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Effects of seed biopriming under different levels of nitrogen and phosphorus on crop growth and nodulation of cowpea (*Vigna unguiculata*)

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Abstract
Application of *Rhizobium* + PSB 10% + 75% N and 75% P + 100% K (T_6) recorded significantly higher plant height at 15DAS (23.4 cm), 30DAS (37.1 cm), 45DAS (47.7 cm), 60DAS (59.5 cm), 75DAS (63.4 cm), At harvest (68.1 cm), number of trifoliate leaves per plant at 15DAS (3.8), 30DAS (15.0), 45DAS (29.1), 60DAS (36.0), 75DAS (37.2), At harvest (39.5), number of branches plant^{-1} at 30DAS (7.1), 45DAS (13.7), 60DAS (18.0), 75DAS (22.2), At harvest (24.0), Days taken for 50% flowering 59.7, number of nodules plant^{-1} (36.4), fresh weight of nodules (520.3 mg), dry weight of nodules (166.3 mg).

Keywords: *biopriming*, phosphorus, recorded significantly higher

Introduction
Pulses or dicotyledons contains 20-30% of protein compared to cereals or monocotyledons (Arora, 1989) [1], hence they have gained important part in our diet. Simultaneously, these pulses are also rich in vitamins and minerals they are popularly called as" poor man's meat" and "rich man's vegetable" (Singh and Singh, 1992) [7]. Besides, these pulses play a dynamic role in maintaining the soil fertility of the soil by fixing the atmospheric nitrogen into the soil in association with the micro-organisms.

Cowpea is called as vegetable meat due to high amount of protein in grain with better biological value on dry weight basis. Cowpea grain contains 23.4 per cent protein, 1.8 per cent fat and 60.3 per cent carbohydrates on dry weight basis and it is rich source of calcium and iron. Apart from this, cowpea forms excellent forage and it gives a profused vegetative growth and covers the ground so well that it checks the soil erosion. It also forms a good silage and green manure crop. Being a drought-tolerant and warm-weather crop, cowpea is well adopted to the drier regions of the tropics, where other food legumes do not perform well. It has the ability to fix about 70-240 kg atmospheric nitrogen per hectare per year through its root nodules. In addition, it is shade tolerant and compatible to intercrop with maize, millet, sorghum, sugarcane and cotton (Davis *et al.*, 1991) [3].

The factors attributed for low yields of pulses in India as compared to the world productivity are non-availability of quality seeds of improved and short duration varieties, growing of pulses under marginal and less fertile soil with low inputs and without pest and disease management, growing of pulses under moisture stress, unscientific post-harvest practices and storage under unfavourable conditions. Hence, there is a scope for improving the production potential of this crop by use of organic, inorganic and bio-fertilizers.

Bio priming is the immersion of seeds in a microbial suspension for a pre-determined period by drying of seeds to prevent onset of germination (Maureen o callaghan 2016) [4] application of beneficial microorganisms to seeds is an efficient mechanism for placement of microbial inocula into soil where they will be well positioned to colonise seedling roots. Keeping above fact in view present investigation was planned with following objective to study effects of seed biopriming under different level of nitrogen and phosphorus on crop growth and nodulation.

Materials and Methods
The present study was conducted in Kharif season of 2016 at Sam Higginbottom University of Agriculture, Technology and Sciences, to study the effects of biopriming under different levels of nitrogen and phosphorus on crop growth and seed yield of cowpea. The seeds were soaked for eight hours with biopriming agents such as *Rhizobium*, PSB and Calcarea phos 6X solutions for 8 hoursas accordingly with the concentrations as included in the experiment and shade dried. Nitrogen and phosphorus was applied as soil application as according to treatment, for control 25:50:25 kg N:P:K was applied

Treatment Details

T_0: Control
T_1: *Rhizobium* 10% + 75% N and 75% P + 100% K
T_2: *Rhizobium* 10% + 50% N and 50% P + 100% K
T_3: PSB 10% + 75% N and 75% P + 100% K
T_4: PSB 10% + 50% N and 50% P + 100% K
T_5: *Rhizobium* 10%+ PSB 10%
T_6: *Rhizobium* + PSB 10% + 75% N and 75% P + 100% K
T_7: *Rhizobium* + PSB 10% + 50% N and 50% P + 100% K
T_8: Calcarea phos 6X 5%
T_9: Calcarea phos 6X 10%

Observation on plant height, leaves plant^{-1} branches plant^{-1}, number nodules plant^{-1}, nodule fresh weight and nodule dry weight were recorded. The data pertaining to various growth stages and nodulation were subjected to analysis of variance prescribed for randomized block design as described by Panse and Sukhatme (1967).

Results and Discussion

Table 1 revealed that maximum height of plant (66.1 cm) at harvest was achieved with treatment rhizobium + PSB 10% + 75% N and 75% P + 100%K (T6) followed by control (T0) (62.4) and minimum height of plant found in (T5) *Rhizobium* + PSB 10% No. of branches at harvest (24) and at other subsequent stages of plant growth was also recorded maximum with treatment *Rhizobium* + PSB 10% + 75% N and 75% P + 100%K (T6) Similarly number of leaves at harvest (36.0) were achieved maximum in treatment T6. This might be due to increased nutrient availability due to better microbial activity which results in higher number of leaves resulting higher photosynthates accumulation and nitrogen application increased growth of plant, because nitrogen as a major component of protoplasm helps in photosynthesis and enhances metabolic rate, cell division and cell elongation which thereby, allows the plants growth faster (Tisdale *et al.*, 1995). T_5 (*Rhizobium* 10%+ PSB 10%) recorded lower growth parameters which may be due to unavailability of adequate amount of N and P for its growth and development as no additional inorganic nutrient source (fertilizers) were applied. The present findings corroborated with the earlier observation made by Kumaran (2001).

