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Economic Analysis of Drip Fertigation, Organic Product for Rice-Fallow-Greengram (*Vigna radiata* L.) in Western Agroclimatic Zone of Tamil Nadu, India

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ABSTRACT

Background: Rice fallow pulse cropping system was familiarized in Tamil Nadu. There is reduction in yield due to inappropriate management of pest, disease, weed, fertilizer and nutrient management moreover cultivated as rainfed/ mixed cropping system. However, succeeding crop is sown without any preparatory cultivation in the stubbles of the previous crop. It minimizes the labour and fuel cost. The present study investigated the economic analysis of drip fertigation, Organic product for rice-fallow-greengram.

Methods: A field experiment was conducted at Wetland farms of Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore during 2019-21. There are thirteen treatments in randomized block design with replicated thrice which is imposed with fermented fish waste and fermented egg product applied through drip at vegetative stage and peak flowering stage.

Result: The field experiment result revealed that the application drip fertigation @ 125% RDF, 100% PE with FFW (2 times) (T11) recorded higher net return (` 48,958 and ` 33,402 during summer 2020 and *Kharif* 2021, respectively).

Key words: Fermented egg product, Fermented fish waste, Growth, Goss, Net income, Economics.

INTRODUCTION

Pulses are considered to be the major sources of protein among the vegetarians in India and complement the staple cereals in the diet with proteins, essential amino acids, vitamins and minerals. It contains 22-24% protein, which compares well with that of other important grain legumes which is almost twice the protein in wheat and thrice that of rice (Srinivasan *et al.,* 2019). There is reduction in yield due to inappropriate management of pest, disease, weed, fertilizer and nutrient management moreover cultivated as rainfed/ mixed cropping system. However, succeeding crop is sown without any preparatory cultivation in the stubbles of the previous crop. It minimizes the labour and fuel cost.

Application of water and nutrients in sufficient amounts by drip fertigation to extend nutrient use efficiency by increasing the provision of nutrient within the soil and might be water and nutrient shown to exhibit strong interaction in respect of yield. Combined effects of fertilizer and irrigation are higher than the total of their individual effect (Aggarwal, 2000). Fertigation offers flexibility of fertilization, enabling the particular nutrient requirement of the crop to be met at various plant growth stages (Salih *et al.,* 2012). Drip irrigation have better beneficial water utilization, increased plant growth and economic produce, increased plant chemical efficiency and also overcomes issues such as reduced salinity and weed growth, reduced energy requirements and improved cultural practices. Additionally, promote the root characteristics *viz.* root length, root volume and root dry weight (Gowtham, 2016).

The bio fermented products obtained from plant or animal sources contains several compounds and mixture of several things such as microorganisms, plant hormones, plant growth regulating rhizobacteria, enzymes and humic acid trace elements that increases water holding capacity, enhance metabolism, increases antioxidants and regulates plant growth and yield, when applied as foliar spray reduces the micro nutrient deficiencies (Mesquita *et al.,* 2012). Fermented fish waste, one of the bio extract products has

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the capacity to replace chemical fertilizers. The liquid nature of the product increases the availability of nutrients when it is applied through drip irrigation. The bio fermented product has the potential to enhance the beneficial microbes present in the soil and helps in nitrogen fixation. The foliar application of fermented fish waste and fermented egg product along with recommended dose of fertilizers increases the grain yield of rice and it also improves the metabolic and cellular activity of greengram also (Priyanka *et al.,* 2019).

Fermented fish waste (FFW) and fermented egg product (FEP) are being used for improving the crop growth and development. Application of egg lime mix with *panchakavya* on crops such as paddy, wheat, banana, vegetables, greens and fruit trees remarkably increased the yield and longevity of the plants (Prabu, 2008). Natural plant growth regulators (*e.g.* Auxin, Gibberellin and cytokinin) present in these liquid organic formulations give a major boost to crop yields by accelerating the plant's metabolic function (Zhang and Ervin, 2008). The use of organic manures alone might not meet the plant requirement due to presence of relatively low levels of nutrients. Therefore, in order to make the soil well supplied with all the plant nutrients in the readily available form and to maintain good soil health, it is necessary to use organic manures in conjunction with inorganic fertilizers to obtain optimum yields. Indigenous technical knowledge of using locally preparing different organic liquid manures such as fermented egg product, fermented fish waste and panchagavya *etc.,* are getting popular among organic farmers. With the available knowledge a research study was carried out to evaluate the drip fertigation, Fermented fish waste and fermented egg product for rice-fallow-greengram (*Vigna radiata* L.) cropping system.

