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Evaluation of the Effect of Organic and Liquid Manures on Growth and Yield Attributes of Urdbean in Semi-Arid Region

Verma Singh Ram [a++], Yadav S.S. [b#], Umesh Kumar Singh [c++*], Anju Kanwar Khangarot [d†], Srivastava Hritik [e++] and Disha Joshi [f‡]

[a] Department of Agronomy, Sri Karan Narendra Agriculture University, Jobner, Rajasthan, India.
[b] S.K.N. College of Agriculture, Jobner Rajasthan, India.
[c] Department of Agronomy, Lovely Professional University, Jalandhar, Punjab, India.
[d] College of Agriculture, Kotputli, Kotputli-Behror,303108, India.
[e] Department of Agronomy, Sher-e-Kashmir University of Agriculture. Sciences and Technology of Jammu, India.
[f] Department of Agronomy, MPUAT, Udaipur, Rajasthan, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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[++] Research Scholar;
[#] Professor & Dean;
[†] Assistant professor (Agronomy);
[‡] Ph. D. Scholar;
**Corresponding author: E-mail: 1999umesh8@gmail.com;*

ABSTRACT

A field experiment was conducted at Agronomy farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during *kharif* season of 2020 on loamy sand soil. It comprised four treatments of organic manures (control, 100% RDP through FYM, through vermicompost and through poultry manure) and two foliar spray each of four liquid manures (control, panchgavya @ 5%, vermiwash @ 10% and cow urine @ 5%) thereby making sixteen treatment combinations. The experiment was laid out in a Randomized Block Design with three replications. 'Krishna' as a Urdbean variety was used as a test crop and sown was done on 13th July, 2020 at a row spacing of 30 cm. Results revealed that two foliar sprays of 5% panchgavya was the most superior liquid manure treatment in increasing plant height(56.9cm), number of branches/plants(9.35), dry matter accumulation/plant(128.6g), number and weight of nodules/plant(33.01),(69.4g), CGR, RGR at 50 DAS(1.66gcm^{-2}day^{-1}) and at harvest, chlorophyll content(2.58mg.g^{-1}), LAI(3.44%) being at par with two foliar spray of 10% vermiwash.

Keywords: Vermiwash; panchgavya; liquid manure; urdbean; vermicompost.

1. INTRODUCTION

Urdbean [*Vigna mungo* (L.) Hepper] is India's third most significant pulse crop. It is indigenous to India and descended from the wild plant Phaseolus sublobatus. Generally, it is consumed in the form of 'Dal'. It is the main ingredient in 'papad, idly, and dosa. It is high in protein (25%), carbs (60%), fat (1.3%), and phosphoric acid. Pulses to being an essential source of nutritional protein for a huge section of the global population, help to improve soil health and mitigate climate change through their intriguing nitrogen-fixing properties and the addition of a substantial number of residues to the soil. India is the world's top producer (25-28% of global output), user (29% of global consumption), and importer of pulses [1]. During the 2019-2020 crop year, pulses occupied roughly 29.36 million hectares in India, with a yield of 23.02 million tons and an average productivity of 779 kg/ha (Anonymous, 2019-20).

Chemical fertilizers are undoubtedly vital nutrient providers, but their unbalanced, continual, and unjustified usage has resulted in environmental degradation, deterioration of soil health, and loss of soil fertility. Another major difficulty for farmers is a scarcity of fertilizers at reasonable prices. Under these conditions, a system based on the balanced and wise use of fertilizers, organic manures, and low-cost liquid organic manures must be created and implemented [2,3]. Organic farming increases soil productivity and pest population control by promoting natural processes and cycles that are compatible with the environment and ecology of the cropping field [4,3].

Vermicompost is a sustainable organic source of nutrients regenerated from organic wastes using earthworms. It is a rich source of nutrients (1.67% N, 1.2% P, 1.0% K and 7.61% Ca, 0.56% Mg, 0.11% Zn and 1.33% Fe. Besides containing a good proportion of exchangeable Ca, Mg, Na etc., it also adds organic carbon to the soil and helps to release the nutrients slowly and effectively to the rooting zone of the crop plants.

Poultry manure is relatively resistant to microbial degradation. However, it is essential for establishing and maintaining optimum soil physical condition which is important for plant growth, its availability remains an important issue due to its bulky nature, while inorganic fertilizer is no longer within the reach of poor-resource farmers due to its high cost. It contains 1.30% N, 180% P and 0.80% K, respectively.

