American Journal of Experimental Agriculture
8(3): 159-166, 2015, Article no.AJEA.2015.159
ISSN: 2231-0606

SCIENCEDOMAIN *international*
www.sciencedomain.org

SCIENCEDOMAIN

Influence of Bioinorganic Combinations on Yield, Quality and Economics of Mung Bean

R. S. Meena[1*], Yubaraj Dhakal[1], J. S. Bohra[1], S. P. Singh[1], M. K. Singh[1], Pratik Sanodiya[1] and Hemraj Meena[1]

[1]*Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, U. P., 221 005, India.*

Authors' contributions

This work was carried out in collaboration between all authors. All authors contribute for designed the study, performed the statistical analysis and wrote the first draft of the manuscript. Author RSM carried out edited corrections and facilitated all e-mail correspondences. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJEA/2015/17065
Editor(s):
(1) Peter A. Roussos, Lab. Pomology, Agricultural University of Athens, Greece.
Reviewers:
(1) Anonymous, Egypt.
(2) Milena Moteva, University of Architecture, Institute of Soil Science, Bulgaria.
(3) Anonymous, Malaysia.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=1077&id=2&aid=8953

Original Research Article

Received 25th February 2015
Accepted 18th March 2015
Published 24th April 2015

ABSTRACT

A field study was conducted during rainy (*kharif*) season of 2013 to find out the effect of bioinorganic nutrient combinations on yield, quality and economics of mungbean [*Vigna radiate* (L.) Wilczek]. The twelve treatments comprised one control, three levels of inorganic sources (75, 50 and 100% NPK of recommended dose) and other eight in combination *viz.* 50% RDF+ *Rhizobium* + Phosphorus solublizing bacteria (PSB), 50% RDF + 2.5 t/ha Vermicompost, 50% RDF+2.5 t/ha Vermicompost/ha + *Rhizobium* + PSB, 75% RDF+ *Rhizobium* + PSB, 75% RDF + 2.5 t/ha Vermicompost, 75% RDF + 2.5 t/ha Vermicompost + *Rhizobium* +PSB, 100%RDF+ *Rhizobium*+ PSB and 100% RDF + 2.5 t/ha Vermicompost were laid out in randomized block design with three replications. Amongst combinations, significant improvement in plant height at harvest, yield attributes, yield, protein per cent, nutrient content and uptake were recorded with application of nutrients through 75% RDF + 2.5 t/ha vermicompost + *Rhizobium* + PSB as compared to other combinations, followed by treatments 100% RDF + 2.5 t/ha vermicompost and 100% RDF + *Rhizobium* + PSB. The highest and comparable net returns were obtained with the application of

**Corresponding author: E-mail: rsmeenaagro@gmail.com;*

100% RDF + *Rhizobium* + PSB (INR 52894.73) followed by 75% RDF + 2.5 t/ha vermicompost + *Rhizobium* + PSB (INR 51582.60) and 75% RDF + + *Rhizobium* + PSB (INR 50664.74). The above studies show that bioinorganic combinations have their own roles play to higher productivity, not only solely supply all the nutrients to the soils but also create favorable conditions for betters growth to producing crop.

Keywords: Economics; nutrient; PSB; Rhizobium; vermicompost; yield.