Table 2 revealed that Days taken for 50% flowering, varied non significantly between the treatments and lower number was recorded in T_8: Calcarea phos 6X 5% (56) and higher in T6 which is at par with T0 and T4. No. of nodules plant^{-1} at physiological maturity varied significantly, higher number of nodules were recorded in (T6) *Rhizobium* + PSB 10% + 75% N and 75% P + 100%K (36.4) followed by control T0. Similar trend is followed for fresh and dry weight of nodules, higher fresh weight (520.3 mg) dry weight (166.3) in T6. This might be due to increased activity of *Rhizobium* when inoculated with higher dose and higher N dose resulted in a faster growth of the crop during early growth stages of the crop indicating better growth which ultimately increased the nodulation activity which is in conformity with the findings of Salem and Massuri (1986) [6] in broadbean and Bengston (1991) [2] in kidney bean.

Table 1: Effect of biopriming under different levels of N and P on plant height, No. of leaves plant^{-1}, and No. of branches palnt^{-1}.

	Plant height						**No. of leaves plant^{-1}**						**No. of branches plant^{-1}**				
Treatments	**15DAS**	**30DAS**	**45DAS**	**60DAS**	**75DAS**	**At harvest**	**15DAS**	**30DAS**	**45DAS**	**60DAS**	**75DAS**	**At harvest**	**30DAS**	**45DAS**	**60DAS**	**75DAS**	**At harvest**
T_0	22.9	36.6	45.8	58.0	61.1	62.4	3.6	13.2	28.9	30.1	32.4	37.5	6.4	13.0	16.4	18.7	22.7
T_1	22.3	35.0	44.6	57.5	60.2	61.0	3.4	13.1	27.9	29.1	32.3	37.1	6.3	12.6	15.7	18.3	21.2
T_2	21.5	33.5	42.4	55.8	58.6	62.4	3.3	12.6	23.2	28.6	31.8	34.5	5.5	10.8	15.1	17.9	20.7
T_3	20.7	32.1	40.1	52.8	57.7	59.9	3.3	11.8	23.1	28.3	31.2	33.6	5.0	10.3	14.2	17.4	19.7
T_4	20.5	28.6	39.5	48.3	56.2	57.9	3.3	11.8	21.1	27.4	29.0	33.5	4.7	9.4	13.7	16.8	19.3
T_5	18.5	25.9	35.2	40.2	45.1	46.3	3.2	7.90	16.3	25.3	27.6	30.3	4.5	9.1	12.1	15.4	16.9
T_6	23.4	37.1	47.7	59.5	63.4	66.1	3.8	15.0	29.1	36.0	37.2	39.7	7.1	13.7	18.0	22.2	24.0
T_7	22.2	34.6	44.0	55.9	60.4	62.0	3.3	13.0	26.6	28.8	32.2	35.4	5.9	11.7	15.2	18.2	20.3
T_8	18.2	27.9	35.6	44.8	47.5	49.6	3.2	11.5	21.7	26.3	28.3	33.0	4.6	9.3	13.7	16.8	17.7
T_9	21.3	33.1	40.9	55.5	58.5	59.9	3.3	11.8	24.0	28.5	31.4	34.2	5.4	10.6	14.9	17.7	19.8
S.Em.±	2.09	2.35	2.42	3.19	4.02	3.49	0.2	0.83	1.95	0.94	1.63	1.68	0.89	0.84	1.00	1.23	1.32
CD @ 5%	NS	6.99	7.19	9.49	NS	NS	NS	2.47	5.79	2.80	4.85	5.00	NS	2.49	2.97	3.66	3.91
CV%	9.19	12.58	10.08	10.47	12.24	10.30	10.39	11.84	13.95	5.78	9.09	8.35	27.94	13.16	11.62	11.97	11.28

Table 2: Effect of biopriming under different levels of N and P on Days taken for 50% flowering, No. of nodules plant^{-1} at physiological maturity, Fresh weight and Dry weight of nodules (mg plant^{-1}).

Treatments	**Days taken for 50% flowering**	**No. of nodules plant^{-1} at physiological maturity**	**Weight of nodules (mg plant^{-1})**	
			Fresh weight	Dry weight
T_0: Control	59.7	36.2	509.0	162.8
T_1:Rhizobium 10% + 75% N and 75% P + 100%K	59.3	34.7	501.0	161.3
T_2:Rhizobium 10% + 50% N and 50% P + 100% K	59.0	30.5	492.0	159.5
T_3 : PSB 10% + 75% N and 75% P + 100% K	59.0	29.9	484.0	158.2
T_4 : PSB 10% + 50% N and 50% P + 100% K	59.7	29.9	483.7	156.1
T_5 : Rhizobium 10% + PSB 10%	58.3	26.0	431.0	143.3
T_6 : Rhizobium + PSB 10% + 75% N and 75% P + 100% K	59.7	36.4	520.3	166.3

T_7 : Rhizobium + PSB 10% + 50% N and 50% P + 100% K	59.3	31.8	493.7	160.3
T_8 : Calcarea phos 6X 5%	56.0	29.8	478.0	152.1
T_9 : Calcarea phos 6X 10%	59.0	30.1	489.0	159.3
S.Em.±	0.87	1.87	10.20	3.81
CD @ 5%	NS	5.57	30.31	10.24
CV%	2.56	10.40	3.62	3.78

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