Panchgavya and cow urine are cheaper and ecofriendly organic fermented preparations that are made out of cow products namely dung, urine, milk, curd and ghee and give very good sources for foliar fertilization of crops. It is used to activate soil and to protect the plants from disease and it also increases the nutritional status as well as nutritional quality of plants. It has modest NPK content of 0.10, 0.017, 0.019 per cent, respectively. It is used as foliar spray as well as soil application along with irrigation water and also used for seed or seedling treatment etc.

Cow urine is a good source of nitrogen, phosphate, potassium, magnesium, calcium, sulphate and chloride. It contains 95 per cent water, 2.5 per cent urea, 2.5 per cent

other mineral hormones, salts and enzymes. It works as a plant hormone and also it has been reported to correct the micronutrient deficiency in the plants. It contains 6.8 to 21.1 g N per liter.

Vermiwash obtained from earthworm bed contains many growth regulating substances. It is a transparent pale, yellow liquid extract of organic waste materials which is collected after the passage of water through different layer of earthworm culture units. Vermiwash contains 1.34, 0.30 and 2.00 per cent of N, P and K, respectively. It is very effective as foliar spray. The vermiwash also contain enzymes and secretions of earthworms that stimulate the growth and yield of crops. The cost of inorganic fertilizers is increasing enormously to an extent that they are out of reach of small and marginal farmers. By the use of inorganic fertilizers, the population of beneficial organisms decrease and natural regeneration of nutrition in the soil cease, soil becomes barren and soil fertility decreases. Application of these organic liquid formulations will enhance the soil microbial activity and population to a larger extent and has a positive effect on growth and yield of crops as well as harmony with nature.

2. MATERIALS AND METHODS

A field experiment entitled “Effect of Organic and Liquid Manures on Growth and Yield of Urdbean [*Vigna mungo* (L.) Hepper]” was conducted at Agronomy farm, S.K.N. College of Agriculture, Jobner during *kharif* season of 2020.Geographically, Jobner situated 45 km west of Jaipur at 26^{o} 05' North latitude, 75^{o} 28' East longitude and at an altitude of 427 metres above mean sea level. The area falls in agro-climatic Zone-III (Semi-arid Eastern Plain Zone) of Rajasthan. Rainfall totalled 255.7 mm throughout the crop season, with August accounting for the majority of it. The mean daily maximum and minimum temperatures during the growing season of Urdbean fluctuated between 30.2 to 40.9^{o}C and 14.3 to 25.4^{o}C, respectively. Similarly, mean daily relative humidity ranged between 43 to 87 per cent. The average sunshine ranged between 1.8 to 8.0 hours/day. soil samples from 0-15 cm depth were taken from five random spots of the experimental area prior to layout and representative composite sample was prepared by mixing and processing of all soil samples together. The homogeneous composite soil sample was subjected to mechanical, physical and chemical analyses to ascertain its physico-chemical properties. The experimental field was loamy sand in texture, Ph 8.20, EC 1.41, alkaline in reaction, poor in organic carbon 0.15, with low available nitrogen 128.0 and medium in available phosphorus 16.12 and potassium 153.4 content.

Krishna is a drought tolerant variety of urdbean was used for the experimental trail. The treatment was laid down in factorial randomized block design with 4 organic manure *viz*; [(control 100% RDP through FYM100% RDP through vermicompost100% RDP through poultry manure)]and 4 liquid manures [Control, Panchgavya (2 spray @ 5%), Vermiwash (2 spray @ 10%), Cow urine (2 spray @ 5%)] making 16 treatment and it was replicated three times.

The experimental field was thoroughly prepared by deep ploughing with tractor drawn disc plough followed by ploughing. Then planking was done to obtain fine tilth, well rotten FYM, vermicompost and poultry manure were applied as per treatments and incorporated well into the soil. The seeds were sown by “Kera” method with row spacing of 30 cm by hand plough using a seed rate of 20 kg/ha. Crop seed was uniformly treated with *Azospirillum* @ 750 g/ha and soil was treated with VAM and *Trichoderma* @ 5 kg/ha to all the treatments. Thinning was done 15-20 days after sowing to facilitate optimum plant population by maintaining intra row spacing of 10 cm. Two lifesaving irrigations were applied to the crop through sprinkler system. Spraying of liquid manures *viz*., panchgavya, vermiwash and cow urine @ 5 per cent, 10 per cent, and 5 per cent respectively and water @ 500 l/ha were done twice first at 25 DAS and second 15 days later at flowering initiation stage spraying was done using the battery-operated knapsack sprayer during early morning and late evening time. The quantity of liquid manures used for each spraying were panchgavya 25 liters ha^{-1}, vermiwash 50 liters ha^{-1}, cow urine 25 liters ha^{-1}.