1. INTRODUCTION

Mung bean [*Vigna radiate* (L.) Wilczek] has been grown in India since ancient times. It is one of the important pulse crop of India and is grown under sole, mixed and multiple cropping systems during rainy (*kharif*), spring and summer seasons under wide range of agro-climatic conditions [1]. In commercial agriculture, the use of macro nutrient fertilizers cannot be ruled out completely resulted soil is hungry. However, there is a need for bioinorganic combinations of alternate sources of nutrients for sustaining soil health and crop productivity [2]. In bioinorganic combinations *Rhizobium*, phosphorus solubilizing bacteria (PSB) and vermicompost are important components. Vermicompost has been found to have beneficial effects when used as a total or partial substitute for mineral fertilizer and as soil amendments in field studies. Likewise, some studies show that vermicomposting leachates or vermicompost water-extracts, used as substrate amendments, also promote the growth and yield parameters of crops [3]. Further, bio-fertilizers are low cost and eco-friendly input have tremendous potential of supplying nutrients which can reduce the chemical fertilizer dose by 24–45% [4]. Nitrogen and phosphorus are the major nutrients which play an important role in crop production. The nitrogen recognized as kingpin to the fertilization programme for higher yield. Phosphorus increases the root efficiency which in turn improves moisture and nutrient utilization under rainfed conditions. For increased nutrient supply through bio-fertilizers, there is a need for improving the efficiency of biological nitrogen-fixation system. Phosphorus-solubilizing bacteria are also reported to be beneficial in increasing the phosphorus availability in soil and thereby seed yield of mungbean. Hence, there is a need to apply vermicompost to improve nutritional environment of the soil. However, meager information is available on the combined effect of vermicompost, *Rhizobium* and phosphorus solubilizing bacteria (PSB) inoculation along with fertilizer nutrients in mungbean for maintaining soil health and higher crop productivity [5]. The main objective of this study was to evaluate the effect of bioinorganic combinations on growth, yield, nutrient parameters and economics of mung bean.

2. MATERIALS AND METHODS

2.1 Experimental Site

An attempt was made to study the response of mungbean to integrated nutrient management. Field experiment was conducted during rainy (*kharif*) season of 2013 at Agronomy Farm, Institute of Agricultural Sciences, BHU, Varanasi (UP), India (Fig. 2). Experimental site was located under eastern plain zone the middle ganges valley of north India elevation 82.71 m, between 82° 56'E – 83° 03'E and 25° 14'N – 25° 23.5'N [6].

2.2 Soil

The soil was sandy clay loam with pH 7.32, available N 160.13 kg/ha [7], P 22.64 kg/ha [8], K 211.41 kg/ha [9] and 0.36% organic carbon [10], in 0-30 cm soil depth.

2.3 Treatment

The twelve treatments comprised one control, three levels of inorganic sources (75, 50 and 100% NPK of recommended dose) and other eight in combination *viz.* 50% RDF+ *Rhizobium* + Phosphorus solublizing bacteria (PSB), 50% RDF +2.5 t/ha Vermicompost, 50% RDF+2.5 t/ha Vermicompost/ha + *Rhizobium* + PSB, 75% RDF+ *Rhizobium* + PSB, 75% RDF + 2.5 t/ha Vermicompost, 75% RDF + 2.5 t/ha Vermicompost + *Rhizobium* + PSB, 100%RDF+ *Rhizobium* + PSB and 100% RDF+2.5 t/ha Vermicompost. Recommended dose of fertilizer 20: 40: 20 kg /ha (N_2:P_2O_5:K_2O) [11,12] were applied as per treatments as basal dose at the time of sowing in furrows at 30 cm apart in at the depth of 10 cm [13]. The required quantity of *Rhizobium* cultures, i.e. @ 200 g culture per 10 kg seed was mixed to 10% sugar solution to form slurry. The culture of PSB 200 g per 12 kg fine soil was well mixed with the help of hand and then applies to as per treatment details. Vermicompost was applied as per treatment. Green gram variety HUM 12 (Maliviya Jenchetna) was sown at 15 kg/ha in line at 30 cm at a depth of 5 cm on 6 August.

2.4 Variety

Variety was developed from the Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, India and notified by Central Varietal Release Committee, ICAR, New Delhi for its cultivation to entire Uttar Pradesh and Uttarakhand. A recommended variety HUM 12 (Maliviya Jenchetna) for cultivation in summer and rainy (*Kharif*) seasons matures in Mean 66, Range 60-71 days. Germination 95%, Plant height is 45-55 cm. Growth habit is erect. Pod shape is long slender, medium in size. Pod length, pods/plant, seeds/pod and 100-grain weight is 6.4 cm, 30, 10.8 and 4.4 g, respectively

