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EFFECT OF DIFFERENT FERTILITY LEVELS AND BIO-ORGANICS ON GROWTH, YIELD AND PROTEIN CONTENT OF MUNGBEAN (*VIGNA RADIATA* L. WILCZEK) IN ARID REGION OF RAJASTHAN, INDIA

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ABSTRACT

A field experiment was conducted at Agronomy farm, Mahatma Jyoti Rao Phoole, College of Agriculture & Research, Achrol, Jaipur, Rajasthan during Kharif season of 2019 on sand loam soil which consisted of four fertility levels (Control, 50%, 75%, 100% and 125% RDF) and bio-organics (Control, PSB, Vermicompost and PSB + Vermicompost) thereby making combinations of 20 treatment and tested in a Randomized Block Design with three replications. Result showed that the application of 125 % RDF gave significantly increased plant height, dry matter accumulation, chlorophyll content, yield attributes and protein content in seed followed by 100% RDF, 75 % RDF, 50% RDF and Control. Application of bio-organics significantly increased the plant height, dry matter accumulation, chlorophyll content and yield attributes followed by Vermicompost @ 2 t/ ha, PSB and control.

Keywords: *Vigna radiata*, Bio-organics, RDF, protein content, Vermicompost, Mungbean, Greengram

Introduction

Greengram (*Vigna radiata L. Wilczek*) belongs to the family Leguminaceae and sub-family Papilionaceae also known as Mungbean is a self-pollinated leguminous crop grown during Kharif as well as summer seasons in arid and semi-arid regions of India. Summer mungbean is cultivated in states of Madhya Pradesh, Punjab, Haryana, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh and Tamil Nadu. The association of PSB and pulse plants helps in improving fertility of soil and cost-effective method of phosphate fertilization in legumes (Singh *et al.,* 2015). Vermicompost is also valuable and suitable cost-effective organic manure which has special place and best alternative in the sustainable agriculture and organic cultivation (Marko *et al*., 2013). Mungbean plays a very important role in supplying protein (24.5%) requirement of humans (Peter and Bhalerao 2015). Vermicompost is a sustainable organic manure and rich source of major and micronutrients. However, poor nutrient economy of light textured soils necessitates the need for supplementing fertilizer with organic manures (Alizadeh, 2012). Priya *et al*. (2024) showed that significantly higher growth parameters viz., plant height, number of nodules, dry weight and yield attributes and Stover yield was observed at application of 5 t/ha FYM along with foliar spray of 7.5 % K sap at 15 and 30 DAS performed better in terms of yield and economic returns. Pandey *et al.,* (2019) showed that application of NPK through inorganic source with FYM and vermicompost significantly increased yield attributes at all level of fertilizer. Hence, in the present study impact of different fertility level and bio-organics on growth, yield and protein content on Mungbean (*Vigna radiata* (*L.*) *wilczek*) in arid region of Rajasthan.

Materials and Methods

A field experiment was conducted at Agronomy farm of MJRP College of Agriculture and Research,

Tala (Achrol) Jaipur (Rajasthan) during Kharif, 2019 season. Geographically, MJRP is situated 30 km from Jaipur at 26005' North latitude, 75028' East longitude and at an altitude of 427 meters above mean sea level. The place falls in agroclimatic zone III A (Semi-arid eastern plain zone) of Rajasthan. The long-term average annual rainfall of the locality ranges between 400-500 mm, 85 per cent of which is received from south-west monsoon during the months of July and sept but has declined over recent years. A total of 220.4 mm rainfall was received during crop season. The experiment comprising of five levels each of fertility (Control, 50% RDF, 75% RDF and 100% RDF, 125% RDF*) and bio-organics (Control, PSB, Vermicompost @ 2 t/ha and PSB* + Vermicompost @ 2 t/ha) thereby making combinations of twenty treatments laid out in Randomized Block Design and replicated thrice. (* RDF= Recommended Dose of Fertilizer and *PSB = Phosphorus Soluble Bacteria)

The observations recorded on Growth parameters, yield and protein content in seeds.

