Research Journal of Agriculture and Forestry Sciences _____ISSN2320– 6063
Vol. **13(1),** 27-34, January **(2025)** *Res.J. Agriculture and Forestry Sci.*

Impact of goat manure and fish meal on yields of green gram and radish in intercropping system

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Available online at: www.isca.in, www.isca.me
Received 9th November 2024, revised 18th December 2024, accepted 4th January 2025

Abstract

Sustainable crop production is foreseeable requirement with increasing world population. Intercropping is a good conception to effectively make use of the space and obtains more than one crop yields. Application of organic manures as a substitute of chemical fertilizers in intercropping system is an environmentally friendly to increase crop productivity. According to the above perceptions, experiment study was carried out to determine the effect of goat manure and fish meal on intercropping of green gram and radish. It was designed in a randomized complete block design with five treatments and four replicates. They were chemical fertilizers (T1), 10 t/ha goat manure alone (T2), 10 t/ha goat manure + 0.1 t/ha fish meal (T3), 15 t/ha goat manure (T4) and 15 t/ha goat manure + 0.1 t/ha fish meal (T5). The fresh and dry weights of leaves, stem, root, seeds and pods of green gram were weighed at 7th weeks. And also plant height, leaf area and pod length were taken. Fresh weights of leaves, tuber and whole plant parameters of radish were recorded. Results revealed that there were substantial differences in yields of green gram and radish among the treatments. Highest seed yield for green gram was recorded as 2654.73 kg/ha that was obtained in T5. Similarly, T5 produced highest yield for radish and that was 39,428.33 kg/ha. Therefore, the study clearly shows that there is a positive effect of goat manure and fishmeal application in green gram crop intercropped with Radish.

Keywords: Fish meal, goat manure, green gram, radish, yield.

Introduction

Intercropping is the cultivation of two or more crops simultaneously on the same land and it is an important cropping system for the development of sustainable food production[1]. Efficiency of intercropping depends on mainly the management and cultures involved[2]. This cropping system leads to efficient utilization of sunlight, nutrients and water and also minimizing risk on pest and disease[3]. Therefore, proper selection of main crop and intercrop in intercropping system is needed. Selection of legume crop to intercrop with non-legume crops can increase the nitrogen content in soil because of fixing atmospheric nitrogen by legume plant. The leaching of nitrogen from leaves and decomposition of legume leaves may also be the reasons in nitrogen transfer to the associated crops[4]. The LER values reveal greater potential for yield advantage in cropping with legumes. Dantata[5] stated that intercropping with legumes is a desirable agronomic practice toward boosting the crop production.

Vigna radiata (L) is commonly known as green gram and it is one of the prominent sources of protein and certain essential acids like lysine and tryptophan in vegetarian diets. Green gram is relatively drought tolerant and well adapted to range of soil conditions. Green gram is an important grain legume in Sri Lanka specially grown in dry zones and intermediate zones of the country. Radish is known as a widespread root vegetable grown in tropical and temperate regions. It is a short duration crop and quick growing crop. Soil and climatic conditions should be optimum for their growth and yield performance[6]. Radish is an annual or biennial vegetable crop depending upon the type for the purpose it is grown. In Sri Lanka, radish is cultivated in all agro-ecological region during the year in the presence of adequate moisture level. Radish is grown for its young tender tuberous root and it is rich in natural anti-oxidant vitamin C and other minerals.

Addition of fertilizer is required to sandy soil to improve the productivity. Inorganic fertilizer is applied by farmers continuously but inorganic fertilizer is not available for long period in the soil. Salt accumulation in soil due to excessive utilization of inorganic fertilizer causes to reduce crop yield[7]. Therefore, farmers are advised to use the locally available organic manure efficiently with reduced amount of inorganic fertilizers for obtaining the optimum seed yield of legume crop with less cost of production[8,9]. The response of fertilizer depends on the crop varieties and the soil types[10]. Addition of organic fertilizer enhances soil physical properties, microbial activities, water absorption and available nutrients especially in sandy soil and it reduces the adverse effect on environment and humanhealth[8,11].

