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Effect of *Rhizobium* Inoculants on Cowpea under Rainfed Condition

Sarker, P. C., A. F. M. F. Rahman, S. M. A. Shiblee, A. Muqit,
A. S. M. M. Uddin and [1]M. N. Anwar
RARS, BARI, Hathazari, Chittagong, Bangladesh, [1]BARI, Joydebpur, Gazipur, Bangladesh

Abstract: A 2-year on-farm experiment was conducted under rainfed condition to study the effect of *Rhizobium* inoculation (with or without chemical fertilizer) and chemical fertilizer (0 and 50-30-20 Kg ha^{-1} P_2O_5, K_2O and S) on cowpea. Two sources of biofertilizer were used. Biofertilizer showed significantly higher yield attributes and seed yield of cowpea as compared to control. Biofertilizer of BARI source gave the highest cowpea seed yield (880 Kg ha^{-1}) and the lowest seed yield (658 Kg ha^{-1}) was obtained without biofertilizer. No significant difference was found between the two sources of bio-fertilizer. Chemical fertilizer showed better performance than control in case of seed yield and all yield contributing characters of cowpea. Interaction of bio-fertilizer and chemical fertilizer also showed statistically significant difference. PKS with biofertilizer of both BAU and BARI sources gave the highest seed yield (987 Kg ha^{-1}) and the lowest seed yield (525 Kg ha^{-1}) was obtained from control treatment. Though the highest average rate of return (4556%) was found using biofertilizer of BARI source but on consideration of net return and also soil health, PKS with biofertilizer of BARI source where ARR was the second highest may be suggested for growing cowpea under rainfed condition.

Key words: *Rhizobium*, cowpea, biofertilizers, chemical fertilizer

Introduction

Cowpea (*Vigna unguiculata* L. Walp) is one of the legumes which are of major nutritional, agricultural, economic and overall of general importance as food source for men and animals (Okigbo, 1979) and one of the oldest pulse crops grown in Asian and African tropics (Gowda and Kaul, 1982). It is a highly nutritious pulse, containing 24.2 % protein, 62% soluble carbohydrate and 3.2% minerals (Anonymous, 1984; Elias *et al.*, 1964). The economic value of this crop has long been recognized in Africa, particularly as a subsidiary crop to be relied on, during the "hungry season" (Aykroyd and Doughty, 1964). However, cowpea is still a major pulse crop only in the Chittagong region (Gowda and Kaul, 1982) and this crop has also been cultivated in the districts of Noakhali, Comilla, Dhaka, Tangail and Barisal (Anonymous, 1984). Cowpea is grown on a wide range of soil types in the semi-arid to sub-humid low land tropics (Rachie and Silvestre, 1977).

The average yield of cowpea is quite low all over the world. Rhizobium significantly improves the yield in many legume crops (Dravid, 1991). There is a great possibility to increase its production by inoculating effective nitrogen fixing bacteria to cowpea seed. Cowpea is cultivated as a low input crop on marginal lands of poor fertility, particularly in rainfed areas of Chittagong region. However, it responds favorably to added fertilizers (Gowda and Kaul, 1982). The common practice of planting cowpea with little or no fertilizer usually results in poor yield. Results of various investigations in the tropics have indicated a significant response of cowpea to P (Akinola, 1978). Deficiency of Phosphorous is now considered one of the major constraints to successful production of legumes and upland crops in Bangladesh (Islam and Noor, 1982). The effect of P in producing higher seed yield was quite evident. Roy and Tripthi (1985) reported that grain and straw yields increased due to application of P_2O_5 up to 75 Kg ha^{-1} in chickpea. Rajput(1994) reported that cowpea seed yield increased up to 50 Kg P_2O_5 ha^{-1}. Potassium fertilizer along with other fertilizers significantly increased seed yield up to 30 Kg K_2O ha^{-1}. Sulphur along with other nutrient elements significantly increased seed yield up to 20 Kg ha^{-1} (Chowdhury *et al.*, 1997). From the above discussion, the fertilizer dose 50-30-20 Kg ha^{-1} P_2O_5, K_2O and S for higher cowpea yield may be considered as better doses. There is a scope to increase cowpea seed yield by *Rhizobium* inoculation with chemical fertilizer. But the study in this regard is very little. The present study was, therefore, under taken to evaluate the effect of *Rhizobium* inoculants with or without chemical fertilizer to cowpea.