2.5 Observations

Plant stand per meter row length was counted at 20 DAS and at harvest from ten randomly selected spots in each plot and the average was worked out. Ten plants were selected randomly from each plot, tagged permanently and used for measurement of plant height. Height of main shoot from the ground surface to base of fully expended leaf was measured by meter scale in centimeters. Average plant height at each growth stage (20 DAS and at harvest) was worked out and recorded. Ten pods were taken at random from the tagged plant and their length was recorded and average length of pod was then calculated. The pods of ten randomly selected and tagged plants were counted and average number of pods per plant was worked out and recorded as mean number of pods per plant. Number of seeds per pod was recorded at harvest by counting the number of seeds of ten randomly selected pods from five tagged plants and average number of seeds/pod was calculated. After threshing, winnowing and cleaning, the product of each plot was weighed separately in kg per plot and converted in terms of seed yield in q/ha. Straw yield was calculated by subtracting the seed yield from biological yield (q/ha). After complete sun drying harvested produce grain and straw of each plot were recorded separately or individual net plot was weighed with the help of spring balance and weight was recorded in kg /plot. Later, biological yield/plot was converted in q/ha. The harvest index was calculated by dividing the economic (grain) yield by total biological yield (grain + straw) and multiplying the fraction by 100 [14].

$$\text{Harvest Index (\%)} = \frac{\text{Seed yield}}{\text{Biological yield}} \times 100$$

2.6 Plant and Grain Analysis

For estimation of nitrogen, phosphorus and potassium content, representative samples of seed and straw were taken at the time of threshing. Each dried straw sample was ground fine powder in Willey mill for estimating the nutrient content. For estimating the nutrient content in seed, each sample was ground by an electric grinder. Nutrient content and protein content in grain and straw were determined by using standard methods.

Nutrient	Analytical method
Nitrogen	Alkaline permanganate method [7]
Phosphorus	Vanado-molybdo-phosphoric acid yellow colour method [15]
Potassium	Flame-Photometric method [15]
Protein in seeds	Nitrogen percentage in seed × 6.25 [16]

2.7 Economics

To find out more profitable treatment, economics of different treatments were worked out in terms of net return (INR/ha) on the basis of prevailing market rate so that the most remunerative treatment could be recommended. The net return was worked out by using following formula: Net return (INR) = Gross return (INR)-Cost of cultivation (INR) Treatment wise benefit: Cost ratio was calculated to ascertain economic viability of the treatment using the following formula:

$$\text{B:C ratio} = \frac{\text{Net returns}}{\text{Cost of cultivation}}$$

2.8 Statistical Analysis

Experiment was laid out in randomized block design with three replications. The significant difference between the treatments and to draw valid conclusion, the data obtained by various observations were subjected to statistical analysis by following appropriate method of analysis of variance (ANOVA) as outlined by

Fisher's [17]. Appropriate standard error for each of the factor was worked out. Significance of differences among treatment effects was tested by "F" test. Critical difference (CD) was worked out wherever the difference was found significant at 5 or 1 per cent level of significance.

2.9 Weather

The daily weather data from 6th August (32th SMW) to 28th October (43rd SMW) were converted into weekly data and mean values were computed. The meteorological data were recorded from agro meteorological observatory at agronomy farm, during the crop growing season showed that the average temperature remained between 17.5ºC and 34.3ºC which was within range for growth of mung bean. Temperature is known to have strong effect on vegetative and reproductive phases [18,19]. The rainfall during the experimental period was 248.5 mm. The maximum rainfall of 112.2 mm was reached during the week number 37 in the month of September. The maximum relative humidity was about 94 per cent was observed in the month of September while the minimum was 37 percent in the month of October. Diversity of mung bean was growing environment as nearly attributable to the difference in the amount and distribution of rainfall in relation to potential evapotranspiration followed by difference in temperature. The weather conditions have greater influences on a crop like mung bean which requires particular temperature, humidity and precipitation during the vegetative phase and more sun-shine duration during the reproductive phase for higher yield. Even slight deviation from the optimum range may adversely affect the crop growth and seed yield [20].

