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ELUCIDATING THE ROLE OF BIOINOCULANTS ON NUTRIO-PHYSIOLOGICAL CHARACTERS OF VEGETABLE COWPEA

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ABSTRACT

Cowpea is one of the fascinating leguminous crop and also used as vegetable. It is grown mostly in rainfed condition where unfavourable weather conditions like erratic and uncertain rainfall, low and high temperature and moisture stress at various crop growth stages occurs. This can be overcome by the application of bioinoculants. Bioinoculants are the micro-organisms which can be used as fertilizer improving the plant growth and development. The experiment was carried out with *NovoBac*,a new bioinoculant applied as seed treatment and/or soil drenching at different concentration in Cowpea under randomized block design to assess the nutrient status of the plant. It was observed that, *NovoBac*as seed treatment @ 2g/kg and soil drenching @ 500g/ha on 15DAS improved the nitrogen, phosphorous and potassium uptake of the plant significantly by 23.29, 37.14 and 18.50 per cent over control.

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INTRODUCTION

Cowpea (*Vignaunguiculata* L. Walp.) is one of the most important food crops in the semi-arid tropics. It is cultivated primarily for seeds, but also can be used as vegetable (for leafy greens, green pods, fresh shelled green peas, and shelled dried peas), a cover crop and a fodder. Cowpea seed is a nutritious component in the human diet as well as a nutritious livestock feed. It is considered nutritious with a balanced proportion of protein (23%), fat (1.3%), fibre (1.8%) and carbohydrate (67%). Cowpea is used as a rotational cover crop to meet a crop's nitrogen needs, to control erosion and to improve soil properties. The increasing usage of chemicals reduced the activity of bioinoculants in soil. This can be prevented by the application of bioinoculants which improve the nutrient uptake of the plants. In soils low in phosphorus, the roots of cowpea develop effective bacterial associations and improve the soil's nutrients availability. The growth enhancement by *Bacillus* is attributed to its ability to increase the uptake of NPK and also the production of IAA (Sheng and Huang, 2001).

NovoBac is a natural, soluble, beneficial microbial formulation applied as seed treatment, soil drenching and drip or direct to soil media. The composition of *NovoBac*includes several species of *Bacillus* amounting to a minimum of 8.5 x 10^9cfu/g (*Bacillus licheniformis*- 2.50 x 10^9 cfu/g, *Bacillus amyloliquefaciens*- 2.00 x 10^9 cfu/g, *Bacillus pasteurii*- 0.90 x 10^9 cfu/g, *Bacillus laevolacticus*- 2.10 x 10^9 cfu/g and *Bacillus subtilis*- 1.00 x 10^9 cfu/g). The present study was taken up to assess the effect of *NovoBac* at different levels, as seed treatment and/ or soil drenching on nutritional changesin cowpea.

MATERIALS AND METHODS

In this experiment, the bioinoculant (*NovoBac*) was given as seed treatment and/or soil drenching in vegetable cowpea variety VBN2 and the observations were recorded at specific growth stages i.e., vegetative, flowering, pod filling and harvest stages. The experiment was laid out following randomised block design with eleven treatments and three replications *viz.,*- Control (T_1), *Trichodermaviride* seed treatment @ 4 g/kg (T_2), *Rhizobium + Phosphobacteria* seed treatment @ 25g/kg(T_3), *NovoBac* Seed treatment @ 1 g/kg (T_4), *NovoBac* Seed treatment @ 2 g/kg (T_5), *NovoBac* Soil drenching @ 250 g/ha on 15 DAS (T_6), *NovoBac* Soil drenching @ 500 g/ha on 15 DAS (T_7), *NovoBac* Seed treatment @ 1 g/kg + Soil drenching @ 250 g/ha on 15 DAS (T_8), *NovoBac* Seed treatment @ 2 g/kg + Soil drenching @ 250 g/ha on 15 DAS (T_9), *NovoBac* Seed treatment @ 1 g/kg + Soil drenching @ 500 g/ha on 15 DAS (T_{10}), *NovoBac* Seed treatment @ 2 g/kg + Soil drenching @ 500 g/ha on 15 DAS (T_{11}).