Materials and Methods

The experiment was laid out in a two factor randomized complete block design with (RCBD) four replications. Factor one was use of biofertilizer (with or without chemical fertilizer) to cowpea. The other factor was chemical fertilizer (with or without biofertilizer). There were three treatments of biofertilizer viz., i) no bio-fertilizer (I_0), ii) bio-fertilizer of BAU, Mymensingh, Bangladesh source (I_1) and iii) bio-fertilizer of BARI, Gazipur, Bangladesh source (I_2) and two treatments of chemical fertilizer viz. i) zero (0) and ii) 50-30-20 Kg P_2O_5, K_2O and S. PKS in the form of triple super phosphate, muriate of potash and gypsum, respectively. Soil samples collected before setting up the first experiment had pH 5.17, organic matter 1.62%, Nitrogen 0.12%, Potassium 0.22 me/100 g soil, Phospphorus 16.5 ppm, Sulphur 14.0 ppm, Boron 0.27 ppm and Zinc 1.24 ppm. All fertilizers were applied as basal, during final land preparation. *Rhizobium* inoculants with the help of water were mixed with cowpea seeds using it as a sticker at the rate of 25 g Kg^{-1} seed early in the morning. Cowpea seeds were sown in line with 30 cm x 15 cm spacing and two seeds were sown per hill. Gap filling and thinning were done after 10 days of first sowing. Weeding and plant protection measures were taken as and when necessary. Ten plants from each unit plot were selected at random for the data collection of plant height, number of seeds per pod and 100 seed weight. Plot wise seed yield and stover yield were recorded. Pods were hand picked 3 times to complete harvesting. The collected data were analyzed statistically. The difference between treatment means was compared by Least Significant Difference (LSD). Economic evaluation was also performed.

Results and Discussion

Biofertilizer showed significantly higher seed yield of cowpea than not using it (Table 1). It also enhenced cowpea yield attributes to gave higher yield. Biofertilizer of BAU source

Table 1: Effect of bio-fertilizer on yield and yield contributing characters of cowpea (pooled data, in 1997-98 and 1998-99)

Treatment	Plant height (cm)	Branch/plant (No.)	Pod/plant (No.)	Seed/pod (No.)	100 seed weight (g)	Seed yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})	Seed yield increase over control (%)
Io	29.55 c	3.59 c	6.32 b	6.74 b	9.69 b	658 b	2034 b	---
I_1	36.85 a	4.56 b	7.61 a	7.99 a	10.15 a	858 a	2543 a	30
I_2	33.85 b	4.99 a	7.85 a	7.77 a	10.21 a	880 a	2569 a	34
LSD (0.05)	1.045	0.213	0.41	0.305	0.247	27.27	83.89	

The figures having common letter(s) did not differ significantly at 1% level by DMRT

Io = no bio-fertilizer, I_1 = bio-fertilizer of BAU source and Is = bio-fertilizer of BARI source

Table 2: Effect of chemical fertilizer on yield and yield contributing characters of cowpea (pooled data, in 1997-98 and 1998-99)

Treatment	Plant height (cm)	Branch/plant (No.)	Pod/plant (No.)	Seed/pod (No.)	100 seed weight (g)	Seed yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})
CFo	31.52 b	3.87 b	6.46 b	6.90 b	9.68 b	676 b	2046 b
CF	35.32 a	4.90 a	8.05 a	8.10 a	10.35 a	922 a	2719 a

The figures having common letter(s) did not differ significantly at 1% level by DMRT

CFo = without chemical fertilizer; CF = with chemical fertilizer

Table 3: Interaction effect of bio-fertilizer and chemical fertilizer on yield and yield contributing characters of cowpea, Chittagong (pooled data, in 1997-98 and 1998-99)