Among several types of organic manures, goat manure is significantly known for high level of potassium which is a major

component of ash and also potentially require for protein synthesis[12]. N, P, K, Ca, Mg, chemical property, pH, growth and yield parameters increase with the application of goat manure[13]. Fish meal is a fine textured powder form product obtained from fish and it is most popularly used as a feed additive in poultry meal due to its protein richness. Fish meal protein consists considerable amount of all essential amino acids. Hence, fish-based fertilizer normally contains higher amount of nutrients and also promotes soil microbial activity. Most often made of Bi-catch fish. Fish meal is known as a good fertilizer for increasing the nutrient uptake[14]. Demand for organically growing produce is increasing in the lobal market[15]. Thus, this experiment was done tostudy the influence of goat manure and fishmeal on growth and yield of green gram and radish intercropping.

Materials and Methods

The experiment was conducted at the Crop farm, Eastern University, Sri Lanka during the period of January 2019 to May 2019 to study effects of goat manure and fishmeal on green gram (*Vigna radiate L.*) intercropped with radish (*Raphanus sativus* L.) in sandy soil. The experiment site is located in the agro-ecological described as low country dry zone (DL2), at the altitude of 76.2 m. above mean sea level. Annual rainfall is between 1600 mm to 2300 mm. Most of the rainfall being received during the months of October to January from both inters monsoonal and North-East monsoonal types. Mean temperature ranges from 28-32^{o}C. In this experiment, green gram, MI-5 variety was grown as main crop and radish, beeralurabu variety was grown as companion crop. All the treatments were laid out in a Randomized Complete Block Design (RCBD) with four replicates and five treatments. Each plot was considered as an experimental unit in each block of RCBD, therefore 20 experimental units were arranged. The plot size was 1.2 m×1.0 m and. there were five plots in a block. Green gram crops were planted at the spacing between rows 30 cm and within the rows 10 cm. Radish plants were raised at the spacing of 30 cm and 10 cm spacing within the row. Treatments are as follows: i. T1-Recommended Chemical fertilizers, ii. T2 - 10 t/ha goat manure + 0 t /ha fish meal, iii. T3 - 10t/ha goat manure+ 0.1 t/ha fish meal, iv. T4 - 15t /ha goat manure + 0 t /ha fish meal, v. T5 - 15 t/ ha goat manure + 0.1 t /ha fish meal.

The experimental site was ploughed with mammoty and then the land was leveled manually by means of mammoty. Goat manure was collected, sundried and powdered. After that it was applied two weeks prior to planting of green gram according to the application rate. Two (T3 and T5) of the treatments were mixed with fish meal at the rate of 0.1t/ha. Chemical fertilizers as a control treatment were applied as recommended by the Department of Agriculture, Sri Lanka. It was applied two days prior to planting. Green gram seeds were sown according to the layout in Figure-1. After 3 weeks of planting green gram seeds, radish seeds were sown.

Proper soil moisture is an important for good and uniform germination. Plants were irrigated twice a day until 2 weeks after seed sowing. Then plants were irrigated as once in a day. Basal chemical fertilizers (35 kg/ha urea, 100 kg/ha TSP, 75 kg/ha MOP) were added to the T1 treatment experimental plots then top dressing was applied with 30 kg/ha urea at 30 days after planting (at the time of first flowering). Earthing up was done at 2 weeks after sowing of radish. Weeding was manually done at the two weeks intervals. Green gram leaves were attacked by cutworm. They were made holes on the leaves. They were controlled by spraying of profenaphos at the rate of 3 ml mixed in 2 L water. There was no any disease observed in the field during the experiment period.

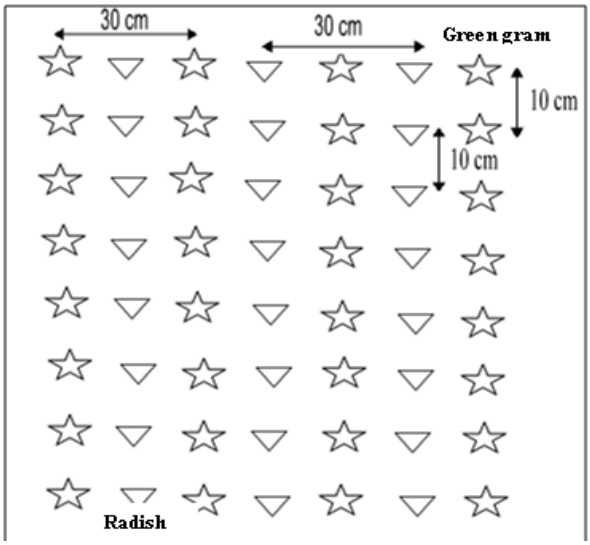

Figure-1: Field layout in this experiment.

