COCP-702, respectively. Other varieties were not significantly better than both the check varieties. All the varieties were statistically comparable with check variety RC-101. PGCP-3, PGCP-5 and CPD-78 were significantly poor than check variety COCP-702.

Zhenzhu, Xu and Guangsheng, Zhou (2005) reported that plant nitrogen assimilation directly takes part in the synthesis and conversion of amino acid through the reduction of nitrate and the protein is assimilated in plant cell through amino acid.

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