3. RESULTS AND DISCUSSION

The data showed that application of 75% RDF+ vermicompost + bio-fertilizers (*Rhizobium* and PSB) significant increase in plant height at harvest and yield attributes (Table 1), which resulted in better yield attributes ultimately there were beneficial effect on yield, harvest index protein per cent, nutrient content and uptake as compared to other treatments and control. And which was found to be at par with 100% NPK of RDF level + 2.5 t/ha vermicompost and 100% NPK of RDF + *Rhizobium* + PSB. The highest seed yield of mungbean was obtained with the application of recommended dose of 75% RDF + 2.5 t/ha vermicompost + *Rhizobium* + PSB (12.34 q/ha), followed by treatments 100% RDF + 2.5 t/ha vermicompost (12.05 q/ha) and 100% RDF + *Rhizobium* + PSB (11.95 q/ha) (Table 2). Maximum protein content (24.72%) was recorded in 75% RDF + 2.5 t/ha vermicompost + *Rhizobium* + PSB (Fig. 1).

Table 1. Effect of integrated nutrient management on plant height and yield attributes of mung bean

Treatment	Plant stand m^{-2}		Plant height (cm)		Yield attributes			
	20 DAS	At harvest	20 DAS	At harvest	Length of pod (cm)	No. of pods /plant	No. of seeds /pod	Seed index (g)
Control	30.04	28.68	21.25	49.59	4.16	25.68	8.01	3.03
50%RDF	30.71	28.86	22.51	50.85	5.41	28.03	9.27	3.21
75%RDF	32.38	29.41	24.09	52.55	7.11	30.04	10.97	3.45
100%RDF	33.04	30.25	25.42	53.60	8.16	31.08	12.02	3.60
50%RDF+Rh+PSB	37.04	30.08	17.51	52.15	6.71	29.12	10.57	3.42
50%RDF+2.5 t /ha VC	43.71	30.48	24.01	52.35	6.91	29.65	10.77	3.49
50%RDF+2.5t /haVC+Rh+PSB	34.38	29.55	25.65	53.95	8.80	31.48	12.61	3.66
75%RDF+Rh+PSB	35.38	29.62	25.51	53.75	8.31	31.30	12.17	3.61
75%RDF+2.5t /ha VC	41.04	29.92	25.63	53.85	8.77	31.44	12.57	3.63
75%RDF+2.5t /ha VC+Rh+PSB	36.38	31.01	26.28	54.64	9.20	32.49	13.06	3.71
100%RDF+Rh+PSB	36.71	30.61	25.97	54.25	8.82	31.72	12.67	3.68
100%RDF+2.5t /ha VC	34.71	30.22	26.14	54.35	8.91	32.18	12.77	3.70
S.Em±	2.96	1.32	2.06	0.63	0.36	0.43	0.36	0.04
CD (P = 0.05)	NS	NS	NS	1.84	1.04	1.26	1.05	0.10

RDF: recommended dose of fertilizer, VC: vermicompost, Rh: rhizobium, PSB: phosphorus solublizing bacteria, DAS: days after sowing, NS: non significant

Table 2. Effect of integrated nutrient management on yields and economics of mung bean

Treatment	Yield (q/ha)			Harvest index (%)	Net returns (INR/ha)	Benefit: cost ratio
	Seed	Straw	Biological			
Control	7.29	24.74	32.04	22.74	29,990.48	2.62
50%RDF	8.55	27.09	35.64	23.99	36,020.98	2.96
75%RDF	10.25	28.78	39.03	26.25	44,457.41	3.55
100%RDF	11.30	29.83	41.13	27.45	49,565.84	3.84
50%RDF+Rh+PSB	9.85	28.38	38.23	25.76	42,713.64	3.50
50%RDF+2.5 t /ha VC	10.05	28.59	38.64	26.02	40,070.98	2.52
50%RDF+2.5t /haVC+Rh+PSB	11.65	30.40	42.05	27.70	48,383.35	3.03
75%RDF+Rh+PSB	11.45	29.98	41.43	27.63	50,664.74	4.03
75%RDF+2.5t /ha VC	11.55	30.23	41.78	27.63	47,497.93	2.92
75%RDF+2.5t /ha VC+Rh+PSB	12.34	31.15	43.49	28.32	51,582.60	3.16
100%RDF+Rh+PSB	11.95	30.48	42.43	28.16	52,894.73	4.08
100%RDF+2.5t /ha VC	12.05	30.58	42.63	28.26	49,698.51	2.98
S.Em±	0.37	0.40	0.73	0.54	1,918.86	0.14
CD (*P* = 0.05)	1.09	1.16	2.13	1.60	5,627.84	0.41