Plant height and number of leaves on green gram plants were taken where height was measured from top of ground level to tip of main stem by using centimeter scale. The pod weight was weighed and length of a mature pod was measured at the stage of harvesting. Length was measured from the top to bottom. The number of seeds in each pod was counted after the harvesting stage and then hundred seed weight was measured. In each treatment, mature pods of green gram were harvested at two weeks intervals after the changing the pod colour into black colour. Thereafter pod and seed weights were measured after air drying under sunlight for three days.

The sample plants were carefully pulled out from each plot and plant parts were separated as leaves, stem and root and then their fresh weights were weighed by using electronic balance. After that dried weight of leaves, stem and root were weighed after keeping in the oven at 105^{o}C overnight. After pulling out radish plant at harvesting stage, the total plant fresh weight was weighed and then radish yield was calculated. Collected data were statistically analysed using statistical software SAS 9.4 and treatment means were compared according to the Duncan Multiple Range Test (DMRT) at 5 % significant level.

Results and Discussion

The experiment was done to perform whether goat manure has an influence on growth and yield of green gram intercropped with radish. And also, determine the influence of goat manure and fishmeal on growth and yield of green gram and radish.

Green gram as a main crop: Plant height: The results showed that there is a significant variation ($p<0.05$) in plant height among the treatments of green gram plants at 7th week after planting (Table-1). The average plant height (45.75 cm) was considerably high ($p<0.05$) in T5 (15 t/ha goat manure + 0.1 t/ha fishmeal). This may be due to increased availability of goat manure nutrients and positive influence of fish meal on nutrient uptake. Uwah and Eyo[16] stated that goat manure at higher rates (15 and 20 t/ha) gave better growth probably because of higher uptake of essential nutrients in the manure when compared to lower levels in sweet maize. Awodun *et al.*[13] found that growth and yield parameters raised with rate of goat dung application, hence the 10 t/ha goat dung gave the highest values of these parameters in pepper among goat dung treatments.

Leaf Area: The leaf area in green gram plant was significantly influenced by the treatments (Table-1). Treatment T5 was remarkable different ($p<0.05$) from all the other treatments. Highest value for leaf area was recorded in T5 as 488.9 cm^2. Increased availability of nitrogen may contribute to the enlargement of leaf area. T1 (chemical fertilizer) did not express remarkable changes in Leaf area compared with other treatments. Blayeri *et al.*[17] confirmed the increasing leaf area due to the application of poultry manure and it is because of higher nitrogen availability. Herve *et al.*[18] stated that the leaf area increases due to the height increase of intercropped plants.

Pod length and weight: Treatments had significant effect in the length of a pod (Table-1). T5 resulted the significantly higher ($P<0.05$) pod length (11.48 cm) among all the treatments. T1 showed the lowest pod length. There was no remarkable change in pod length between T1 and T2. The pod weight was considerably influenced ($P<0.05$) among the treatments (Table-2). Among the all treatments, T5 was resulted with remarkably higher ($P<0.05$) fresh pod weight (1.03 g) than other treatments except T4 (15 t/ha goat manure alone) Similarly Awodun *et al.*[13] reported that goat manure showed higher values of pod weight and number of pods for 8 t/ha goat manure. In the present study, T1 showed significantly lower pod weight. T2 (10 t/ha goat manure alone) and T3 (10 t/ha goat manure + 0.1 t/ha) did not exhibit significant difference in fresh pod weight.

The treatments significantly influenced the pod dry weight. There was no significant remarkable change in the pod dry weight between T4 and T5. T5 were produced significantly higher dry pod weight (0.98g) than T1, T2 and T3. Pod formation is depended on the potassium content. Therefore, amount of goat manure is comparatively high in T4 (15 t/ha) and T5 (15 t/ha +0.1 t/ha). It may lead to higher fresh and dry weights in green gram pods. In addition to potassium, nitrogen also greatly contributes to the pod yield. Poultry waste is a rich source of nitrogen than P and K[9]. Kandil *et al.*[19] reported that the increase in nitrogen level improved pod yield, straw yield and seed protein content.

