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Effect of Weed Management and Vermicompost on Growth Indices and Yield of Clusterbean under Udaipur Region

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ABSTRACT: The Research Farm, Department of Agronomy, Rajasthan College of Agriculture, Udaipur (Rajasthan) conducted a field study during 2020-21 and 2021-22 at different weed management practices and levels of vermicompost were studied. The experiment was laid out in factorial randomized block design with three replications and 8 treatments of weed management and two level of vermicompost. Pre-emergence application of pendimethalin + imazethapyr (RM) 750 g ha^{-1}*fb* one hand weeding at 40 DAS recorded significantly higher growth indices *viz.* CGR, RGR, NAR and LAI and seed and haulm yield during both the study years. Application of vermicompost 5 t ha^{-1} also observed significantly higher growth indices *viz.* CGR, RGR, NAR and LAI and seed and haulm yield during both the study years.

Keywords: Clusterbean, Weed management, Vermicompost, Yield.

INTRODUCTION

The dicotyledonous annual grain legume known as clusterbean (*Cyamopsis tetragonoloba* (L.) Taub) belongs to the fabaceae family and papilionaceae subfamily. Native to the Indian subcontinent is the clusterbean. It is a crop of considerable social and economic significance due to its deep roots and ability to withstand drought and high temperatures. It is commonly referred to as "guar" and requires very little input. The Sanskrit term "Gauaahar", which implies cow feed or other livestock feed, is where the word "Guar" derives from. It is mostly grown in tropical India's dry and semi-arid regions under rainfed conditions. This crop can flower and bear fruit even in situations where there is a temporary water shortage. It is one of the best legume crops for the climatic conditions of Rajasthan because of its great potential to rebound from water stress. It grows well in Rajasthan's agro-climatic conditions and is cultivated in regions with yearly rainfall ranging from 350 to 750 mm (Kherawat *et al*., 2013). Clusterbean is grown on 5.6 million hectares of land in India, with an average annual yield of 2.7 million tonnes and productivity of 482 kg ha^{-1}. Total clusterbean growing area, 83% of the acreage and 65% of the production are contributed by Rajasthan (Govt. of Rajasthan, 2020; Anonymous, 2016-17b). Clusterbean is primarily grown in the Rajasthani districts of Barmer, Churu, Sriganganagar, Nagaur, Jalore, Sikar, Jaisalmer, Bikaner, Jaipur, and Alwar. Because crops are extremely vulnerable to crop-weed competition, nutrient stress, and soil moisture stress, particularly at their crucial growth stages, these three elements are considered to be the most restricting ones among the many causes causing low production. Weeds among them also contribute to losses to a greater extent, which lowers agricultural productivity.

Several uses for clusterbean cultivation include vegetable production (tender pods), green manuring, green fodder, and seed production. Because to the presence of gum or glutamin (galactomannan) content (30–35%) in the endosperm of its seed, it has become a commercial and industrial crop. Its gum is utilised in a variety of industries, including those that deal with food processing, paints, cosmetics, medicines, synthetic resins, water-blocking fabrics, paper, petroleum, mining explosives, oil drilling agents in explosives, as well as thickening and fire-retardant agents. In addition to that, clusterbean gum is widely utilised as a sizing agent in the paper and textile sectors and as a powerful flocculent and filterant in mining and metallurgical processes (Sharma *et al*., 2017; Kumawat *et al*., 2017). Cluster beans increase soil fertility by fixing a significant amount of atmospheric nitrogen (Nagar and Meena 2004).

Clusterbean is a crop grown during the rainy season, and because of the frequent rains that create a climate that is ideal for weed growth and competition for nutrients, moisture, and space, yields are significantly reduced. Cluster bean crop weed competition's critical window is between 20 and 30 DAS and presence of weeds after this result in substantial yield decreases of 47% to 92% (Punia *et al*., 2011; Patel *et al*., 2005; Bhadoria *et al*., 2000; Yadav, 1998). Appropriate weed control is regarded as being the most significant agronomic component among others that are known to increase crop productivity. As a slow-growing crop, clusterbeans are initially vulnerable to weed competition, hence weed-free conditions should be maintained in clusterbean fields throughout the early stages of crop establishment.