RDF: recommended dose of fertilizer, VC: vermicompost, Rh: rhizobium, PSB: phosphorus solublizing bacteria

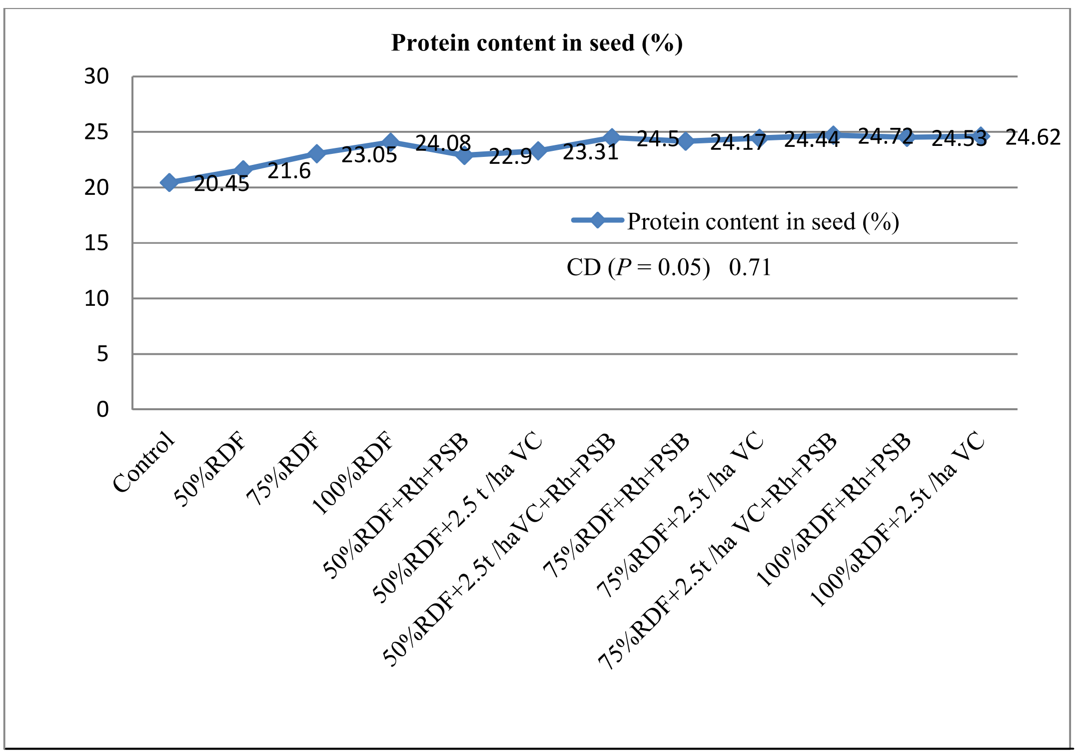

Fig. 1. Effect of integrated nutrient management on nutrient content (%) of mung bean

