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Growth and Yield of Urdbean Influenced by Vermicompost and Vermiwash

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Authors' contributions

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

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ABSTRACT

The field experiment was conducted at Agronomy farm, S.K.N. College of Agriculture, Jobner (Rajasthan) to evaluate the Growth and yield of urdbean [*Vigna mungo* (L.) Hepper] influenced by vermicompost and vermiwash. The field experiment was carried out during the *Kharif* season, 2020

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on loamy sand soil. The experiment comprising 20 treatment combinations with different doses of vermicompost (control, vermicompost 1.5 t/ha, vermicompost 3.0 t/ha, vermicompost 4.5 t/ha and vermicompost 6.0 t/ha,) and foliar spray of vermiwash (control, vermiwash 5%, vermiwash 10% and vermiwash 15%) was carried out in a 3 times replicated factorial randomised block design. The research explored the effect of various doses of vermicompost and vermiwash on different growth parameters and yield of urdbean on various stages. Results revealed that application of vermicompost 4.5 t/ha significantly enhanced the growth attributes of urdbean *viz.*, plant height, number of branches/plant, dry matter accumulation at 50 DAS and at harvest, CGR (Crop Growth Rate), LAI (Leaf Area Index), chlorophyll content, number of total and effective root nodules, fresh and dry weight of nodules. It also recorded significantly higher seed, stover and biological yields (940, 1920 and 2860 kg/ha) over lower levels. However, it was seen to be at par with vermicompost 6.0 t/ha. Results further showed that application of vermiwash 15% foliar spray at the time of flower initiation stage also resulted in significant increase in the above all mentioned growth parameters as well as recorded highest yield.

Keywords: Foliar spray; LAI; Seed yield; Stover yield; Urdbean [Vigna mungo (L.) Hepper]; vermicompost; vermiwash.

1. INTRODUCTION

India is the largest pulse growing country contributing 9-10 % in the national food basket. In India, pulses are produced with a minimum use of resources. Pulses are a 'Smart Food' as these are critical for food basket. In addition, pulses are highly water efficient crops which can grow in drought prone areas and help in improving soil fertility by fixing atmospheric nitrogen in soil. As a result of stagnant pulse production, the per capita availability of pulses has been decreased from 60 g in the year 1951 to 43 g/day in the year 2016 [1]. Urdbean is a pulse grown in Indian subcontinent. Like its relative, the mung bean, it has been reclassified from the Phaseolus to the Vigna genus. Urdbean originated from India, where it has been in cultivation from ancient time and is one of most highly prized pulses of India. Urdbean is an erect, dense, annual plant having tap root system with smooth, rounded nodules. The pods are narrow, cylindrical and upto six cm long. The plant grows 30-80 cm long with large hairy leaves and 4-6 cm seed pods. Urdbean contains 24% protein, 60% carbohydrate, 1.3% fat, 3.2% minerals, 0.9% fiber. It also contains calcium 54 mg, phosphorus 385 mg, iron 9.1 mg/100 g and the calorific value of 347 Kcal/100 g. It is consumed in the form of 'dal' (whole or split, husked and unhusked) and used as nutritive fodder for animals. It is also a green manuring crop. Urdbean can be grown in all seasons *i.e. Kharif* (Bihar, Chattisgarh, Gujarat, Haryana, Jharkhand, Maharashtra, Madhya Pradesh, Punjab and Rajasthan), *Rabi* (Andhra Pradesh, Karnataka, Odisha, Tamil Nadu and West Bengal) and *Summer* (Andhra Pradesh, Bihar, Chattisgarh, Rajasthan, Tamil Nadu and West Bengal) varying upon different geographical area and climatic condition. Among different sources of organic manure, vermicompost is the most important manure for nutrient supplementation or management for increasing crop production. The vermicomposting technology has a benefit over composting, which is generally due to 'humus' content in vermicompost ejected by earth-worms and in conventional composting system it takes a very long time to form humus, because of slow rotting process of organic matter. It is the best method among all other composting techniques as it is cost effective, eco-friendly and very effective for sanitization of solid waste more particularly against the waste of biological origin. It is considered as a bio-oxidative process in which earthworms and microbes along with other degradable community interact and accelerate the decomposition process of organic waste [2]. Vermicompost has been reported for several beneficial effects in soil such as improvement in chemical, physical and biological conditions and can be used effectively to achieve sustainable agricultural growth [3]. Vermiwash is coelomic fluid extraction which contains enzymes, plant growth hormones, vitamins, macro and micro nutrients. Vermiwash is an organic liquid fertilizer, which have excellent growth promoting effects besides serving as biopesticides for plants [4]. Vermiwash has potential application in sustainable development in agriculture with respect to it's origin, cost effectiveness, availability, reproductibility, reliability as well as biopesticide and ecofriendly soil conditioner which makes it more useful [5]. Vermiwash keeps providing the biological available nutrients to plants over a period of time and it also has