3. RESULTS AND DISCUSSION

3.1 Plant Height and Number of Branches Plant^{-1}

The maximum height at all the stage was recorded under 100% RDP through poultry manure remain at par with 100% RDP through

vermicompost, it increased the plant height by 15.9, 23.4 and 23.2 per cent over control at 25 and 50 DAS and at harvest stages, respectively. The same trend was followed in case of no. of branches/ plant these two treatments enhanced the branches/plant by 10.5 and 8.4 per cent over 100% RDP through FYM and 25.2 and 22.9 per cent over control, respectively at 50 DAS stage.

Concerning liquid manure, maximum plant height at 25 and 50 DAS and at harvest stages was recorded under two sprays of 5% panchgavya which was 14.7, 24 and 23.9 per cent higher than control, respectively. However, it was found at par with 100% sprays of vermiwash wherein a corresponding increase of 13.3, 20.4 and 21.4 was observed. However no. of branches/plant also follow the same trend at 50 DAS and harvest stages which were 30 and 36.5 per cent more than control. Being at par with each other, two foliar spray of vermiwash and 5% cow urine also improving the branches/plant by 22.8 and 16.5 per cent at 50 DAS and 31.1 and 22.5 per cent at harvest stages, respectively in comparison to control. Increase in the growth parameters is because of the fact that organic manures like 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. Early root growth and cell multiplication leading to more absorption of other nutrients from soil deeper layers ultimately resulting in increased plant growth Kumavat et al. [5] and Yadav [6], Singh et al. [7] and Kudi et al. [8].

3.2 Dry Matter Accumulation, Crop Growth Rate (CGR) and Relative Growth Rate (RGR)

The maximum dry matter was obtained at 50 DAS under 100% RDP through vermicompost which are 7.3 and 8.2 per cent higher at 50 DAS and 19.5 and 25.8 per cent at harvest over 100% RDP through FYM and control however, it was found at par with 100% RDP through poultry manure wherein a corresponding increase of 6.5 and 18.7 per cent at 50 DAS and 7.3 and 24.7 per cent at harvest were recorded respectively. In case of liquid manure Two sprays panchgavya significantly increased the dry matter accumulation of urdbean by 8.2 and 17.9 per cent at 25 DAS, 7.4 and 20.3 per cent at 50 DAS and 8.6 and 31.5 per cent at harvest over cow urine and control, respectively. However, it showed statistical similarity with vermiwash spray which was 14.4, 19.3 and 27 per cent more than dry matter recorded under control at these three stages, respectively.

The values of CGR recorded lower during 0-25 DAS, highest during 25-50 DAS and than moderate during 50 DAS-harvest stages. During 0-25 DAS, application of 100% RDP through poultry manure, vermicompost and FYM attained 11.6, 10.1 and 7.2 per cent higher CGR values than control and thus found at par among themselves. During 25-50 DAS and 50 DAS-at harvest, the highest CGR value were obtained under 100% RDP through vermicompost which were 22.1 and 42.3 per cent more than 100% through FYM and 12.6 and 28.8 per cent than control, respectively. Application of 100% RDP through poultry manures also increased the CGR by 20.7 and 40.5 per cent over control and thus showed statistical equivalence with under 100% RDP through vermicompost. Where as in case of liquid manure two a spray of 5% panchgavya resulted in the highest CGR values of 0.79, 2.69 and 1.66 g/m^2/day during 0-25 DAS and 50 DAS at harvest stages, respectively. Being at par with vermiwash, it increases the CGR by margin of 17.9, 21.2 and 62.7 per cent over control. During these stages respectively thus corresponding increase in CGR under vermiwash spray was 14.9, 21.2 and 48.0 per cent similar result found by Kumar et al. [9] and Kumar et al. [10].

Application of 100% RDP through vermicompost, poultry manure and FYM recorded significantly higher RGR values (9.29, 9.26 and 9.59 mg/g/day) than control. However, they were found at par among themselves in enhancing RGR. How ever with the application of liquid manure, foliar application of panchgavya represented the higher RGR of 9.71 mg/g/day at during these stages indicating an increase of 7.4 and 29.5 per cent over vermiwash spray and control, respectively. However, it showed statistical similarity with cow urine spray wherein RGR value of 9.42 mg/g/day was noted. Higher chlorophyll content and nodule growth resulted in higher photosynthesis and high growth rate which might have resulted in a favorable effect on growth attributes viz. dry matter accumulation, CGR, RGR and dry weight of root nodules. These results are in close conformity with the findings of Mathur et al. [11], Kumavat [12], Singh et al. [7] and Kudi et al. [8] in blackgram and Singh et al. [13].