MATERIALS AND METHODS

A field experiment was laid out in Field No. B6 at Wetland Farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore during 2020 and 2021 situated in Western Agro- Climatic Zone of Tamil Nadu at 11°N latitude, 77°E longitude and at an altitude of 426.7 m above MSL (mean sea level). The experiment was laid out in a Randomized complete block design with thirteen treatments which is replicated thrice. Treatment details of greengram are T_1 - Drip fertigation (DF) @ 75% Recommended Dose Fertilizer (RDF), 75 % Pan Evaporation (PE) with Fermented Fish Waste (FFW) (2 times), T_2 - DF @ 75% RDF, 75% PE with Fermented Egg Product (FEP) (2 times), T_3 - DF @ 100% RDF, 75% PE with FFW (2 times), T_4 - DF @ 100% RDF, 75% PE with FEP (2 times), T_5 - DF @ 125% RDF, 75% PE with FFW (2 times), T_6 - DF @ 125 % RDF, 75 % PE with FEP (2 times), T_7 - DF @ 75% RDF, 100% PE with FFW (2 times), T_8 - DF @ 75% RDF, 100% PE with FEP (2 times), T_9 - DF @ 100% RDF, 100% PE with FFW (2 times), T_{10} - DF @ 100% RDF, 100% PE with FEP (2 times), T_{11} - DF @ 125% RDF, 100% PE with FFW (2 times), T_{12} - DF @ 125% RDF, 100% PE with FEP (2 times), T_{13} - Surface irrigation with 100% RDF. For greengram crop, Fermented egg product was applied at vegetative stage and peak flowering stage @ 5 lit. ha^{-1} through drip system and Fermented Fish Waste was applied through drip at vegetative and peak flowering stages @ 5 lit. ha^{-1}. The experimental site soil nutrient content was low in available nitrogen, medium in available phosphorus and high in available potassium was given in the Table 1. Greengram variety CO 8 was used for the experiment which is 100-105 days duration and drought tolerant. The seeds were purchased from Department of Pulse, TNAU, Coimbatore. Healthy and matured greengram (CO 8) seeds were used and treated with imidacloprid 17.8 SL at 2 ml kg^{-1} seed to protect the crop from sucking pests during initial crop growth. Sowing was done by dibbling two seeds on raised beds with a spacing of 30 cm × 10 cm. Before sowing of greengram, glyphosate (41% SL) was applied to the experimental field with concentration @ 10 ml $litre^{-1}$ water. Pre-emergence application of pendimethalin @ 1 kg *a.i.* ha^{-1} on 3 DAS followed by one hand weeding during the vegetative period was done, to keep the field weed free till the crop canopy has considerably covered the ground. The fermented fish waste and fermented egg product are water soluble and rich in N, P and micronutrients with microbial load. The average life span of drip system is seven years. The fertilizer was given as per the treatment details listed above (Naik *et al*., 2023).

The growth attributes such as plant height, LAI and days to 50 per cent flowering are recorded. The maximum plant height was measured from the base of the stem to the tip of the longest trifoliate leaf. Root characteristic of greengram were recorded at 45 DAS and at harvest stages. Yield attributes *viz*., number of pods per plant, number of seeds per pod, pod weight per plant, pod length and grain yield were recorded during harvest stage. The data on the different growth and yield parameters were analysed statistically by adopting Fisher's method of ANOVA suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Plant growth parameters like plant height, root length, root volume, root dry weight, days to 50 per cent flowering and physiological parameters SPAD Values are significantly influenced by the drip irrigation and fertigation levels at different growth stages of greengram. The days to 50 per cent flowering ranged from 30.3 to 39.6 and from 31.0 to 39.3 days during summer 2020 and *Kharif* 2021, respectively. Among treatments, DF @ 125% RDF, 100% PE with FEP (2 times) (T12) took more days for 50% flowering (39.6 and 39.3 days during both the years). During summer 2020 season, significantly longer root length was observed under surface irrigation with 100% RDF (T_{13}) (10.8 and 18.9 at 30 DAS and 45 DAS, respectively over all other treatments. However, it was on par with DF @ 125% RDF, 75% PE with FEP (2 times) (T_6). There is no significant difference in root length at harvest stage during both the years of experimentation and also in *Kharif* 2021. Higher

