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Effect of integrated nutrient management on vegetative growth of cowpea [*Vigna unguiculata* (L.) Walp.]

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Abstract
An investigation was carried out during 2017 at the Horticultural Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, U.P. Considering the various parameters, vegetative growth of cowpea varied with the different level of fertility and different sources of inorganic and bio-fertilizers *viz. Rhizobium* and PSB. It was concluded that application of bio- fertilizer have positive effects on availability of nutrients. Observation on vegetative growth parameters like Seed germination percentage, plant height (cm), days to first flowering, green pod length (cm), immature seed weight (g), chlorophyll content and root length (cm) found the maximum vegetative growth in the treatment of T_7- 100% RDF + *Rhizobium*+ PSB and number of leaves per plant found maximum in treatment T_{10} (75% RDF + *Rhizobium* + PSB).

Keywords: Cowpea, RDF, *Rhizobium*, PSB, growth, nitrogen, phosphorus, quality of cowpea

Introduction
Vegetable cowpea is one of the most important crop among the various important legumes. The center of origin of cowpea considered as Central Africa. It belongs to Phaseoleae tribe, family Leguminosae and sub family Fabaceae having chromosome number (2n = 22). Cowpea considered as high biological value and protein content also known as vegetable meat.The nutritional profile of cowpea grain is similar to that of other pulses with a relatively low fat content and a total protein content that is two to four fold higher nutritious than cereal and other tuber crops. The storage proteins in cowpea seeds are rich in the amino acids, lysine and tryptophan when compared to cereal grains. Total seed protein content ranges from 23% to 32% of seed weight. Green cowpea pods contain moisture, protein, carbohydrate and fats in amounts of 82.6%, 4.3%, 8.1% and 0.2% respectively and having fair amount of calcium, phosphorus, iron *etc.* Cowpea generally enriched with amino acid profile particularly lysine, leucine and phenylalanine contents are relatively high content. Tender fruits contain 80 mg calcium, 74 mg phosphorus and 2.5 mg iron per 100 g fresh. In plant growth and development, various metabolic activity directed by nitrogen which driving force for activity is in roots zone and strong framework of root influenced by application. In plant growth, potassium shows direct and indirect effect. Potassium directly regulate the transpiration rate, improves absorption of water and provide favorable environment in order to tolerate the dryness. Uptake of organic nitrogen during vegetative period of growth are largely influenced by the onset of flowering than those dependent on symbiotic nitrogen fixation development and crop. Biological nitrogen fixation increased the growth of seedling due to the presence of available nitrogenous compound. The biological reduction of atmospheric nitrogen to ammonium provides about 62-65% of the biosphere available nitrogen. Most of this ammonium is contributed by legume *Rhizobia* symbiotic association which are initiated and regulated by the bacterial infection (*Rhizobia*) of legume hosts resulting in the formation of large number of root nodules (Lodwig *et al*., 2003) [5]. *Rhizobia* form a symbiotic relationship with roots of cowpea plant and enhances effective biological nitrogen fixation. The higher population of *Rhizobia*, high rate of probability of nodule infection parts. *Rhizobial* population in the soil can be extremely variable both in the composition and the symbiotic characteristics of a species. Native and inefficient *Rhizobium* strains can compete with efficient ones shows inoculation activity for sites of infection on the host plant of roots surface. The inoculation with *Rhizobium* with an objective of increasing their number in the rhizosphere so that there is substantial increase in the microbial nitrogen fixing to support the plant growth. The seed inoculation with suitable *Rhizobium* culture increased the green pod yield and seed yield over

uninoculated control treatment (Vaisya *et al.*, 1983) [10]. The inoculation with phosphate solubilizing bacteria, bio-fertilizer may increase the crops yield up to 20-30 per cent. The combining effect of organic and inorganic nutrients source used as integrated nutrient management has been proved superior to the use of each component separately found (Palaniappan and Annadurai, 2007) [8].