Similarly highest NPK content and uptake were recorded in 75% RDF + 2.5 t/ha vermicompost + *Rhizobium* + PSB (Tables 3 and 4). The combined inoculation of *Rhizobium* and PSB with vermicompost has proved one of the most efficient approaches to in increasing in plant height and yield attributes, yield, protein per cent (Fig. 1), nutrient content and uptake [21]. Dual inoculation might have contributed something towards enhanced plant growth and increased nitrogen or soluble phosphorus. Increased growth parameters with dual inoculation with *Rhizobium* and PSB were observed in mung bean [22,23]. Vermicompost improve the physical, chemical and biological properties of soils including supply of almost all the essential plant nutrients for the growth and development of plant. Similar reported [24,]. Synergism in *Rhizobium and* PSB might have also resulted in better yield and nutrient content with their dual inoculation [25,26]. The highest and comparable net returns (Table 2) were obtained with the application of 100% RDF + *Rhizobium* + PSB (INR 52894.73) followed by 75% RDF + 2.5 t/ha vermicompost + *Rhizobium* + PSB (INR 51582.60) and 75% RDF + + *Rhizobium* + PSB (INR 50664.74). The maximum benefit cost ratio recorded with application of 100% RDF + *Rhizobium* + PSB (4.08) followed by 75 % RDF + 2.5 t/ha + *Rhizobium* + PSB (4.03) with inoculants (*Rhizobium* + PSB) (53.40), 100% RDF (3.84) and 75% RDF + 2.5 t/ha vermicompost + *Rhizobium* + PSB (3.16) were over control [27,28].

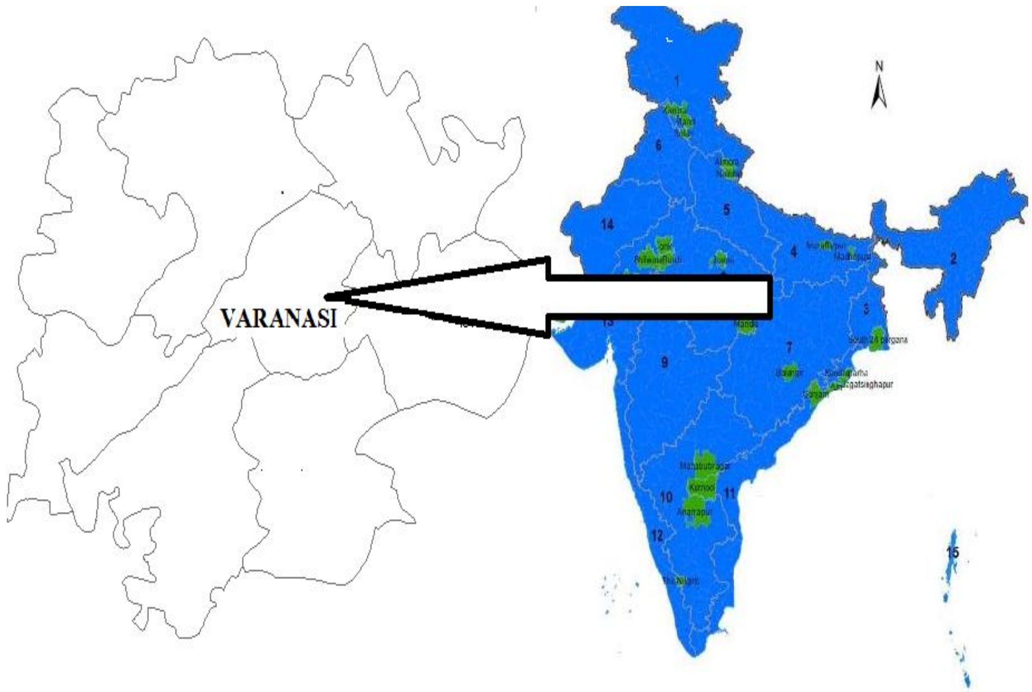

Fig. 2. Experimental site in India

Table 3. Effect of integrated nutrient management on nutrient content of mung bean