Vermicompost also enhances soil health but also provides both major and minor nutrients. It functions as a chelating agent and influences the effectiveness of herbicides. Moreover, it enhances the physical characteristics of the soil, such as its capacity to hold water. The adsorption of herbicide molecules on soil particles was significantly influenced by soil moisture content in addition to other factors. Several researchers looked at how the amount of organic matter in soils affects the adsorption of herbicides and their effectiveness (Suba and Essington 1999). The relationship between weed control and vermicompost on clusterbean growth and yield has therefore been investigated. Nevertheless, the impact of vermicompost and herbicide treatment on flora composition, weed density, and biomass is not analysed and reported. The secret to increasing food grain output and maintaining soil fertility is vermicompost, which has an appropriate supply of plant nutrients (Sharma *et al*., 2018).

Due to heavy rainfall during the crop growing season that accelerated microbial degradation of herbicides, none of the herbicides (pendimethalin, imazethapyr, and imazamox), regardless of their dose and timing of application, caused any harm to the next *rabi* crop (Punia *et al*., 2017). Different herbicides applied to the cluster bean crop had no carryover effect on the subsequent mustard crop, likely as a result of herbicide detoxification through microbial degradation mediated by high temperature and moisture and possibly due to herbicide leaching as a result of 594.3 and 500.5 mm of rainfall in the crop growing season at experimental locations, respectively (Sangawan *et al*., 2016). Any and all doses and combinations of imazethapyr, imazethapyr + imazamox (Odyssey), quizalofop-ethyl, fenoxapropp-ethyl, and pendimethalin had no lasting effects on the growth, development, and yield of the following wheat crop (Manhas and Sidhu 2014). Effective weed control methods are more important for clusterbean productivity. Weed control is now generally acknowledged to be crucial for maintaining crop output. In order to analyse high growth and yield by efficient weed management and application of vermicompost, this experiment was conducted.

METHODS AND MATERIALS

A field experiment was carried out during 2020-21 and 2021-22 at Udaipur (24°35' North latitude and 74°42' East longitude, with an average altitude of 579.5 m above mean sea level), this region falls under the agro-climatic zone Iva (Sub-humid Southern Plain) of Rajasthan and agro-climatic zone VIII (Central Plateau and Hills) of India. The soil at the experimental site was sandy-loam, which has high drainage qualities and a reaction pH of 7.9. The soil had medium level of organic carbon (0.73%), medium levels of available nitrogen (284.59 kg ha^{-1}) and available phosphorus (19.36 kg ha^{-1}) and high levels of potassium (347.86 kg ha^{-1}) (mean of both the year). The experiment was laid out in factorial randomized block design with 18 different treatment combinations (nine weed management practices and two vermicompost levels) and three replications. The treatments were Pendimethalin 750 g ha^{-1} PE *fb* hand weeding at 40 DAS, Imazethapyr 60 g ha^{-1} PoE *fb* hand weeding at 40 DAS, Pendimethalin + Imazethapyr (RM) 750 g ha^{-1} PE *fb* hand weeding at 40 DAS, Imazethapyr + Imazamox (RM) 60 g ha^{-1} PoE *fb* hand weeding at 40 DAS, Aciflourfen + clodinafop (RM) 245 g ha^{-1} PoE, Imazethapyr 60 g ha^{-1} PoE *fb* Quizalofop (TM) 60 g ha^{-1} PoE, Oxyflurofen 150 g ha^{-1} PE *fb* Imazethapyr 75 g ha^{-1} PoE, Hand weeding at 20 and 40 DAS and weedy check with two vermicompost levels (control and vermicompost 5 t ha^{-1}). As a test crop, the clusterbean variety RGC-1038 was grown in accordance with a set of best practises for Rajasthan's agroclimatic zone IVa. The soil was medium in organic carbon (0.73 and 0.74%), slightly alkaline in reaction (pH 7.9 and 7.8) with medium in available nitrogen (282.53 and 286.65 kg ha^{-1}), phosphorus (19.33 and 19.98 kg ha^{-1}) and high in potassium (346.18 and 349.54 kg ha^{-1}) during 2020 and 2021, respectively. As per treatment, pre-emergence herbicide were applied one day after sowing, while post-emergence herbicide was applied at 2-4 leaf stage of weeds *i.e.* about 21 DAS (Days after sowing). The herbicides were sprayed with knapsack sprayer fitted with a flat fan nozzle using 500 liters of water $hectare^{-1}$ after its calibration. In the weed free check, weeds were removed manually by uprooting them and when observed in order to keep weed free. In the treatments herbicide in combination with hoeing at 20 and 40 DAS was carried out manually by hand hoe. After field preparation, the plot was layout and vermicompost was put uniformly throughout the plot and mixed in with the soil before sowing. The recommended dose of fertilizer *i.e.* 20 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} were drilled in crop rows through urea and di-ammonium phosphate (DAP) at the time of sowing as basal application.