Growth parameters

Plant height

Five plants were selected randomly from each plot, tagged and used for measurement of plant height. Height of main shoot i.e., from the ground surface to base of fully expanded leaf was measured by meter scale in centimeters. Average plant height at each growth stage (25, 50 DAS and at harvest) was taken.

Number of branches per plant

The five plants randomly selected and tagged in each plot for height measurement and used to record the number of branches per plant at 50 DAS and at harvest and their average was recorded.

Dry matter accumulation per plant

Plants from one meter row length were uprooted from rows of each plot at 25, 50 DAS and at harvest. After removal of root portion, the samples were first air dried for some days and finally dried in an electric oven at 70^0C till a constant weight was achieved. The weight was recorded and expressed as average dry matter in g per meter row length.

Chlorophyll content (mg/g)

The chlorophyll content at 40 DAS was estimated by the method advocated by Arnon (1949) by taking 50 mg fresh leaf material. Samples were homogenized in 80% acetone, centrifuged for 10 minutes at 2000 rpm and made final volume to 10 ml. Absorbance of clear supernatant solution was measured by Spectronic -20 at 652 nm. The chlorophyll content was expressed in mg/g of fresh weight leaves.

- **Fresh and dry weight of nodules per plant (mg)**
- **Total nodules**

The total root nodules so obtained from five plants from each plot was weighed and then subjected to oven dry at 70^0C till a constant weight was obtained and then average was taken.

➢ **Yield attributes**

- **Number of pods per plant**

The randomly selected plants used for recording height and branches were used for counting total number of pods at harvest and their average was taken.

- **Number of seeds per pod**

Number of seeds per pod was recorded at harvest by counting number of seeds of ten randomly selected pods from five tagged plants and average was taken.

Test weight

One thousand seeds were counted from sample drawn randomly from finally winnowed and cleaned produce of each plot and their weight was recorded as test weight.

Seed yield

The total biomass of each plot was threshed and cleaned. Seeds so obtained was weighed in term of kg/plot and then converted into Kg/ha.

Straw yield

Straw yield was calculated by subtracting the seed yield from biological yield and converted into q/ha

Biological yield

After complete sun drying, picked pods and harvested bundles of each net plot was weighed for biological yield and converted in terms of Kg/ha.

Harvest index

Harvest index was computed by using the formula outlined by Singh and Stoskopf (1971).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (q/ha)}}{\text{Biological yield (q/ha)}} \times 100$$

Protein content in seed

The per cent crude protein content in seed was calculated by multiplying nitrogen per cent in seed with a factor 6.25 (A.O.A.C., 1960).

Result and Discussion

Plant height (cm)

Plant height was observed maximum at harvest on the application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing the taller plants by 46.29 cm, 44.99 cm, 43.29cm, 42.10cm, 39.70 cm at harvest respectively. In bio-organics, plant height was observed maximum at harvest stage in treatment PSB + Vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 46.50cm, 43.50 cm, 42.90 cm, 40.20 cm respectively as shown in Table 1. Similar result was found by Pandey *et al.,* (2019) and Singh *et al.* (2019).

Number of branches per plant

Number of branches per plant was observed maximum at harvest on the application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing the taller plants by 13.86, 13.26, 12.96, 11.47, 8.57 at harvest respectively. In bio-organics, Number of branches per plant was observed maximum at harvest stage in treatment PSB + Vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 14.30, 12.10, 11.90, 9.80 respectively. As organic manures help to stabilize root development, nodules formation and nitrogen fixation by supplying assimilates to the root as shown in Table 1. Similar result was found by Pandey *et al*. (2019).

The organic manures play an important role in root development and proliferation resulting in better nodules formation and nitrogen fixation by supplying assimilates to the root. They also increase water holding capacity and phosphate availability in soil thus provide better environment in rhizosphere for growth and development. The vermicompost enhanced the release of nutrients early in the crop period.