Table 1 Effect of organic and liquid manures on plant height and number of branches per plant in urdbean at different stages

Treatments	Plant height (cm)			Number of branches/plant	
	25 DAS	50 DAS	At harvest	50 DAS	At harvest
Organic manures					
Control	15.1	38.1	46.5	5.55	6.91
100% RDP through FYM	16.3	42.7	52.0	6.29	8.15
100% RDP through vermicompost	17.3	45.7	55.4	6.82	9.10
100% RDP through poultry manure	17.4	47.0	57.3	6.95	9.42
SEm±	0.4	1.0	1.5	0.16	0.22
CD (P=0.05)	1.1	2.9	4.2	0.46	0.64
Liquid manures					
Control	15.0	37.8	45.9	5.52	6.85
Panchgavya (2 sprays @ 5%)	17.2	46.9	56.9	6.88	9.35
Vermiwash (2 sprays @ 10%)	17.0	45.5	55.7	6.78	8.98
Cow urine (2 sprays @ 5%)	16.7	43.3	52.7	6.43	8.39
SEm±	0.4	1.0	1.5	0.16	0.22
CD (P=0.05)	1.1	2.9	4.2	0.46	0.64
CV (%)	7.92	8.06	9.60	8.68	9.13

** Treatments were partially applied at 25 DAS stage*S

Table 2. Effect of organic and liquid manures on periodical crop dry matter accumulation in urdbean

Treatments	Dry matter accumulation (g/plant)		
	25 DAS	50 DAS	At harvest
Organic manures			
Control	17.2	72.7	100.5
100% RDP through FYM	18.5	81.0	116.8
100% RDP through vermicompost	19.1	86.9	126.4
100% RDP through poultry manure	19.3	86.3	125.3
SEm±	0.4	2.0	3.1
CD (P=0.05)	1.1	5.7	9.0
Liquid manures			
Control	16.8	72.4	97.8
Panchgavya (2 sprays @ 5%)	19.8	87.1	128.6
Vermiwash (2 sprays @ 10%)	19.2	86.4	124.3
Cow urine (2 sprays @ 5%)	18.3	81.1	118.4
SEm±	0.4	2.0	3.1
CD (P=0.05)	1.1	5.7	9.0
CV (%)	7.30	8.42	9.18

Table 3. Effect of organic and liquid manures on crop growth rate (CGR) and Relative growth rate (RGR) during different stage of urdbean

Treatments	CGR (g/m²/day)			RGR (mg/g/day)	
	0-25 DAS	25-50 DAS	50 DAS-At harvest	25-50 DAS	50 DAS-At harvest
Organic manures					
Control	0.69	36.03	8.03	2.22	1.11
100% RDP through FYM	0.74	36.88	9.09	2.50	1.43
100% RDP through vermicompost	0.76	37.86	9.29	2.71	1.58
100% RDP through poultry manure	0.77	37.49	9.26	2.68	1.56
SEm±	0.02	0.84	0.23	0.06	0.04
CD (P=0.05)	0.05	NS	0.65	0.18	0.12
Liquid manures					
Control	0.67	36.43	7.50	2.22	1.02
Panchgavya (2 sprays @ 5%)	0.79	37.01	9.71	2.69	1.66
Vermiwash (2 sprays @ 10%)	0.77	37.60	9.04	2.69	1.51
Cow urine (2 sprays @ 5%)	0.73	37.23	9.42	2.51	1.49
SEm±	0.02	0.84	0.23	0.06	0.04
CD (P=0.05)	0.05	NS	0.65	0.18	0.12
CV (%)	7.34	7.82	8.80	8.32	10.24

Table 4. Effect of organic and liquid manures on number and weight of nodules/plant in urdbean