Treatment	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)	
	Seed	Straw	Seed	Straw	Seed	Straw
Control	3.27	1.22	0.350	0.141	0.860	1.108
50%RDF	3.46	1.54	0.368	0.169	1.043	1.184
75%RDF	3.69	1.77	0.373	0.187	1.267	1.205
100%RDF	3.85	1.89	0.419	0.212	1.432	1.213
50%RDF+Rh+PSB	3.66	1.75	0.385	0.198	1.243	1.197
50%RDF+2.5 t/ha VC	3.73	1.81	0.356	0.188	1.308	1.228
50%RDF+2.5t/haVC+Rh+PSB	3.92	1.96	0.428	0.227	1.485	1.270
75%RDF+Rh+PSB	3.87	1.89	0.422	0.215	1.447	1.217
75%RDF+2.5t/ha VC	3.91	1.92	0.425	0.220	1.475	1.252
75%RDF+2.5t/ha VC+Rh+PSB	3.96	2.00	0.483	0.284	1.534	1.307
100%RDF+Rh+PSB	3.92	1.97	0.442	0.239	1.511	1.276
100%RDF+2.5t/ha VC	3.94	1.99	0.454	0.242	1.519	1.303
S.Em±	0.039	0.080	0.026	0.016	0.036	0.0266
CD (P = 0.05)	0.114	0.236	0.075	0.047	0.105	0.0780

RDF: recommended dose of fertilizer, VC: vermicompost, Rh: Rhizobium, PSB: phosphorus soludlizing bacteria

Table 4. Effect of integrated nutrient management on total nutrient uptake by mung bean

Treatment	Nutrient uptak (kg/ha)		
	Nitrogen	Phosphorus	Potassium
Control	54.11	6.06	33.65
50%RDF	71.28	7.72	41.01
75%RDF	88.78	9.21	47.68
100%RDF	99.82	11.08	52.36
50%RDF+Rh+PSB	85.62	9.43	46.23
50%RDF+2.5 t /ha VC	89.26	8.95	48.24
50%RDF+2.5tVC+Rh+PSB	105.32	11.89	55.92
75%RDF+Rh+PSB	101.06	11.30	53.10
75%RDF+2.5t /ha VC	103.12	11.57	54.88
75%RDF+2.5t /ha VC+Rh+PSB	111.22	14.78	59.63
100%RDF+Rh+PSB	107.04	12.58	56.94
100%RDF+2.5t /ha VC	108.30	12.89	58.14
S.Em±	3.60	0.77	1.40
CD (P = 0.05)	10.558	2.265	4.122

RDF: recommended dose of fertilizer, VC: vermicompost, Rh: Rhizobium, PSB: phosphorus solublizing bacteria

4. CONCLUSION

The above studies show that bioinorganic combinations have their own roles play to higher productivity, not only solely supply all the nutrients to the soils but also create favorable conditions for betters growth to producing crop. Increased growth, yield and nutrient parameters of mung bean in this study, this may be associated with the supply of essential nutrients by continuous mineralization of organic manures, enhanced inherent nutrient supplying capacity of the soil and its favorable effect on soil physical and biological properties to better yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ram K, Meena RS. Evaluation of Pearl Millet. Mung bean intercropping systems in Arid Region of Rajasthan (India). Bangladesh Journal of Botany. 2014;43(3): 367-370.
2. Pattanayak SK, Rao DLN, Mishra KN. Effect of biofertilizers on yield, nutrient uptake and nitrogen economy of rice–peanut cropping sequence. Journal of the Indian Society of Soil Science. 2007;55: 184–9.
3. Ram Swaroop, Ramawatar. Role of vermicompost in crop production–A Review. International Journal of Tropical Agriculture. 2012.30(3-4):143-146.
4. Gupta SC. Effect of combined inoculation on nodulation, nutrient uptake and yield of chickpea in Vertisol. Journal of the Indian Society of Soil Science. 2006;54:251–4.
5. Meena RS. Effect of organic and inorganic sources of nutrient on growth attributes and dry matter partitioning of mungbean [*Vigna radiata* (L.) Wilczeck] in arid western Rajasthan. Environment & Ecology. 2013;31(1):131-134.
6. Singh Rana PB. Varanasi as heritage city (India) on the scale the UNESCO World Heritage List: From Contestation to Conservation. EASAS papers. Swedish South Asian Studies Network. 2006;1-11.
7. Subbiah BV, Asija GL. A raped processor of determination of available nitrogen in nitrogen in soil. Current Sciences. 1956;25: 259-260.
8. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circ. Washington. 1954;939.
9. Stanford S, English L. Use of flame photometer in rapid soil tests for K and Ca. Agronomy Journal. 1949;41:446–7.
10. Walkley A, Black IA. Rapid titration method for organic carbon of soils. Soil Science. 1947;37:29-32.
11. Meena RS, Sharma SK. Effect of organic and inorganic sources of nutrients on yield attributes, yield and economics of Greengram [*Vigna radiata* (L.) Wilczeck]. Annals of Agri-Bio Research. 2013;18(3): 306-308.
12. Meena RS, Sharma SK. Physiological parameters and chlorophyll content of