Dry matter accumulation per plant (gm)

Dry matter accumulation per plant was observed maximum at harvest on the application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing taller plants by 117.36 gm, 112.35 gm, 111.15 gm, 103.45 gm, 90.79 gm at harvest respectively. In bio-organics Dry matter accumulation per plant was observed maximum at harvest stage in treatment PSB + vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 118.20 gm, 108.35 gm, 104.59 gm, 96.93 gm respectively as shown in Table 1. Similar result was found by Pandey *et al*., (2019).

Chlorophyll content

Chlorophyll content was observed maximum at reproductive stage in the application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing higher chlorophyll content as 3.74 mg/g, 3.58 mg/g, 3.43 mg/g, 3.19 mg/g, 2.69 mg/g respectively. In bio-organics, chlorophyll content was observed maximum at reproductive stage in treatment PSB + vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 3.80 mg/g, 3.38 mg/g, 3.26 mg/g, 2.86 mg/g respectively as shown in Table 2. Similar result was found by Pandey *et al*. (2019).

Total number of root nodules per plant

Total number of root nodules per plant was observed maximum at application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing 34.30, 32.63, 32.31, 31.28, 29.57 respectively. In bio-organics, total number of root nodules per plant was observed maximum in treatment PSB + vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 34.30, 32.27, 31.60, 29.92 respectively as shown in Table 2. Similar result was found by Pandey *et al*. (2019).

Number of effective root nodules per plant

Number of effective root nodules per plant was observed maximum at application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing 32.68, 31.11, 30.52, 29.44, 27.95 respectively. In bio-organics, number of effective root nodules per plant was observed maximum in treatment PSB + vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 32.43, 30.32, 30.11, 28.49 respectively as shown in Table 2. Similar result was found by Pandey *et al*. (2019).

Fresh weight of root nodules per plant

Fresh weight of root nodules per plant was observed maximum at application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing 114.05, 108.10, 107.21, 105.23, 100.12 respectively. In bio-organics, fresh weight of root nodules per plant was observed maximum in treatment PSB + vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 112.72, 106.56, 105.64, 102.86 respectively as shown in Table 2. Similar result was found by Pandey *et al*. (2019).

Dry weight of root nodules per plant

Dry weight of root nodules per plant was observed maximum at application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing 65.20, 62.21, 61.48, 60.11, 55.52 respectively. In bio-organics, fresh weight of root nodules per plant was observed maximum in treatment PSB + vermicompost @ 2 t/ha followed by

Vermicompost @ 2 t/ ha, PSB and Control with 64.70, 61.19, 60.49, 57.22 respectively as shown in Table 2. Similar result was found by Pandey *et al.* (2019).

Number of pods per plant

Number of pods per plant was observed maximum at application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing with 27.18, 26.56, 25.60, 24.00, 21.10 respectively. In bio-organics, number of pods per plant was observed maximum in treatment PSB + Vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 27.33, 26.68, 23.52, 22.04 respectively as shown in Table 3. Similar result was found by Bhadu *et al.* (2018).

Number of seeds per pod

Number of seeds per pod was observed maximum at application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing with 12.93, 12.26, 11.36, 9.86, 7.20 respectively. In bio-organics, number of seeds per pod was observed maximum in treatment PSB + Vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 13.20, 12.55, 9.35, 7.80 respectively as shown in Table 3. Similar result was found by Bhadu *et al.,* (2018).

Test weight (gm)

Test weight was observed maximum at application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing with 31.88, 31.18, 30.25, 28.60, 26.10 respectively. In bio-organics, test weight was observed maximum in treatment PSB + vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 32.05, 31.45, 28.21, 26.68 respectively as shown in Table 3. Similar result was found by Bhadu *et al.,* (2018).