Hundred seed weight: There was a significant influence of treatment in hundred seed weight ($P<0.05$). T5 did not remarkably vary in hundred seed weight with T1 and T4 (Table-2). Goat manures enrich in nutrients and release nutrient slowly. Therefore, sufficient amount of nutrient may be available for considerable change in seed yield in addition to growth. Imthiyas and Seran[20] stated that compost does not supply entire amount of nutrient at one cropping season. Organic manure application can sustain crop yield level for longer period after the application stops because nitrogen and other nutrient in manure are available to plants after first year of applications. This is in accordance with Seran[8] mentioned that farm yard manure discharges nutrients gradually which is available to plants even later stage of plant growth.

Table-1: Effect of fertilizer application on plant height, leaf area and pod length of green gram plants in each treatment at 7th week after planting.

Treatments	Plant height (cm)	Leaf area (cm^2)	Pod length (cm)
T1	35.00±0.82^{d}	361.21±13.29^{d}	09.00±0.00^{d}
T2	40.38±0.24^{b}	384.09±09.45^{cd}	09.25±0.14^{d}
T3	41.63±0.24^{bc}	409.27±02.92^{c}	09.88±0.13^{c}
T4	43.00±0.35^{b}	452.65±09.52^{b}	10.60±0.07^{b}
T5	45.75±0.48^{a}	488.90±15.90^{a}	11.48±0.10^{a}
F test	*	*	*

Value represents mean ± standard error of four replicates. F test:-*: $P<0.05$. Means followed by the similar letter are not significantly variation by Ducan's Multiple Range Test at 5% level.

Seed yield: Seed yield was increased with the increasing rate of goat manure (Figure-2). High seed yield (2654.73 kg/ha) was observed in T5. Influence of fish meal may cause to increase the uptake of nutrients. Application of goat manure with fishmeal could attribute with an increasing release of required plant nutrients for high seed production which is highly depended on macro and micronutrients. The remarkable differences in seed yield between T3 and T5 is also may be due micro nutrient availability high in T5 than T3. Uwah and Eyo[16] reported that the increase in grain yield with increasing rates of goat manure (20t/ha) improved the nutrient availability consequently use of goat manure led to the considerable improvement of growth and yield in sweet maize. Parasuraman *et al.*[21] stated higher availability of plant nutrients in the fertilized treatments had higher growth and yield of groundnut. Seran *et al.*[15] stated that addition of cattle manure had remarkable effect on nutrient constituents of seeds than application of synthetic fertilizers.

Fresh weight of crop residue: There is a considerable influence of treatments in fresh weight of stem (Table-3). T5 was significantly disparity ($p<0.05$) in stem fresh weight from other treatments. And plants treated with T5 produced the highest value for stem fresh weight (9.58 cm). T1 was recorded for the lowest stem fresh weight. T1 and T2 as well as T3 and T4 were produced statistically similar amount of fresh stem weight. Significant influence of the treatments was also observed on fresh weight of leaves (Table-3). T5 significantly changed ($p<0.05$) in leaf fresh weight from all the other treatments and it was recorded the higher value (9.37 g). The increased level of nutrient availability of goat manure and fish meal may be contributed to the fresh weight increase in leaves. Chemical Treatment (T1) was recorded for the lowest leaf fresh weight. The result is supported by the finding of Ipinmoroti *et al.*[22] that soil fertility in N, P, K, Ca and Mg was booted by the utilization of organic manure than NPK fertilizers.

Table-2: Effect of fertilizer application on pod weight and hundred seed weight of a green gram at 1st harvesting.

Treatments	Fresh pod weight (g)	Dry pod weight (g)	Hundred seed weight (g)
T1	0.63 ± 0.02^{c}	0.55 ± 0.04^{c}	4.75 ± 0.21^{ab}
T2	0.78 ± 0.05^{b}	0.74 ± 0.05^{b}	4.10 ± 0.65^{b}
T3	0.88 ± 0.04^{b}	0.76 ± 0.03^{b}	4.38 ± 0.55^{b}
T4	0.99 ± 0.04^{a}	0.92 ± 0.02^{a}	4.75 ± 0.25^{ab}
T5	1.03 ± 0.04^{a}	$0.98\pm.04^{a}$	$5..82\pm.18^{a}$
F test	*	*	*

Values represent means ± standard errors of four replicates. F test:-*: P<0.05.Means followed by the identical letter are not remarkably different according to Duncan's Multiple Range Test at 5% level.