root volume (2.03, 2.44 and 3.01 cm^3 during summer 2020 and 2.10, 2.70 and 3.23 cm^3 during *Kharif* 2021 at 30 DAS, 45 DAS and harvest stages, higher plant height (Fig 1) and higher root dry weight (g $plant^{-1}$) was observed under DF @ 125% RDF, 100% PE with FFW (2 times) (T11) than other treatments. Among the treatments, significantly more SPAD values (T11) (43.2 and 45.3 during summer 2020 and 42.8 and 45.9 during *Kharif* 2021 at 30 and 45 DAS, respectively) was observed and presented in Table 2. Higher leaf area index value was observed under drip fertigation @ 125% RDF, 100% PE with FFW (2 times) (T_{11}) at peak flowering stage Fig 1. This is in agreement with the findings of Tiwari and Dhakar (1997) who stated that reduced soil moisture inhibited the leaf expansion and stem elongation.

During both the years of investigation, drip fertigation @ 125% RDF, 75% PE with FFW (2 times) (T11) (Fig 2) recorded higher yield attributes *viz.,* number of pods $plant^{-1}$, number of grains pod^{-1} and number of grains $plant^{-1}$ of greengram over all other treatments. Sufficient moisture availability reflected in increasing yield attributes due to frequent water application under drip irrigation system might be due to optimum moisture conditions during crop growth results increased yield attributes. These findings are supported by Ranjitha *et al.* (2018). The grain yield was found

Table 1: Physico-chemical characteristics of the experimental field.

Soil properties	Reference	Values
Physical properties		
Field capacity (%)	Dastane (1972)	38.25
Permanent wilting point (%)	Richard (1954)	11.68
Available soil moisture (%)	Farbrother (1973)	26.57
Bulk density (Mg m^{-3})	Dakshinamurthy and Gupta (1968)	1.33
Textural composition		
a. Clay (%)	International Pipette Method, Piper (1966)	42.10
b. Silt (%)		11.71
c. Coarse sand (%)		17.32
d. Fine sand (%)		28.15
Textural class		Clayloam
Chemical properties		
Available N (kg ha^{-1})	Subbiah and Asija (1956)	213.0
Available P (kg ha^{-1})	Olsen *et al.* (1954)	15.00
Available K (kg ha^{-1})	Stanford and English (1949)	608.0
Organic carbon (%)	Walkley and Black (1934)	0.70
pH (1:25 soil and waterextraction)	Jackson (1973)	8.1
EC (dSm^{-1}) (1:2.5 soil and water extraction at 27°C)	Jackson (1973)	0.41

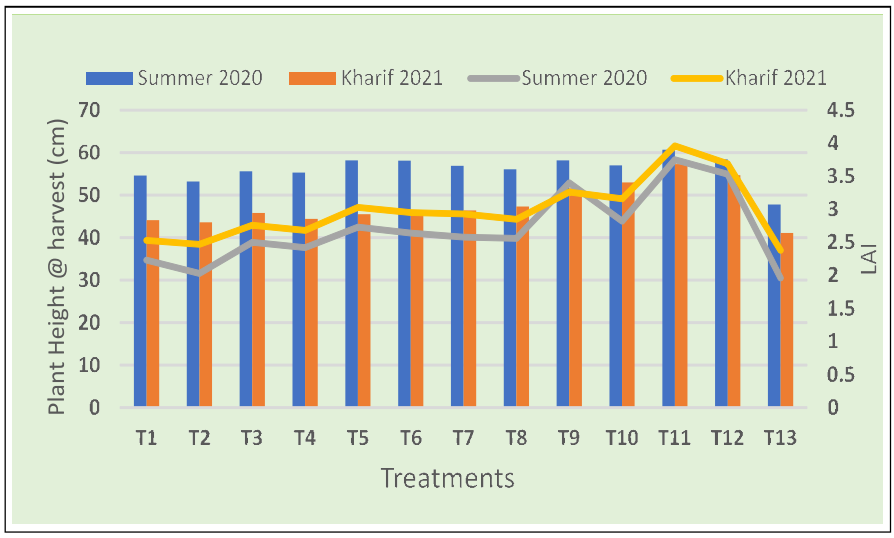

Fig 1: Effect of drip fertigation on plant height (cm) at harvest and leaf area index (LAI) of greengram at peak flowering stage during summer-2020 and *Kharif* season-2021.

Table 2: Effect of drip irrigation and fertigation levels on root length (cm), root volume (cm^3), root dry weight (g $plant^{-1}$) and seed yield of greengram during summer 2020 and *Kharif* 2021.