*Nutrio-physiological analysis:*The total nitrogen content in soil and plant samples were estimated by Microkjeldhal method as proposed by Humphries (1956) and total N uptake at different stages were worked out by summing up the uptake in different parts of the plant after multiplying the total dry matter of the plant parts with the corresponding N content and expressed as kg ha^{-1}. The dried plant samples and soil samples were collected at different phenophases and determined for phosphorus content through colorimetric method from triple acid extract and soil extract respectively (Piper, 1966) and P uptake was worked out and expressed as kg ha^{-1}. The potassium contents of the plant samples and soil samples taken at various phenophases were analysed by flame photometry using triple acid extract and soil extract (Piper, 1966). The total K uptake was then calculated and expressed as kg ha^{-1}.

Data analysis: The data collected were subjected to statistical analysis in randomized block design by adopting the AGRES package

RESULTS AND DISCUSSION

Nitrogen uptake

The bioinoculant (*NovoBac*) has profound influence on nitrogen uptake (Table 1). The bioinoculant strongly influenced the absorption of nitrogen by roots and it is evident from the table that T_{11} (*NovoBac* seed treatment @ 2g/kg + soil drenching @500g/ha on 15 DAS) increased nitrogen uptake significantly in all the stages when compared to control and other treatments. T_{11} increased the nitrogen uptake significantly at pod filling (15.87) and harvest (23.87) stages. The enhancement of total nitrogen uptake by *Rhizobium* might be assigned to more availability of nitrogen for uptake, enhanced cation exchange capacity of roots due to better root proliferation besides, to higher dry matter accumulation and grain yield (Utpal and Bandopadhyay, 2004). PGPR strains could improve plant growth by increased production of growth regulators and plant nitrogen uptake (Binjola and Narendra Kumar, 2013). Increasing N uptake in our experiment with inoculation of*Bacillus* may be related to the fact that *Rhizobium* sp., a genus which fixes atmospheric nitrogen in symbiosis with legume, is phyllogenitically closer to *Bacillus* than to other rhizobial genera (Sahin *et al.*, 2004).

Phosphorus uptake (kg ha^{-1})

The data in Table 2 reveals the effect of bioinoculant (*NovoBac*) on uptake of phosphorus. T_{11} (*NovoBac* seed treatment @ 2g/kg soil drenching @500g/ha on 15 DAS) increased the phosphorus uptake in all the stages of crop growth than any other treatments by recording 0.44, 3.97, 6.75 and 9.60 at vegetative, flowering, podfilling and harvest stages respectively. The lowest uptake of phosphorus observed in control (T_1).Phosphorous favours betters root proliferation, nodule formation, nitrogen fixation and hence, better uptake of nutrients. The increase in phosphorus content may be due to *B. megaterium*inoculation to produce organic, inorganic acids and CO_2 which lead to an increase in soil acidity and consequently convert the insoluble forms of phosphorus into soluble ones (Bhattacharyya*et al.*, 2014). These are in agreement with the findings of Park *et al.*, 2003 in tobacco.

Potassium uptake (kg ha^{-1})

The effect of bioinoculant (*NovoBac*) on potassium uptake is presented in Table 3. T_{11} (*NovoBac* seed treatment @ 2g/kg + soil drenching @500g/ha on 15DAS) significantly increased

Table 1: Effect of bioinoculant (*NovoBac*) on Nitrogen uptake (kg ha^{-1}) at different growth stages of cowpea

Treatments	Vegetative (30 DAS)	Flowering (45 DAS)	Pod filling (60 DAS)	Harvest stage (80 DAS)
T_1	3.69	9.60	13.42	19.36
T_2	3.98	10.00	13.76	19.76
T_3	4.37	10.43	14.50	22.45
T_4	4.67	10.75	15.00	22.76
T_5	4.87	10.87	15.39	23.00
T_6	4.13	10.38	14.00	20.00
T_7	4.26	10.42	14.38	22.00
T_8	5.00	11.10	15.43	23.50
T_9	5.42	11.48	15.73	23.65
T_{10}	5.31	11.38	15.64	23.54
T_{11}	5.67	11.57	15.87	23.87
Mean	4.67	10.72	14.82	22.17
SEd	0.02	0.06	0.08	0.12
CD (p = 0.05)	0.05	0.13	0.18	0.25

Table 2: Effect of bioinoculant (NovoBac) on Phosphorus uptake (kg ha^{-1}) at different growth stages of cowpea