Treatment	Plant height (cm)	Branch/plant (No.)	Pod/plant (No.)	Seed/pod (No.)	100 seed weight (g)	Seed yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})
Io	26.95 d	3.20 e	5.41 c	6.14 c	9.45 c	525 d	1728 d
I_1	35.25 b	3.98 d	6.76 b	7.38 b	9.75 bc	730 c	2187 c
I_2	32.35 c	4.43 c	7.21 b	7.19 b	9.83 b	773 b	2221 c
PKS + Io	32.15 c	3.99 d	7.23 b	7.34 b	9.93 b	792 b	2340 b
PKS + I_1	38.45 a	5.15 b	8.45 a	8.61 a	10.55 a	987 a	2900 a
PKS + I_2	35.35 b	5.55 a	8.49 a	8.35 a	10.59 a	987 a	2918 a
LSD (0.05)	1.477	0.301	0.579	0.431	0.350	38.56	118.6

The figures having common letter(s) did not differ significantly at 1% level by DMRT

Table 4: Summery of cost and return analysis

Treatment	Total variable cost (Tk. ha^{-1})	Gross return (Tk. ha^{-1})	Net return (Tk. ha^{-1})	Benefit-cost ratio	Average rate of return (%)
I_0	6220	8828	2608	1.42	-
I_1	6308	12220	5912	1.94	-
I_2	6308	12925	6617	2.05	4556
PKS+I_0	8501	13249	4748	1.56	-
PKS+I_1	8589	16520	7931	1.92	-
PKS+I_2	8589	16523	7934	1.92	225

Price : Tk./Kg

Cowpea seed : 16.00 Triple super phosphate : 14.00 cowpea straw : 0.25 Muriate of potash : 9.00

Biofertilizer: 100.00 Gypsum: 2.50

showed the plant height and BARI source showed the highest number of branch/plant. For above two characters significantly different response was found from the two sources of biofertilizer and the lowest response was found from control treatment. For other yield attributes like pod/plant, seed/pod, 100 seed weight, and also seed yield and straw yield, biofertilizer of both sourses showed the statistically similar response and higher than that of control treatment. Biofertilizer increased up to 34% cowpea seed yield over control treatment. Shaktawat (1988) reported that the seeds inoculated with *Rhizobium* gave higher cowpea seed yields than uninoculated ones. Dravid (1991) also supported that *Rhizobium* significantly improves the yield in many legume crops. Raj and Patel (1991) reported that *Rhizobium* inoculation increased seed yield by 0.15 t. *Rhizobium* can minimize the use of chemical, nitrogenous fertilizer which is rather expensive and causes injury to soil properties. But there was found no significant difference among the two sources of bio-fertilizer.

Chemical fertilizer showed better performance than using no chemical fertilizer in case of seed yield, straw yield and all yield contributing characters of cowpea like, plant height, branch/plant, pod/plant, seed/pod and 100 seed weight (Table 2). Cowpea had significant response to phosphorus, potassium and sulphur fertilizer (Akinola, 1978; Saraf, 1983 and Chowdhury *et al.*,1997). Interaction of using bio-fertilizer and chemical fertilizer also showed statistically significant difference (Table 3). The highest plant height (38.45cm) was found using BAU inoculum with PKS and the lowest was found from control treatment. Similarly the highest branch/plant was found from biofertilizer of BARI source with PKS. For other yield attributes like pod/plant, seed/pod, 100 seed weight and also seed yield and straw yield, PKS with biofertilizer of both sources showed the statisically similar response and higher than control treatment. The highest seed yield was found from the treatment using PKS with any source of biofertilizer. The best performance of cowpea was found, when chemical fertilizer was used with bio-fertilizer. Singh *et al.* (1989) reported that P application and seed inoculation increased the length, thickness and number of pods, number of grains/pod, pod yield and net profit. The highest net return was found using PKS with biofertilizer of BARI source. Inspite of this, the highest benefit cost ratio and average rate of return was found, when only biofertilizer of BARI source was used. This was due to very low cost of biofertilizer. Biofertilizer is the cheapest source of nitrogen (Table 4) but on consideration of soil health it was not wise to suggest the use of biofertilizer alone. The second highest average rate of return including the highest net return was found when PKS with biofertilizer of BARI source was used. From the above

discussion, it was clear that *Rhizobium* inoculum with chemical fertilizer had a great impact of increasing cowpea seed yield.

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