biochemical factors which is not present in the conventional compost and also not found in the chemical fertilizers. Vermiwash can also reduce the use of chemical fertilizers, pesticides [6]. The experiment was conducted to study the effect of different doses of vermicompost and vermiwash on growth and yield of urdbean.

2. MATERIALS AND METHODS

The field trial was conducted in 2020 at the S.K.N. College of Agriculture's Agronomy Farm in Jobner (26°05' N, 75°28' E), Rajasthan, India. The study site is located in Rajasthan's agroclimatic zone IIIa (Semi-Arid Eastern Plains Zone) at an altitude of 427 metres above mean sea level. The field experiment, which included 20 treatment combinations, was replicated three times and used a factorial randomised block design. It included five treatments of vermicompost (control, 1.5 t/ha, 3.0 t/ha, 4.5 t/ha, and 6.0 t/ha) and four treatments of vermiwash foliar spray (control, 5%, 10%, and 15%). In accordance with the treatments per plot, vermicompost was applied before to the final ploughing. Vermiwash was foliar sprayed on at the flower initiation stage using a knapsack sprayer. The experiment has 60 plots of 4.0 m x 2.4 m size each. The variety 'Uttara' of urdbean was sown after two ploughings (disc ploughing than cross ploughing) followed by planking on 10th July 2020 at the depth of 4-5 cm with the help of '*Kera*' method using a seed rate of 20 kg/ha. The experiment was conducted on organic land and any kind of chemicals or fertilizers were not used in the entire period. Thinning, hoeing and weeding were done after 15 and 20 DAS, respectively to maintain row to row and intra row distance of 30 X 10 cm and keep the field weed free and maintain proper aeration in soil. Five plants were selected randomly from each plot, tagged permanently and used for measurement of plant height, no. of branches/plant and other growth observations were recorded from the selected plants. The weight of the thoroughly sun dried harvested produce of each plot was recorded separately before threshing as biological yield (kg) and then converted into kg/ha. After threshing, winnowing and cleaning the produce of each plot was weighed separately in kg per plot and then converted in terms of seed yield in kg/ha. Straw yield (kg/ha) was obtained by subtracting the seed yield (kg/ha) from biological yield (kg/ha). Experimental data were analyzed using analysis of variance (ANOVA) as per Factorial Randomized Block Design (Gomez and Gomez, 1984). Significance of the treatments were tested using F test with 5% level of significance ($P < 0.05$) and means were compared using the least significant difference (LSD) test at $\alpha = 0.05$.

3. RESULTS AND DISCUSSION

3.1 Effect on Growth parameters

Vermicompost: The increase in levels of vermicompost a significant differences were observed in plant height, number of branches/plant, dry matter accumulation and CGR at 50 DAS and at harvest, leaf area index, chlorophyll content, number of total and effective root nodules and fresh and dry weight of root nodules. Significantly highest plant height (30.2 cm) & (36.0 cm) and no. of branches/plant (11.9) & (13.0) were found with the application of vermicompost 6.0 t/ha whereas, vermicompost 4.5 t/ha remain at par in both the parameters as compare with other treatments at 50 DAS and At harvest. Along with that dry matter g/m row length (79.9) & (116.3) and CGR g/m^2/day (2.47) & (1.40) also remained significantly highest with the application of vermicompost 6.0 t/ha at 50 DAS and At harvest however it remained at par with vermicompost 4.5t/ha. The significantly highest leaf area index (3.89), chlorophyll content (3.89 mg/g) effective nodules (30.5), fresh weight of nodule (102.9 mg) and dry weight of nodule (59.1 mg) were found with the application of vermicompost 6.0 t/ha. Whereas, it was also found to be at par with the application of vermicompost 4.5 t/ha as compare with other level of vermicompost. The application of vermicompost to urdbean had a positive impact on growth and biomass production. Vermicompost improves the physical and biological qualities of soil, including the availability of nearly all of the needed plant nutrients for plant growth and development. As a result, balanced nutrition in a favourable environment may have contributed in the formation of new tissues and development, resulting in an increase in plant height, dry matter accumulation, CGR, leaf area index and chlorophyll content. Findings of the present investigation were in close agreement with those of [7-9]. Higher vegetative growth was observed in the current study with the application of vermicompost at 4.5 t/ha, indicating that it increased the number of beneficial microbes in the root zone during the early stages of infection and stimulated nodule growth by releasing bacterial cells in the cortex [10] which resulted growth in number of effective nodules and their weight. Similar results were also obtained by