Treatment	Days to 50% flowering		Root length (cm)				Root volume (cm^3)				Root dry weight (g $plant^{-1}$)			
	Summer	*Kharif*	Summer 2020		*Kharif* 2021		Summer 2020		*Kharif* 2021		Summer 2020		*Kharif* 2021	
	2020	2021	45 DAS	Harvest	45 DAS	Harvest	45 DAS	Harvest	45 DAS	Harvest	45 DAS	Harvest	45 DAS	Harvest
T_1	30.3	32.3	15.9	19.0	12.6	16.3	1.67	1.93	1.63	1.95	1.17	1.41	1.12	1.29
T_2	31.6	31.0	14.4	19.6	11.1	16.9	1.61	1.85	1.44	1.92	1.11	1.32	0.93	1.07
T_3	32.0	33.6	14.0	17.9	10.7	15.2	1.79	2.24	1.78	2.25	1.29	1.72	1.27	1.59
T_4	32.3	32.6	16.9	19.0	13.6	16.3	1.72	2.31	1.69	2.50	1.22	1.79	1.22	1.73
T_5	35.3	35.3	14.6	19.3	11.3	16.6	1.86	2.46	1.92	2.54	1.36	1.94	1.41	1.85
T_6	34.6	34.0	14.3	19.7	11.0	17.0	1.91	2.36	1.74	2.43	1.41	1.83	1.29	1.50
T_7	34.3	35.3	16.8	17.5	13.5	14.8	1.80	2.28	1.92	2.23	1.30	1.76	1.41	1.65
T_8	35.3	34.6	17.2	17.7	13.9	15.0	1.88	2.21	1.93	2.30	1.38	1.69	1.42	1.45
T_9	36.6	35.6	16.7	18.0	13.7	15.3	2.29	2.56	2.46	2.52	1.79	2.04	1.98	1.87
T_{10}	37.6	37.0	13.8	16.5	10.5	13.8	2.11	2.55	2.08	2.75	1.61	2.02	1.57	1.62
T_{11}	39.3	38.3	11.6	15.7	8.3	13.0	2.44	3.01	2.70	3.23	1.94	2.49	2.19	2.44
T_{12}	39.6	39.3	13.1	17.9	12.0	15.2	2.36	2.92	2.57	2.97	1.86	2.40	1.89	2.08
T_{13}	33.3	34.0	18.9	20.6	15.6	17.9	1.32	1.48	1.29	1.99	0.82	0.96	0.79	1.27
SEd	1.6	1.5	1.7	2.2	1.8	2.2	0.11	0.18	0.14	0.17	0.11	0.18	0.08	0.09
CD (P=0.05)	3.4	3.2	3.6	NS	3.7	NS	0.24	0.38	0.28	0.35	0.24	0.38	0.16	0.19

Table 3: Effect of drip irrigation and fertigation levels on economics of greengram during summer 2020 and *Kharif* 2021.

Treatment	Summer 2020				*Kharif* 2021			
	Cost of cultivation (` ha^{-1})	Gross return (` ha^{-1})	Net return (` ha^{-1})	B:C ratio	Cost of cultivation (` ha^{-1})	Gross return (` ha^{-1})	Net return (` ha^{-1})	B:C ratio
T_1	43208	61413	29957	1.42	43208	58993	15785	1.37
T_2	43298	61040	29494	1.41	43298	54890	11592	1.27
T_3	45445	64635	30942	1.42	45445	61191	15746	1.35
T_4	45535	58765	24982	1.29	45535	62896	17361	1.38
T_5	47682	69355	33425	1.45	47682	67073	19391	1.41
T_6	47772	72120	36100	1.51	47772	68886	21114	1.44
T_7	43208	70020	38564	1.62	43208	65681	22473	1.52
T_8	43298	73471	41925	1.70	43298	66405	23107	1.53
T_9	45445	76032	42339	1.67	45445	72544	27099	1.60
T_{10}	45535	76573	42790	1.68	45535	70061	24526	1.54
T_{11}	47682	84888	48958	1.78	47682	81084	33402	1.70
T_{12}	47772	80182	44162	1.68	47772	80333	32561	1.68
T_{13}	38428	54136	15708	1.41	38428	51068	12640	1.33