Five plants were randomly selected for leaf area at 30, 60 DAS and at harvest. The leaf area was measured with the help of portable leaf area meter at the experimental site. LAI was calculated by the following relationship (Watson, 1958).

$$LAI = \frac{\text{Leaf area (cm}^2)}{\text{Ground area (cm}^2)}$$

The crop growth rate (CGR) of a plant for a time (t) is defined as the increase in dry weight of plant material from a unit area per unit of time. It was calculated with the following formula (Radford, 1967) from periodic dry matter recorded at different stages:

$$\text{CGR (g m}^{-2}\text{day}^{-1}) = \frac{W_2 - W_1}{t_2 - t_1}$$

Where, W_1 = total dry weight of plant at time t_1, W_2 = total dry weight of plant at time t_2, t_1 = time at first observation and t_2 = time at second observation.

The relative growth rate (RGR) of a plant at an instant in time (t) is defined as the increase in dry weight of plant material per unit of material present per unit of time. The mean relative growth rate (RGR) of the crop was calculated by the following formula (Radford, 1967).

$$\text{RGR (g g}^{-1}\text{ day}^{-1}) = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{t_2 - t_1}$$

Where, W_1 = total dry weight of plant at time t_1, W_2 = total dry weight of plant at time t_2, t_1 = time at first observation and t_2 = time at second observation.

Net assimilation rate is an increase in plant material per unit leaf area per unit time. NAR is calculated from the following equation (Radford, 1967).

$$\text{NAR (g m}^{-2}\text{ leaf area day}^{-1}) = \frac{\text{Log}_e A_2 - \text{Log}_e A_1}{(A_2 - A_1)} \times \frac{W_2 - W_1}{t_2 - t_1}$$

Where, A_1= total leaf area at time t_1, A_2 = total leaf area at time t_2, W_1 = total dry matter of plant at time t_1, W_2 = total dry matter of plant at time t_2, t_1= time of first observation and t_2 = time of second observation.

Seed yield obtained from each net plot including the tagged plants was sun dried and recorded treatment wise and expressed as kg ha^{-1}. The unthreshed produce from net plot area after thorough sun drying was weighed for recording the biological yield and expressed as kg ha^{-1}. Haulm yield net plot^{-1} was calculated by subtracting the seed yield from the biological yield and then expressed in kg ha^{-1}. All the data were subjected to statistical analysis by adopting appropriate method of analysis of variance as described by Cocharan and Cox (1967). The homogeneous results of two years were subjected to pooled analysis to establish the trends of treatments applied as per Gomaz and Gomaz (1984).

RESULTS AND DISCUSSION

Weed management practices. The maximum CGR, RGR, NAR and LAI at different growth stages were recorded in pre-emergence application of pendimethalin + imazethapyr (RM) 750 g ha^{-1}*fb* hand weeding at 40 DAS. The increased clusterbean growth parameters mentioned above appear to be due, in general, to the direct effects of various weed management practices through reduced crop-weed competition, while an indirect effect may be reduced competition for plant growth factors of production such as light, space, water, nutrients etc (Meena *et al*., 2020). Results produced in this manner closely match the findings of Tamang *et al.* (2015); Reddy *et al.* (2021); Rani and Venkateswarlu (2022).