[11,12]. With the anova study it was found that there were no interaction effect found between the vermicompost and vermiwash treatments in above described parameters.

Vermiwash: With the increase in the per cent of vermiwash a significant effect was observed on plant height, number of branches/plant, dry matter and CGR. Application of vermiwash 15% had given significantly highest plant height (29.7 cm) and (35.5 cm), number of branches/plant (11.9) and (13.0) however, the dry matter g/m row length (77.1) & (112.6) and CGR g/m^2/day (2.37) & (1.36) also, remained significantly highest with Application of vermiwash 15% at 50 DAS and At harvest. The per cent of vermiwash had also effected the leaf area index, chlorophyll content, number of total and effective root nodules and fresh and dry weight of root nodules. The significantly highest leaf area index (3.26), chlorophyll content (3.82 mg/g), effective nodules (30), fresh weight of nodule (102.8 mg) and dry weight of nodule (58.7 mg) were also found with the application of vermiwash 15%. Whereas, it was found to be at par with the application of vermiwash 10% as compared with other level of vermiwash. It is well known that foliar spray of vermiwash in urdbean crops provides nearly all of the critical plant nutrients required for plant growth and development. The higher amount of organic carbon, nitrogen, phosphorus, potassium, copper, zinc, calcium and magnesium nutrients, vitamins, amino acids and plant growth hormones found in vermiwash could be attributed to the fact that vermiwash 10 % spray was responsible for rapid growth and development of plants. It also has a lot of microorganisms that fix nitrogen and dissolve phosphate [13,14] reported comparable results in urdbean. Higher chlorophyll content and leaf area due to vermiwash treatment resulted in higher photosynthesis and a faster growth rate, which may had influenced growth parameters such as plant height, branch number, dry matter accumulation, CGR and number and weight of effective nodules. The results of current study were also consistent with previous findings of [15,16].

3.2 Effect on Yield

Vermicompost: The application of 4.5 t/ha vermicompost improved seed yield (940 kg/ha), stover yield (1920 kg/ha) and biological yield (2860 kg/ha) which was significantly higher over control, vermicompost 1.5 t/ha and vermicompost 3.0 t/ha, while remained at par with vermicompost 6.0 t/ha (Table 3). The significant rise in seed yield under the effect of vermicompost was mostly due to enhanced growth and as a result an improvement in many yield parameters. Humic acid in vermicompost increases the availability of both native and added micronutrients in soil, resulting in increased plant growth, yield characteristics and yield. These results were in line with those of [17-19].

Table 1. Effect of varying levels of vermicompost and vermiwash on plant height, number of branches/plant, dry matter accumulation and CGR of urdbean at different stages

Treatments	plant height (cm)		number of branches/plant		dry matter accumulation (g/m row length)		CGR (g/m^2/day)	
	50 DAS	At Harvest	50 DAS	At Harvest	50 DAS	At Harvest	25-50 DAS	50 DAS-at harvest
Vermicompost								
Control	25.5	29.6	8.1	8.4	61.4	88.5	1.87	1.04
1.5 t/ha	27.0	31.8	9.4	10.0	66.8	96.4	2.05	1.14
3.0 t/ha	28.6	33.7	10.6	11.6	71.8	104.7	2.21	1.26
4.5 t/ha	29.9	35.6	11.5	12.7	76.9	112.4	2.37	1.36
6.0 t/ha	30.2	36.0	11.9	13.0	79.9	116.3	2.47	1.40
SEm±	0.43	0.57	0.24	0.29	1.55	2.38	0.05	0.03
CD (P = 0.05)	1.24	1.64	0.69	0.83	4.43	6.81	0.13	0.08
Vermiwash								
Control	26.4	31.1	9.1	9.7	63.6	93.2	1.95	1.13
5%	27.8	32.7	10.1	10.9	69.8	100.5	2.15	1.18
10%	29.0	34.2	10.9	11.8	75.0	108.3	2.31	1.28
15%	29.7	35.5	11.2	12.2	77.1	112.6	2.37	1.36
SEm±	0.39	0.51	0.21	0.26	1.38	2.13	0.04	0.03
CD (*P* = 0.05)	1.11	1.46	0.61	0.74	3.96	6.09	0.12	0.07