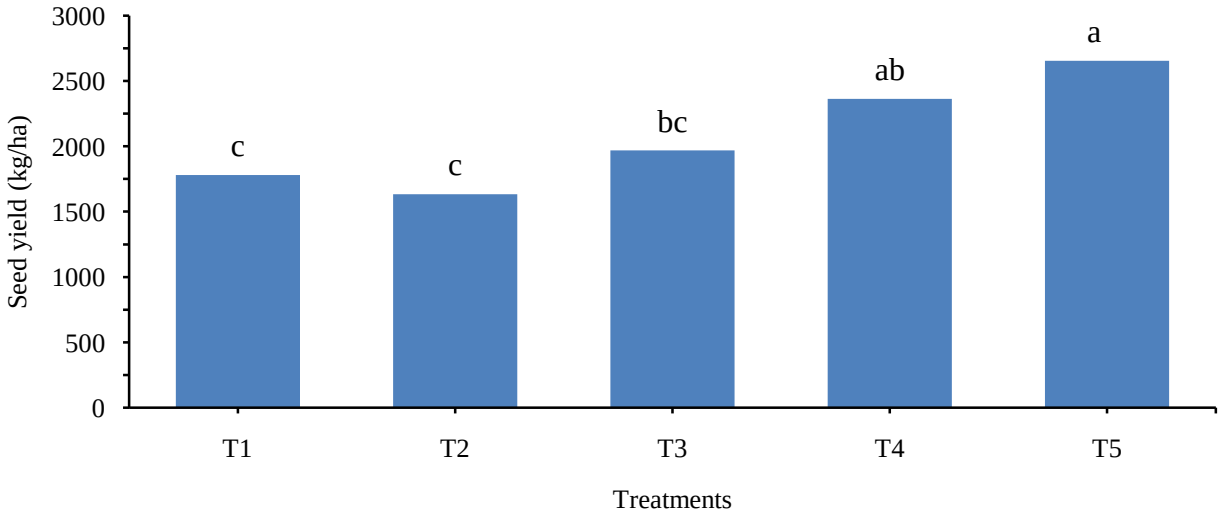

Figure-2: Effect of fertilizer application on seed yield at harvest of greengram plants.

It was further noted that there is a significant influence of treatments on fresh root weight ($p<0.05$). T5 showed a remarkable difference from all the other treatments (Table-3). The lowest fresh weight of root was obtained in T1. T3 and T4 produced statistically similar fresh weight for root. The root fresh weight between T1 and T5 showed a significant difference. This may due to higher nutrient content of T5. Uwah and Eyo[16] stated that root growth was improved in sweet maize largely owing to increased availability of nutrients provided by goat manure and due to the sufficient supply of these macro elements, the fresh root weight in tomato was enhanced. The results showed the significant influences of treatments on fresh weight of leaves, stem and root of green gram. Fresh weight of crop residue included the fresh weights of leaf, stem, and root and pod shell. T5 showed higher value for fresh weight of crop residue among all treatments **(**Figure-3). Lower crop residue weight was resulted in T1.

Dry weight of crop residue: Significant influence of treatments was noted in stem dry weight (Table-4). T5 produced the highest dry weight value for stems of green gram plants and which was considerably varied from all other treatments ($P<0.05$). The lowest stem dry weight for green gram plants was obtained from T1. The dry stem weight of green gram plants that was obtained from T2, T3 and T4 were statistically equal amount. Dosani *et al.*[23] indicated that FYM application increased the production of dry matter content.

The treatments were considerably influence the dry weight of leaves (Table-4). Among all five treatments, T5 had the higher dry leaf weight per plant (2.54 g). Highest weight gain may be due to the highest availability of nutrients in goat manure and fish meal especially present of highest potassium value in goat manure. The lowest dry weight was remarkably differed from all the other treatments ($p<0.05$). Lower dry weight for green gram leaves were recorded in T1. The leaf dry weight in T1 and T2 were statistically similar. Significant influence of treatments was also observed in dry root weight (Table-4). The highest and lowest dry weight values were resulted in T5 and T1 respectively. T5 significantly differed from other treatments ($p<0.05$). Plants in T1 and T2 resulted root dry weight with no significant change.