Material and Methods

The present experiment was conducted at the Horticultural Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi which is situated in south eastern part of Varanasi city at 25º 15' North latitude and 83º 03' East longitude during the summer season. Varanasi is located in the eastern part of Uttar Pradesh and lies in the center of north alluvial plain at an elevation of 128.93 meter above mean sea level on the left side of river the Ganges and enjoys a humid subtropical climate with large variation in summer and winter temperature *i.e.* extreme of hot weather in summer and cold in winter.

The average seasonal rainfall in this area is about 1100 mm. The precipitation occurs mostly from second fortnight of June or first fortnight of July to mid-October with a few showers in winter season. The data indicated that the range of weekly mean maximum temperature varied from 36.9ºC to 42.2ºC. During the growing period of the crop minimum temperatures was 20.1ºC to 27.8ºC. At the time of sowing average weekly temperature play a key role in germination of cowpea crop. The data revealed that the range of weekly mean maximum relative humidity (%) was from 26% to 76% which was considered to be favorable for maintaining the temperature optimum for the growth and development of the crop growth span. The experimental design consisted twelve treatment combinations(100% RDF, 75% RDF, 50% RDF, 100% RDF + Rhizobium, 100% RDF + PSB, 100% RDF + Rhizobium+ PSB, 75% RDF + Rhizobium, 75% RDF + PSB, 75% RDF + Rhizobium + PSB, 50% RDF + Rhizobium, 50% RDF + PSB and 50% RDF + Rhizobium +PSB and control. In this experiment two bio-fertilizer and NPK were taken. The treatments were followed in randomized block design with three replications. Kashi Kanchan variety is selected for present experiment. Seeds of cultivar spacing with row to row 30 cm and plant to plant at 20 cm having field size of 2 X 1.5 m at a depth of 4-5 cm. Observation on vegetative growth parameters like Seed germination percentage, Plant height (cm), Number of leaves per plant, Days to first flowering, Green pod length (cm), Immature seed weight (g), Chlorophyll content (SPAD-502) and Root length (cm) also recorded and subjected to statistical analysis.

Results and Discussion

Persual of data on various vegetative growth parameter presented in Table Number - 1. It was found that the maximum percentage of seed germination was observed in treatment T_7 (100% RDF + *Rhizobium* + PSB) followed by treatments T_{10} (75% RDF + *Rhizobium* + PSB, 94.00%), whereas, minimum germination percentage was recorded under the treatment T_1 (Control). Similar findings regarding integrated use of different inorganic and bio-fertilizers showed significant increase in percent of germination compared to untreated plants (control) given by Senthilkumar and Sivagurunathan (2012) [9] in cowpea. The maximum plant height (69.53 cm) was recorded in treatment T_7 (100% RDF + *Rhizobium* + PSB) followed by treatments T_{10} (75% RDF + *Rhizobium* + PSB, 68.50 cm), whereas, minimum plant height was recorded in treatment T_1 (Control, 63.98 cm). The findings in vegetative growth of the crop with the application of nitrogen and phosphorus along with *Rhizobium* and PSB was in conformity with Choudhary and Yadav (2011) [2] in cowpea. The results observed that maximum (69.53) number of leaves per plant was found in T_{10} (75% RDF + *Rhizobium* + PSB) followed by T_7 (100% RDF + *Rhizobium* + PSB, 67.61). The minimum number of leaves was recorded in treatment T_1 (Control, 45.50). The number of leaves per plant increased might be due to the cowpea seed inoculation with treatment Rhizobium and PSB which enhances development of root and increase uptake of nutrients (Kishan *et al*., 2001) [3] in cowpea. The minimum number of days taken to first flower appearance (40.90 days) were recorded in treatment T_7 (100% RDF + *Rhizobium* + PSB) followed by treatments T_{10} (75% RDF + *Rhizobium* + PSB, 41.30 days), whereas, maximum days (46.29 days) was taken. Similar results were observed by Okeleye and Okelana (1997) [7] in cowpea. The maximum green pod length (29.53 cm) was recorded in treatment T_7 (100% RDF + *Rhizobium* + PSB) followed by treatments T_{10} (75% RDF + *Rhizobium* + PSB, 29.24 cm). The minimum green pod length was recorded in treatment T_1 (Control, 19.39 cm). The results are in concurrence with the findings of Abdel- Ati (2000) [1] in cowpea. The maximum chlorophyll content noticed in T_7 (100% RDF + *Rhizobium* + PSB, 54.23) followed by T_5 (100% RDF + *Rhizobium*, 53.67), T_6 (100% RDF + PSB, 53.33), T_9 (75% RDF + PSB, 53.23) and T_4 (50% RDF, 52.71), while minimum chlorophyll content (50.77) was noticed in treatment T_1 (Control). This also led to efficient and greater partitioning of metabolites and adequate translocation of photosynthates and nutrients to develop reproductive structures (Tisdale *et al*., 1995) [11]. The maximum immature seed weight was observed in T_7 (100% RDF + *Rhizobium* + PSB, 3.14 g) followed by T_{10} (75% RDF + *Rhizobium* + PSB, 3.05g). Minimum immature seed weight was recorded in treatment T_1 (Control, 1.67 g). The increase in yield attributes due to co-inoculation with *Rhizobium* along with PSB might be due to production of growth promoting substances such as auxins, gibberellins and cytokinins which promote plant growth and stimulate the microbial activity in soil condition. The cumulative effect might be due to supply of nitrogen and phosphorus to the crop and also increased mineral solubilization and absorption of phosphorus and other nutrients. similar observation was recorded by Kumar and Kumawat (2014) [4] in mung bean. The maximum root length (24.47 cm) was recorded with treatment T_7 (100% RDF + *Rhizobium* + PSB) followed by treatments T_{10} (75% RDF + *Rhizobium* + PSB, 24.30 cm). whereas, minimum length of root was recorded in treatment T_1 (Control, 19.30 cm). Similar results were also obtained by Mishra (2003) [6] in cowpea.