Treatments	Vegetative (30 DAS)	Flowering (45 DAS)	Pod filling (60 DAS)	Harvest stage (80 DAS)
T_1	0.27	2.49	4.57	7.00
T_2	0.29	2.98	5.00	7.34
T_3	0.34	3.37	5.87	8.43
T_4	0.37	3.40	6.00	8.54
T_5	0.39	3.44	6.23	8.75
T_6	0.30	3.31	5.32	8.21
T_7	0.31	3.35	5.64	8.35
T_8	0.40	3.47	6.37	9.00
T_9	0.42	3.59	6.56	9.43
T_{10}	0.41	3.50	6.43	9.32
T_{11}	0.44	3.97	6.75	9.60
Mean	0.35	3.35	5.88	8.54
SEd	0.0019	0.01	0.02	0.04
CD (p = 0.05)	0.004	0.02	0.06	0.09

Table 3: Effect of bioinoculant *(Novo Bac)* on Potassium uptake (kg ha^{-1}) at differentgrowth stages of cowpea

Treatments	Vegetative (30 DAS)	Flowering (45 DAS)	Pod filling (60 DAS)	Harvest stage (80 DAS)
T_1	2.14	19.02	26.64	45.18
T_2	2.53	19.38	28.35	46.77
T_3	3.04	23.35	31.54	50.35
T_4	3.23	24.40	33.42	52.00
T_5	3.63	25.93	34.65	52.43
T_6	2.82	20.79	30.96	47.65
T_7	3.03	23.18	29.65	49.52
T_8	3.87	26.59	30.54	52.65
T_9	4.27	27.56	35.64	53.21
T_{10}	4.25	27.39	35.42	53.00
T_{11}	4.58	28.37	36.54	53.54
Mean	3.39	24.17	32.12	50.59
SEd	0.03	0.22	0.17	0.28
CD (P: 0.05)	0.08	0.47	0.36	0.60

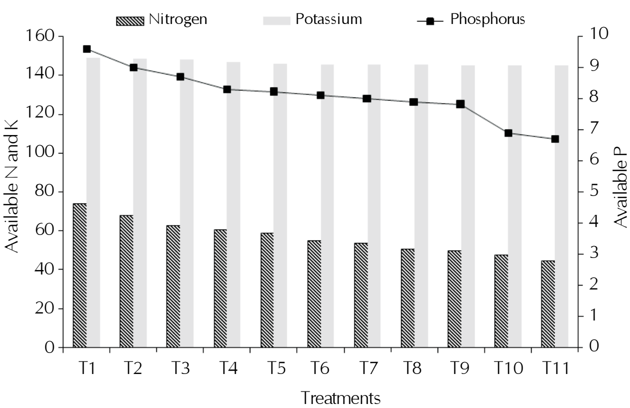

Figure 1: Effect of biostimulant (NovoBac) on available NPK

the potassiumuptake when compared to other treatments in all the crop growth stages. Maximum potassium uptake was recorded at the stage of harvest due to the treatment, T_{11}.The preferential potassium accumulation in the leaves as a result of bacterial inoculation might also be related to changes in membrane activity and subsequently proton efflux in roots (Bashan *et al.*, 1991). Microorganisms and organic decomposition affects the availability of potassium through liberation of organically bound potassium from insoluble form present in soil and minerals to soluble form. These are in findings with Lal*et al.* (2000) with plant nutrients.

Available Nitrogen, Phosphorus and Potassium in soil (kg ha^{-1}): The data on available nitrogen, phosphorus and potassium is presented in Fig.1. The intial soil samples showed no significant difference for all the three nutrients. After the cropping period, soil was analysed for nitrogen, phosphorus and potassium content. T_{11} (*NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAS) treatment favoured for higher level of nitrogen (74.0), whereas control recorded the lowest amount (45.1). The treatmentT_{11}showed higher amount of available phosphorus (9.6) in harvest stage when compared to control. The data on available potassium also showed the same trend. The treatment T_{11} (*NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on15 DAS) recorded higher amount of potassium (148.7) at harvest stage, whereas control recorded lowest amount (144.8). These are due to the effective utilization of nutrients by the vegetable cowpea and leads to reduction in available nutrients in soil (Jeyakumar *et al.,* 2013).

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