Table-3: Effect of fertilizer application in fresh weight of leaf, stem and root of green gram plants after harvesting pods.

Treatments	Fresh weight of crop residue (g)		
	Stem	Leaf	Root
T1	2.74 ± 0.64^{d}	4.76 ± 0.34^{e}	0.75 ± 0.03^{d}
T2	4.09 ± 0.12^{cd}	5.93 ± 0.10^{d}	1.02 ± 0.12^{c}
T3	5.48 ± 0.17^{bc}	6.81 ± 0.25^{c}	1.31 ± 0.02^{b}
T4	6.47 ± 0.16^{b}	7.81 ± 0.32^{b}	1.45 ± 0.09^{b}
T5	9.58 ± 1.05^{a}	9.37 ± 0.12^{a}	2.10 ± 0.09^{a}
F test	*	*	*

Values represent means ± standard errors of four replicates. F test:-*: $P<0.05$. Means followed by the similar letter are not sustainably different according to Duncan's Multiple Range Test at 5 % level.

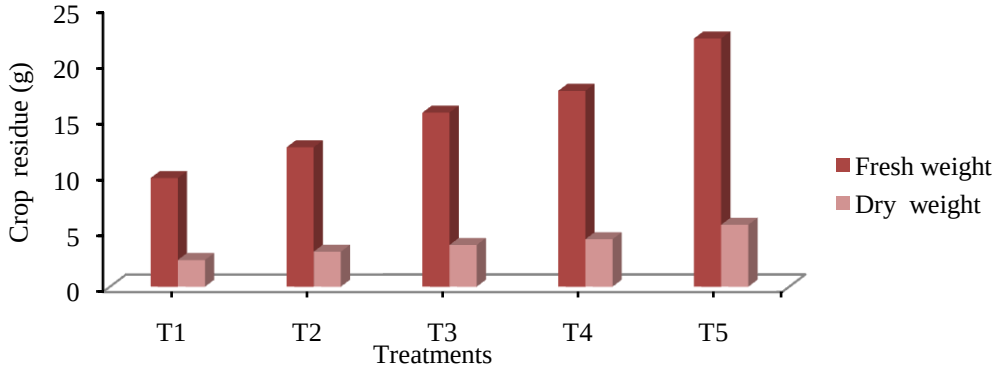

Figure-3: Effect of fertilizer application on crop residue of green gram.

The dry weights of leaf stem, and root was exhibited remarkable variation to applied treatments as a result of nutrients availability which were released from nutrient rich organic manure. Further, fishmeal enhances the nutrient absorption therefore; dry weights in T5 were attained. Similar result was expressed by Mengel[24]. The potassium is required for all synthetic production of carbohydrates and the higher plant biomass. Plant biomass is a vital parameter which has an effect on yield of the crop especially legume that are grown for food, feed and green manuring[25].

Radish as an intercrop: Fresh leaf weight: There was a significant change in fresh weight of leaves per radish plant as a result of applied treatments (Table-5). Among all the five treatments, T5 and T4 had a considerable highest value in fresh leaf weight ($p<0.05$) compared with the other treatments. This may due to increased level of available plant nutrients. The fresh leaf weight that was resulted from T2 was lower than rest of the treatments. Even though similar rate of goat manure was applied in T2 and T3, T3 gave significantly high fresh weigh of leaves. It may be because of increase microbial activity due to available nutrients in fish meal in T3.

Tuber fresh weight: There was a remarkable difference in tuber fresh weight (Table-5). T4 and T5 treatments were produced significantly higher fresh weight for tuber among the treatments ($p<0.05$). There was a significant difference in fresh weight of tuber in T3 and T5. Also, there was a considerable variation in fresh tuber weight in T2 and T4. This result may due to higher nutrient uptake and accumulation of goat manure alone or combined with fish meal. Wright *et al.*[26] noted that highest root growth and rooting depth of barley crop remained higher in treatments, which obtained animal manures relation to where manure was not applied.

Table-4: Effect of fertilizer application on dry weight of leaf, stem and root of green gram plants after harvesting pods.