Seed yield (Kg/ha)

Seed yield was observed maximum at application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing with 1342.00 kg/ha., 1280.00 kg/ha., 1182.00 kg/ha., 1028.00 kg/ha., 781.00 kg/ha. respectively due to better nutritional environment in the root zone for growth and development of the crop as well as in plant system. Phosphorus not only plays important role in root development and proliferation but also improves nodulation and N fixation by supplying assimilates to the roots. In bio-organics, Seed yield was observed maximum in treatment PSB + vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 1362.60 kg/ha., 1302.60 kg/ha., 986.60 kg/ha., 838.60 kg/ha respectively as organic manures play an important role in root development and proliferation resulting in better, nodules formation and nitrogen fixation by supplying assimilates to the root. They also increase water holding capacity and phosphate availability in soil thus provide better environment in rhizosphere for growth and development as shown in Table 3. Similar result was found by Tripathi, A. and Tiwari, A.S., (2022), Bhavya *et al*., (2018), Kumar and Yadav, (2018).

Straw yield (Kg/ha)

Straw yield was observed maximum at application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing with 2498.47 kg/ha., 2387.24 kg/ha., 2221.06 kg/ha., 1947.97 kg/ha., 1589.81 kg/ha. respectively. In bio-organics, Straw yield was observed maximum in treatment PSB + vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 2568.43 kg/ha., 2467.34 kg/ha., 1867.95 kg/ha., 1611.93 kg/ha. respectively as shown in Table 3. Similar result was found by Bhavya *et al*., (2018).

Biological yield (Kg/ha)

Biological yield was observed maximum at application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing with 3840.47 kg/ha., 3667.24 kg/ha., 3403.06 kg/ha., 2975.97 kg/ha., 2370.81 kg/ha. respectively. In bio-organics, biological yield was observed maximum in treatment PSB + Vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 3931.03 kg/ha., 3769.94 kg/ha., 2854.55 kg/ha., 2450.53 kg/ha. respectively as shown in Table 3. Similar result was found by Sahu, R.K. and Chaturvedi, D.P., (2022) and Bhavya *et al*. (2018).

Harvest index (%)

Harvest index was observed maximum at application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing with 34.92, 34.88, 34.71, 34.52, 32.92 respectively. In bio-organics, Harvest index was observed maximum in treatment PSB + Vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 34.55, 34.44, 34.45, 34.11 respectively as shown in Table 3. Similar result was found by Bhadu *et al.,* (2018) and Bhavya *et al*., (2018).

Protein content in seeds (%)

Protein content in seeds was observed maximum at application of fertility levels 125% RDF followed by 100%, 75% 50% and control RDF producing with 22.72, 21.55, 21.47, 21.11, 19.25 respectively. In bio-organics, Protein content in seeds was observed

maximum in treatment PSB + Vermicompost @ 2 t/ha followed by Vermicompost @ 2 t/ ha, PSB and Control with 22.13, 21.94, 20.75, 20.06 respectively as shown in Table 3. Similar result found by Varma *et al.,* (2018).

Conclusions

It is concluded that application of fertility levels 125% RDF exhibited superiority over other level and resulted higher seed yield as compared to other treatments. In bio-organic treatment PSB + Vermicompost @ 2 t/ha application resulted in higher yield as compared to other treatments.

Table 1 : Effect of fertility levels and bio-organics on different growth parameters at different stages of Mungbean crop

Treatments	Plant Height (cm)			Number of Branches/plants		Dry Matter Accumulation per plant (gm)		
	25 DAS	50 DAS	At harvest	50 DAS	At harvest	25 DAS	50 DAS	At harvest
F_0 - Control	11.08	33.04	39.70	8.35	8.57	3.29	38.60	90.79
F_1 - 50% RDF	11.26	35.74	42.10	10.85	11.47	3.49	47.77	103.45
F_2 - 75 % RDF	11.46	37.65	43.29	11.95	12.96	3.59	53.67	111.15
F_3 - 100% RDF	11.54	39.05	44.99	13.75	13.26	3.70	56.27	112.35
F_4 - 125% RDF	12.20	40.15	46.29	14.21	13.86	3.86	58.32	117.36
SEm+ 5%	0.23	0.73	0.86	0.22	0.22	0.07	0.99	2.09
CD (P=0.05)	NS	2.09	2.47	0.62	0.64	0.20	2.83	5.98
Bio-organics								
B_0 - Control	11.20	33.75	40.20	9.20	9.80	3.31	45.76	96.93
B_1 – PSB	11.30	36.65	42.90	11.60	11.90	3.50	49.74	104.59
B_2 - Vermicompost @ 2 t/ ha	11.40	36.85	43.50	12.10	12.10	3.61	51.40	108.35
B_3 - PSB + Vermicompost @ 2 t/ ha	12.12	41.25	46.50	14.40	14.30	3.92	56.80	118.20
SEm+ 5%	0.21	0.65	0.77	0.20	0.20	0.06	0.88	1.87
CD (P=0.05)	NS	1.86	2.21	0.56	0.57	0.18	2.53	5.35