Treatment	Number of nodules/plant		Weight of nodules/plant (mg)	
	Total nodules	Effective nodules	Fresh weight	Dry weight
Organic manures				
Control	30.45	27.90	104.9	58.0
100% RDP through FYM	34.06	30.95	114.3	64.4
100% RDP through Vermicompost	35.39	32.36	122.9	68.4
100% RDP through poultry manure	35.05	31.98	122.1	68.1
SEm±	0.73	0.73	2.9	1.3
CD (P=0.05)	2.10	2.12	8.5	3.8
Liquid manures				
Control	29.50	27.21	103.3	57.3
Panchgavya (2 sprays @ 5%)	36.19	33.01	124.2	69.4
Vermiwash (2 sprays @ 10%)	35.55	32.25	121.6	67.7
Cow urine (2 sprays @ 5%)	33.71	30.72	115.1	64.5
SEm±	0.73	0.73	2.9	1.3
CD (P=0.05)	2.10	2.12	8.5	3.8
CV (%)	7.46	8.26	8.8	7.1

Table 5. Effect of organic and liquid manures on chlorophyll content and leaf area index in urdbean

Treatments	Chlorophyll content (mg/g)	Leaf area index (%)
Organic manures		
Control	2.08	2.89
100% RDP through FYM	2.42	3.16
100% RDP through vermicompost	2.49	3.31
100% RDP through poultry manure	2.52	3.39
SEm±	0.06	0.07
CD (P=0.05)	0.17	0.19
Liquid manures		
Control	2.01	2.79
Panchgavya (2 sprays @ 5%)	2.58	3.44
Vermiwash (2 sprays @ 10%)	2.52	3.35
Cow urine (2 sprays @ 5%)	2.40	3.17
SEm±	0.06	0.07
CD (P=0.05)	0.17	0.19
CV (%)	8.55	7.30

3.3 Number of Total and Effective Nodules/Plant, Fresh Weight and Dry Weight

The minimum number of total and effective nodules/plant, highest fresh weight and dry weight were obtained under 100% RDP through vermicompost and was closely followed by 100% RDP through poultry manure these treatments has enhanced the total nodules/plant by 16.2, 15.1 and 11.9 per cent, effective nodules/plant by 16.0, 14.6 and 10.9 per cent at 25 and 50 DAS and at harvest however Fresh and dry weight of nodules/plant has increase of 17.2 and 17.9 per cent at harvest over control, respectively. Where as in case of liquid manures, the foliar spray of 5% panchagavya was the most superior treatment in enhancing the number of total and effective root nodules per plant. It was witnessed 22.7 and 21.3 per cent. Whereas, fresh weight and dry weight witnessed increase of 20.2 and 21.1 per cent over control, more than control respectively. However, Number of total, effective nodules/plant, Fresh and dry weight of nodules/plant was found at par with 10% vermiwash, wherein a corresponding increase of 20.5, 18.5 17.7 and 18.2 per cent were obtained over control. The total lowest nodules per plant were recorded under two foliar spray of 5% cow urine. This was due to better supply of nitrogen and organic carbon through optimum mineralization through vermicompost made the bacteria active thereby promoting better nodule growth and higher nitrogen fixation. Rajkhowa et al. [14] same result where also reported by Singh et al. [15], Meena et al. [16] and Singh et al. [7], in other pulse crop.

3.4 Chlorophyll Content and Leaf Area Index (LAI)

All the organic manures recorded significantly higher chlorophyll content in leaves and leaf area index than control. The highest Chlorophyll content and leaf area index (LAI) was recorded under 100% RDP through poultry manures which was followed by vermicompost being at par with each other. The FYM also remain at par in case of chlorophyll content, these three organic manures increased the chlorophyll content by 21.2, 19.7 and 16.3 per cent and LAI by 17.3 per cent and 14.5 per cent respectively over control. Shikha et al. [17] and Sitaram et al. [18].

Likewise, application of liquid manures indicated that application of 5% panchagavya recorded the significantly highest chlorophyll content in leaves and LAI of urbean. The chlorophyll content in leaves was 7.5 and 28.4 per cent higher than obtained under cow urine and control, respectively. Along with that two foliar spray of 5% panchgavya and vermiwash were the most superior and equally effective treatments in improving the LAI these treatments witnesses 23.3 and 20.1 percent higher LAI over control same result where also reported by Rajkhowa et al. [19], Somasundarm et al. [20].

4. CONCLUSION

Application of 100% RDP through vermicompost was the most superior treatments for obtaining getting higher seed and straw yields (969 and 2165 kg ha^{-1}) of urdbean. Whereas due to lower market price, application of 100% RDP through FYM fetched the highest net returns of ` 36,314 Rs $ha^{-1}$ with B:C ratio of 2.68. On the other hand, two foliar spray sprays of 5% panchgavya was the most superior treatments in providing the highest seed and straw yields (942 and 2,121 kg $ha^{-1}$) with the maximum net returns of ` 36,798 ha^{-1} and B:C ratio (2.37) of urdbean.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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