greengram (*Vigna radiate* L.) as affected by organic and inorganic sources of nutrients in arid western Rajasthan. International Journal of Tropical Agriculture. 2012;30(1-2):99-101.
13. Meena RS. Effect of organic and inorganic sources of nutrients on nutrient status of crop and soil after harvest of greengram [*Vigna radiata* (L.) Wilczeck] in arid western Rajasthan. Annals of Biology. 2013;29(3):307-310.
14. Singh IO, Stoskopf YC. Harvest index in cereals. Agronomy Journal. 1971;63:224-226.
15. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt Ltd, New Delhi; 1973.
16. AOAC. Official Methods of Analysis. 18th Edition. Association of Official Agriculture Chemists, Washington; 1960.
17. Fisher RA. Statistical methods for research workers. Oliver and Boyd. Edinburg, London; 1950.
18. Meena RS. Yadav RS. Groundnut yields as influenced by heat unit efficiency, fertility levels and varieties under different growing environment in hyper aridne of Rajasthan. Indian Journal of Ecology. 2013;40(1):110-114.
19. Meena RS, Yadav RS, Meena VS. Heat unit efficiency of groundnut varieties in scattered planting with various fertility levels. The Bioscan. 2013;8(4):1189-1192.
20. Hoffman AA, Sorensen JG, Loeschcke V. Adaptation of *Drosophila* to temperature extremes: Bringing together quantitative and molecular approaches. Journal of Thermal Biology. 2003;28:175-216.
21. Sharma P, Gupta RP, Khanna V. Evaluation of liquid *Rhizobium* inoculants in mungbean, urdbean and pigeonpea under field conditions. Indian Journal of Pulses Research. 2006;19(2):208-209.
22. Varghese N. Changing directions of groundnut trade in India: The WTO effect. Int. conf. appl. eco. 2011;731.
23. Meena RS, Ramawatar, Kamalesh A, Ram K. Effect of organic and inorganic source of nutrients on yield, nutrient uptake and nutrient status of soil after harvest of greengram. An Asian Journal of Soil Science. 2013;8(1):80-83.
24. Singh Rajesh, Dubey YP. Effect of Organic and Inorganic Nutrients on Yield of Rajmash (*Phaseolus vulgaris* L.) in Dry Temperate Zone of Himachal Pradesh. 2015;3(1):1-3.
25. Kumar S, Singh RC, Kadian VS. Performance of mungbean as influenced by seed inoculation. Indian Journal of Pulses Research. 2003;16(1):67-68.
26. Othman WMW, Ismail MS. Effect of applied nitrogen and detopping on seed yield of mung bean. Food Legume Improvement for Asian Farm. ACIAR proceedings series. 1987;18:265.
27. Ishtiyaq Ahmed, Najar, Anisa Khan B, Abdul Hai. Effect of macrophyte vermicompost on growth and productivity of brinjal (*Solanum melongena*) under field conditions. International Journal of Recycling of Organic Waste in Agriculture. 2015;10:1007/s40093-015-0087-1.
28. Tiwari KN. Nutrient management for sustainable agriculture. Journal of the Indian Society of Soil Science. 2002;50: 374–7.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=1077&id=2&aid=8953