Table 2. Effect of varying levels of vermicompost and vermiwash on leaf area index, chlorophyll content, number of total and effective nodules, fresh and dry weight of nodules of urdbean

Treatments	leaf area index	Chlorophyll content (mg/g)	Total nodules	Effective nodules	Fresh weight of nodules (mg)	Dry weight of nodules (mg)
Vermicompost						
Control	2.83	2.83	26.8	25.2	95.3	47.5
1.5 t/ha	3.19	3.19	28.8	26.8	98.3	52.1
3.0 t/ha	3.52	3.52	30.5	28.4	100.4	56.6
4.5 t/ha	3.80	3.80	32.2	30.1	102.3	58.9
6.0 t/ha	3.89	3.89	32.8	30.5	102.9	59.1
SEm±	0.09	0.09	0.47	0.47	1.65	0.96
CD (P = 0.05)	0.25	0.25	1.36	1.36	4.72	2.74
Vermiwash						
Control	2.74	2.94	27.5	26.0	96.2	50.3
5%	3.01	3.34	29.0	27.4	98.7	53.2
10%	3.18	3.69	31.7	29.3	101.5	57.3
15%	3.26	3.82	32.6	30.0	102.8	58.7
SEm±	0.07	0.08	0.42	0.42	1.47	0.86
CD (*P* = 0.05)	0.19	0.23	1.21	1.21	4.22	2.45

Table 3. Effect of varying levels of vermicompost and vermiwash on seed, stover and biological yields of urdbean

Treatments	Yield (kg / ha)		
	Seed	**Stover**	**biological**
Vermicompost			
Control	660	1456	2116
1.5 t/ha	770	1673	2443
3.0 t/ha	864	1822	2686
4.5 t/ha	940	1920	2860
6.0 t/ha	985	1951	2936
SEm±	22	28	48
CD (P = 0.05)	62	81	138
Vermiwash			
Control	759	1625	2384
5%	820	1734	2554
10%	885	1832	2717
15%	910	1866	2776
SEm±	20	25	43
CD (*P* = 0.05)	56	72	123

Vermiwash: The foliar spray of vermiwash resulted an increase in seed yield, stover yield and biological yield of urdbean over control (Table 3). In urdbean, vermiwash 10% spray was found to be comparable to vermiwash 15% spray in terms of yield. The increased effectiveness of foliar spraying of nutrients and growth stimulants to plants due to vermiwash spraying could be the reason for the improved yield qualities. When foliar spray of vermiwash was done, smaller amounts of IAA and GA present in vermiwash could have created stimuli in the plant system, which increased the production of growth regulator in the cell system and the action of growth regulators in the plant system stimulated the necessary growth and development, resulting in better yield. Crop yield is the result of a complex interaction of physiological and biochemical processes that alter the anatomy and morphology of growing plants. Similar set of findings were also reported by [20,21].

4. CONCLUSION

Based on the results of one year experimentation, it may be inferred that any

interaction effect between the vermicompost and vermiwash was not found. The growth parameters and yield increased with the increasing levels of vermicompost and vermiwash. The application of vermicompost 4.5 t/ha was found better for obtaining higher plant height, number of branches/plant, dry matter accumulation, number of effective nodules and their weight with higher seed yield (940 kg/ha) in urdbean. However, it was at par with vermicompost 6.0 t/ha. Similarly, foliar spray of vermiwash demonstrated significant positive effect on the growth characters and yield of urdbean. Vermiwash 15 % spray had been the most effective vermiwash spray for enhancing production (910 kg/ha). Through this study, it is evident that the utilization of these organic amendments can enhance various important parameters associated with urdbean. However, further research is warranted to optimize the application rates and explore the long-term effects of vermicompost and vermiwash on urdbean.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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