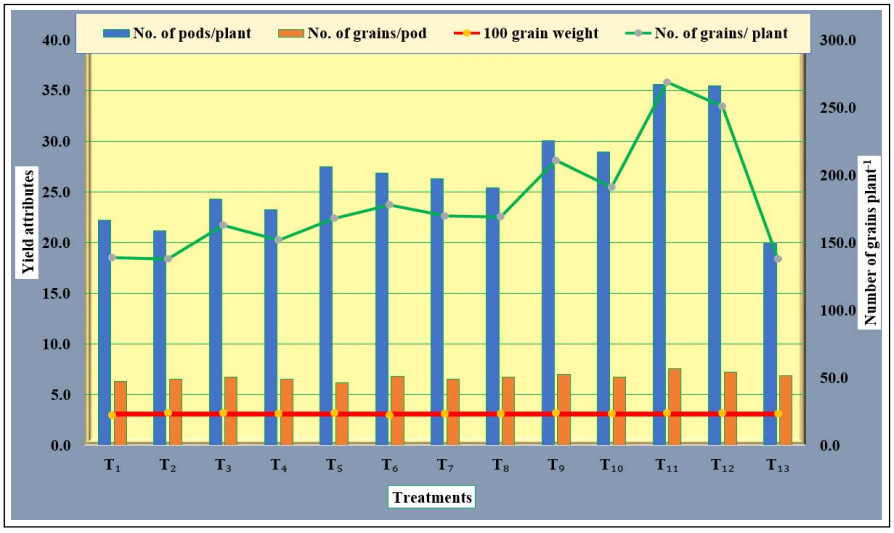

Fig 2: Effect of drip fertigation on yield attributes of greengram during summer-2020 and *Kharif* season-2021.

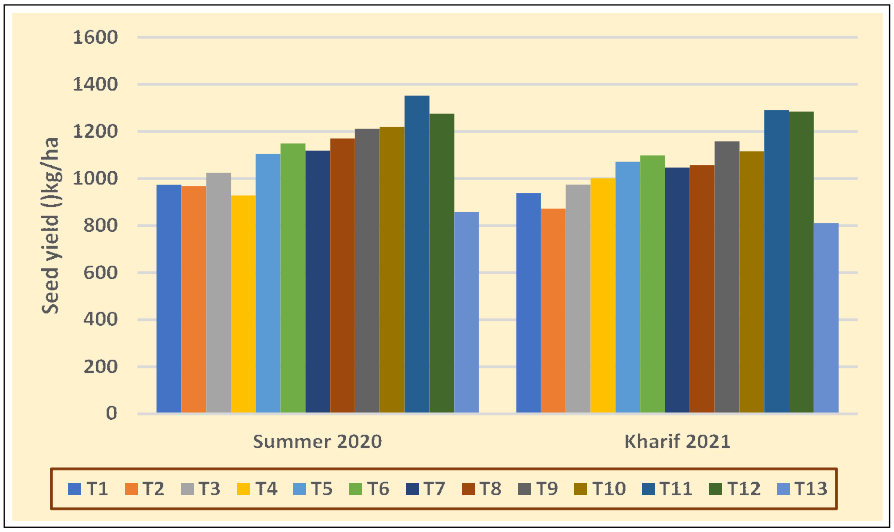

Fig 3: Effect of drip fertigation on yield of greengram during summer-2020 and *Kharif* season-2021.

to be increased with DF @ 125% RDF, 100% PE with FFW (2 times) (T_{11}) and gave a yield of 1352 kg ha^{-1} during summer 2020 and 1291 kg ha^{-1} during *Kharif* 2021 (Fig 3).

Higher gross return was recorded under DF @ 125 % RDF, 100% PE with FFW (2 times) (T11) (` 84,888 and ` 81,084 during summer 2020 and *Kharif* 2021, respectively) given in Table 3. Which was comparable with DF @ 125% RDF, 100% PE with FEP (2 times) (T12) and the findings was confirmed with Srinivasan *et al*. (2021) and Srinivasan *et al*. (2022).

CONCLUSION

The application of drip fertigation @ 125% RDF, 100% PE with FFW (2 times) (T_{11}) recorded higher plant height, physiological parameters including LAI, SPAD values and 50% flowering, in accordance with the results of both seasons. In relation to other treatments, yield attributes, yield and economics performed much better. It was comparable to the DF @ 125% RDF, 100% PE with FEP (2 times), although (T_{12}). As a conclusion, this is considered as an appropriate agro-technique for farmers growing greengram in order to achieve better yield and higher net returns for the farmers.

Conflict of interest

All the authors declare no conflict of interest and agreed for the publication.

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