The seed and haulm yield was significantly influenced by the different weed management practices (Table 1). The maximum seed (1358 kg ha^{-1}) and haulm (2693 kg ha^{-1}) yield was recorded with pre-emergence application of pendimethalin + imazethapyr (RM) 750 g ha^{-1} *fb* hand weeding at 40 DAS, it was being at par with post-emergence application of imazethapyr + imazamox (RM) 60 g ha^{-1}*fb* hand weeding at 40 DAS. When weeds were managed in the early development phase, especially during the most critical crop-weed completion period, yield qualities might be improved. Integration of physical and chemical weed control methods reduced competition and improved the environment for the crop's successful growth. The better weed control and lack of resource competition that resulted in favourable conditions for the crop plant, such as increased availability of nutrients, moisture, light, and other factors, led to better growth and higher dry matter production of plants, which in turn increased seed and haulm yields and, consequently, biological yield. These impacts led to increased yield numbers with character-attributing statistics (Shashidhar *et al.*, 2020). Under different weed control strategies, there was a decrease in weed dry matter production as well as a decrease in weed nutrient absorption. Herbicide integration followed by hoeing led to a decrease in weed dry matter accumulation, which eventually enhanced the yield characteristics and subsequently the clusterbean seed yield. Results obtained in this manner closely match those of Tamang *et al.* (2015); Meena *et al.* (2020). The yield of clusterbean recorded second highest with post-emergence application of imazethapyr + imazamox (RM) 60 g ha^{-1} PoE *fb* hand weeding at 40 DAS. This may be because there is reduced crop-weed competition during key stages, which results in increased water and nutrient absorption as well as higher values of yield-attributing characteristics. Results produced in this manner closely match the findings of Brar (2018); Magar *et al.* (2019).

Vermicompost levels. The maximum CGR, NAR and LAI at different stages were recorded in application of vemicompost 5 t ha^{-1}, significantly increased as compared to control (Table 1 and 2). According to the current research, the increased impact of application vermicompost on several clusterbean growth indices appears to be due to the soil being enhanced with primary, secondary, and micronutrients in sufficient and balanced quantities. These improvements could have helped the roots develop and proliferate more, which helps them better absorb the necessary nutrients in the soil. The major improvement in the nutrient content of plant components (seed and haulm) led to enhanced nutrient availability for plant growth and development from an early stage. The nutrients are a portion of the plant that may be harvested and are mostly transferred from vegetative to reproductive portions. Therefore, a more nutrient-dense environment in plants under the application of vermicompost appears to have encouraged leaf development by promoting active cell division and leaf elongation. With better canopy development, the plant's height, number of branches and number of leaves may intercept, accumulate and use solar energy more efficiently. The above, in turn, may increase the plant's ability to photosynthesize, which in turn may increase the amount of dry matter that accumulates at various growth stages. These outcomes support the conclusions made by Sharma *et al.* (2018); Banotra *et al.* (2021); Massey *et al.* (2021).

The result revealed that application of vemicompost 5 t ha^{-1} recorded significant increase in yield seed (1162 kg ha^{-1}) and haulm yield (2391 kg ha^{-1}) of clusterbean over control (Table 1 and 2). Vermicompost application has been strongly emphasised as being essential for enhancing three key yield-determining factors: the formation of vegetative structure for nutrient uptake, photosynthesis, and strong sink length; and the production of assimilates to fill economically improved sinks (source strength) (Khokhar and Nepalia 2010). The secret to ensuring good yields is the release of nutrients from the source in accordance with the critical phase of their demand. As a result, the combined impact of organic and inorganic fertilisation appears to have maintained a balanced source-sink system by enhancing both the vegetative and generative phases of crop growth, which eventually led to an increase in seed output. Additionally, the increased rate of photosynthesis led to a higher accumulation of dry matter, which is positively connected with seed yield (Banotra *et al.,* 2021). As a result, these outcomes support by Massey *et al.* (2021).

Table 1: Effect of weed management and vermicompost on crop growth rate and relative growth rate of clusterbean (two year pooled basis).