Table 1: Effect of Rhizobium inoculation, nitrogen and phosphorus levels on Vegetative growth of cowpea

Treatment	Seed germination %	Plant height (cm)	Number of leaves per plant	Days to first flowering	Green pod Length (cm)	Chlorophyll content	Immature seed weight (g)	Root length (cm)
T_1 (Control)	84.67	63.98	45.50	46.29	19.39	50.77	1.67	19.30
T_2 (100% RDF)	88.00	68.2	65.54	45.97	23.63	52.01	2.01	21.94
T_3 (75% RDF)	86.67	65.79	61.44	46.11	23.43	52.56	1.93	21.27
T_4 (50% RDF)	86.00	63.13	49.78	46.22	22.43	52.71	1.91	21.20
T_5 (100% RDF + *Rhizobium*)	93.33	64.13	56.22	41.53	28.27	53.67	2.83	23.13
T_6 (100% RDF + PSB)	92.67	65.93	63.62	42.70	27.66	53.33	2.81	22.99
T_7 (100% RDF + *Rhizobium*+ PSB)	94.67	69.53	67.61	40.90	29.53	54.23	3.14	24.47
T_8 (75% RDF + *Rhizobium*)	90.67	65.59	59.56	44.47	26.89	52.37	2.44	22.89
T_9 (75% RDF + PSB)	89.33	68.35	56.06	44.94	25.73	53.23	2.37	22.27
T_{10} (75% RDF + *Rhizobium* + PSB)	94.00	68.50	69.53	41.30	29.24	52.18	3.05	24.30
T_{11} (50% RDF + *Rhizobium*)	93.33	64.93	53.17	45.28	24.92	51.77	2.18	22.27
T_{12} (50% RDF + PSB)	91.33	65.97	49.99	45.67	24.09	52.18	2.02	22.10
T_{13} (50% RDF + *Rhizobium* + PSB)	92.00	66.30	52.67	43.87	27.31	50.95	2.57	22.93
S. Em (±)	2.17	0.92	2.83	0.65	0.76	0.39	0.24	0.36
C.D. 5%	6.36	2.69	8.26	1.90	2.22	1.13	0.71	1.05

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