Treatments	Dry weight (g)		
	Leaf	Stem	Root
T1	1.23 ± 0.08^{d}	0.88 ± 0.11^{c}	0.26 ± 0.02^{d}
T2	1.35 ± 0.06^{d}	1.33 ± 0.11^{bc}	0.35 ± 0.02^{cd}
T3	1.70 ± 0.06^{c}	1.50 ± 0.03^{b}	0.43 ± 0.06^{bc}
T4	2.03 ± 0.09^{b}	1.63 ± 0.02^{b}	0.52 ± 0.02^{b}
T5	2.54 ± 0.18^{a}	2.26 ± 0.29^{a}	0.66 ± 0.06^{a}
F test	*	*	*

Values represent means ± standard errors of four replicates. F test:-*: $P<0.05$.Means followed by the identical letter are not significantly distinct according to Duncan's Multiple Range Test at 5% level.

Table-5: Effect of fertilizer application on fresh weights of leaf, tuber and whole plant and also yield of radish plant.

Treatments	Leaf fresh weight (g)	Tuber fresh weight (g)	Plant fresh weight (g)	Yield (kg/ha)
T1	42.85 ± 1.49^{b}	44.48 ± 0.97^{bc}	087.33 ± 1.87^{c}	29107.5 ± 312.4^{d}
T2	36.49 ± 1.92^{c}	41.53 ± 0.46^{c}	078.02 ± 2.77^{d}	26007.5 ± 325.2^{e}
T3	42.25 ± 0.35^{b}	46.60 ± 1.37^{b}	088.84 ± 1.07^{c}	29613.3 ± 359.2^{c}
T4	56.91 ± 1.20^{a}	54.38 ± 1.33^{a}	111.29 ± 1.12^{b}	37095.0 ± 732.4^{b}
T5	60.66 ± 1.10^{a}	57.63 ± 1.93^{a}	118.29 ± 1.17^{a}	39428.3 ± 724.2^{a}
F test	*	*	*	*

Values represent means ± standard errors of four replicates. F test: -*:$P<0.05$.Means followed by the identical letter are not remarkably different according to Duncan's Multiple Range Test at 5%level.

Plant fresh weight: There was an outstanding difference in plant fresh weight to applied treatments (Table-5). T5 treatment gave significantly higher value for plant fresh weight which was significantly higher than other treatments ($p<0.05$). T2 treatment produced lower plant fresh weight. According to Martinez-Ballesta *et al.*[27], Phosphorus and potassium are very needed nutrients beside nitrogen for tuber crops. Phosphorus is an important nutrient early in plant growth, it boosts root growth, improves nutrient and water efficiency and increases yield. Therefore, this condition was able to supply nutrients from goat manure fish meal.

Radish yield: There was a notable dissimilarity in radish in term of fresh weight of plant among treatments (Table-5). T5 treatment produced significantly higher ($p<0.05$) radish yield than other treatments. T2 treatment gave the lowest amount of yield. Production of radish without providing artificial shade under high temperature is difficult. But this concept has been successfully overcome by intercropping. Therefore, the radish plants in green gram-radish intercropping performed well and gave high plant growth. It might be due to a highly favourable microclimate for the growth and production of radish under intercropping system in addition to increased availability and uptake of nutrients. Further, Litrico and Violle[28] reported that selecting for disparities in rooting depth, phenology, and vegetative architecture between crop species cultivated in an intercrop can minimize competition and increase resource partitioning.

Conclusion

The results showed that by the application of goat manure and fish meal, yield performance of green gram was significantly changed as compared to control treatment. The yield of greengram was high 2654.7 kg/ha in T5 Treatment followed by T4 (15 t/ha goat manure alone) which produced 2362.3 kg/ha. The lowest yield was recorded in T2 (10 t/ha goat manure alone) that was 1633.9 kg/ha. It may due to increased nutrient uptake, increased microbial activity inT4 and T5 than the other treatments. In radish, yield in intercropping system, T5 treatment was highly contributed to the fresh weight of leaf, tuber and plant fresh weight. And also, T5 produced high yield for radish and it was significantly higher than other treatments (39,428.3 kg/ha). Hence, application of 15 t/ha goat manure and 0.1 t/ha fish meal could be used for obtaining yields of both green gram and radish crops in sandy soil.

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