Treatment	Crop growth rate (g m^{-2} day^{-1})		Relative growth rate (g g^{-1} day^{-1})		Yield (Kg ha^{-1})	
	30-60 DAS	60 DAS-Harvest	30-60 DAS	60 DAS-Harvest	Seed	Stover
Weed management						
Pendimethalin 750 g ha^{-1} PE *fb* hand weeding at 40 DAS	9.30	6.41	0.0176	0.0052	1124	2346
Imazethapyr 60 g ha^{-1} PoE *fb* hand weeding at 40 DAS	9.26	6.58	0.0173	0.0053	1165	2394
Pendimethalin + Imazethapyr (RM) 750 g ha^{-1} PE *fb* hand weeding at 40 DAS	10.09	7.23	0.0200	0.0074	1358	2693
Imazethapyr + Imazamox (RM) 60 g ha^{-1} PoE *fb* hand weeding at 40 DAS	10.04	6.68	0.0177	0.0053	1265	2540
Aciflourfen + clodinafop (RM) 245 g ha^{-1} PoE	7.60	7.02	0.0177	0.0065	840	2017
Imazethapyr 60 g ha^{-1} PoE *fb* Quizalofop (TM) 60 g ha^{-1} PoE	8.35	6.95	0.0183	0.0061	921	2084
Oxyflurofen 150 g ha^{-1} PE *fb* Imazethapyr 75 g ha^{-1} PoE	6.58	7.14	0.0170	0.0055	807	2007
Hand weeding at 20 and 40 DAS	9.03	6.56	0.0174	0.0054	1085	2406
Weedy check	4.37	2.87	0.0141	0.0045	478	1252
SEm±	0.33	0.35	0.0006	0.0003	14.69	34.90
CD at 5%	0.94	0.99	0.0018	0.0010	41.46	98.48
Levels of vermicompost						
Control	7.76	5.40	0.0178	0.0053	848	1996
Vermicompost 5 t ha^{-1}	8.83	7.37	0.0171	0.0061	1162	2391
SEm±	0.16	0.17	0.0003	0.0002	6.93	16.45
CD at 5%	0.44	0.47	NS	0.0005	19.55	2346

Table 2: Effect of weed management and vermicompost on crop growth rate and relative growth rate of clusterbean (two year pooled basis).

Treatment	NAR (g m^{-2} day^{-1})		LAI		
	30-60 DAS	60 DAS-Harvest	30 DAS	60 DAS	Harvest
Weed management					
Pendimethalin 750 g ha^{-1} PE *fb* hand weeding at 40 DAS	0.0076	0.0023	0.670	3.69	4.36
Imazethapyr 60 g ha^{-1} PoE *fb* hand weeding at 40 DAS	0.0075	0.0024	0.665	3.74	4.34
Pendimethalin + Imazethapyr (RM) 750 g ha^{-1} PE *fb* hand weeding at 40 DAS	0.0082	0.0028	0.693	3.82	4.51
Imazethapyr + Imazamox (RM) 60 g ha^{-1} PoE *fb* hand weeding at 40 DAS	0.0080	0.0023	0.660	3.79	4.48
Aciflourfen + clodinafop (RM) 245 g ha^{-1} PoE	0.0067	0.0027	0.622	3.42	4.15
Imazethapyr 60 g ha^{-1} PoE *fb* Quizalofop (TM) 60 g ha^{-1} PoE	0.0072	0.0027	0.643	3.48	4.12
Oxyflurofen 150 g ha^{-1} PE *fb* Imazethapyr 75 g ha^{-1} PoE	0.0059	0.0025	0.607	3.39	4.02
Hand weeding at 20 and 40 DAS	0.0075	0.0024	0.671	3.65	4.29
Weedy check	0.0047	0.0013	0.545	2.76	3.44
SEm±	0.0003	0.0001	0.007	0.03	0.07
CD at 5%	0.0008	0.0004	0.019	0.09	0.19
Levels of vermicompost					
Control	0.0067	0.0020	0.620	3.45	4.08
Vermicompost 5 t ha^{-1}	0.0073	0.0027	0.663	3.60	4.30
SEm±	0.0001	0.0001	0.003	0.02	0.03
CD at 5%	0.0004	0.0002	0.009	0.04	0.09

CONCLUSIONS

From the experiment, it is concluded that the pre-emergence application of pendimethalin + imazethapyr (RM) 750 g ha^{-1}*fb* hand weeding at 40 DAS was best for growth in culsterbean and increased the yield of cluaterbean. Application of vemicompost 5 t ha^{-1} recorded significantly higher growth indices and yield of clusterbean.

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