Table 2: Effect of fertility levels and bio-organics on chlorophyll content of leaves and on total nodules, effective nodules, fresh weight and dry weight of nodules per plant at 40 DAS of Mungbean crop.

Treatments	Chlorophyll content (mg/g)	Total nodules	Effective nodules	Fresh weight (mg)	Dry weight (mg)
F_0 - Control	2.69	29.57	27.95	100.12	55.52
F_1 - 50% RDF	3.19	31.28	29.44	105.23	60.11
F_2 - 75 % RDF	3.43	32.31	30.52	107.21	61.48
F_3 - 100% RDF	3.58	32.63	31.11	108.10	62.21
F_4 - 125% RDF	3.74	34.30	32.68	114.05	65.20
SEm+ 5%	0.06	0.64	0.61	2.17	1.22
CD (P=0.05)	0.18	1.83	1.74	6.21	3.50
Bio-organics					
B_0 - Control	2.86	29.92	28.49	102.86	57.22
B_1 – PSB	3.26	31.60	30.11	105.64	60.49
B_2 - Vermicompost @ 2 t/ ha	3.38	32.27	30.32	106.56	61.19
B_3 - PSB + Vermicompost @ 2 t/ ha	3.80	34.30	32.43	112.72	64.70
SEm+ 5%	0.06	0.57	0.54	1.94	1.09
CD (P=0.05)	0.16	1.64	1.56	5.56	3.13

Table 3 : Effect of fertility levels and bio-organics on yield and yield attributes of Mungbean crop

Treatments	Pods/ plant	Seeds/ pod	Test weight (gm)	Seed yield (Kg/ha)	Straw yield (Kg/ha)	Biological yield (Kg/ha)	Harvest index (%)	Protein content in (%)
F_0 - Control	21.10	7.20	26.10	781.00	1589.81	2370.81	32.92	19.25
F_1 - 50% RDF	24.00	9.86	28.60	1028.00	1947.97	2975.97	34.52	21.11
F_2 - 75 % RDF	25.60	11.36	30.25	1182.00	2221.06	3403.06	34.71	21.47
F_3 - 100% RDF	26.56	12.26	31.18	1280.00	2387.24	3667.24	34.88	21.55
F_4 - 125% RDF	27.18	12.93	31.88	1342.00	2498.47	3840.47	34.92	22.72
SEm+ 5%	0.48	0.19	0.58	20.19	38.44	58.62	0.71	0.43
CD (P=0.05)	1.38	0.55	1.66	57.79	110.06	167.83	NS	1.22
Bio-organics								
B_0 - Control	22.04	7.80	26.68	838.60	1611.93	2450.53	34.11	20.06
B_1 – PSB	23.52	9.35	28.21	986.60	1867.95	2854.55	34.45	20.75
B_2 - Vermicompost @ 2 t/ ha	26.68	12.55	31.45	1302.60	2467.34	3769.94	34.44	21.94
B_3 - PSB + Vermicompost @ 2 t/ ha	27.33	13.20	32.05	1362.60	2568.43	3931.03	34.55	22.13
SEm+ 5%	0.43	0.17	0.52	18.05	34.38	52.43	0.64	0.38
CD (P=0.05)	1.24	0.49	1.49	51.69	98.44	150.11	NS	1.10

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