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Influence of intercropping and different nutrient levels on growth and growth attributes of finger millet and green gram

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Abstract
The field experiment entitled "Performance of finger millet and green gram intercropping under different nutrient levels" was investigated during *kharif*, 2024 at the Zonal Agricultural Research Station, Shendapark, Kolhapur. The field investigation laid out using factorial randomized block design, consisting three replications and 18 treatment combinations with first factor is intercropping contains C1: Sole finger millet, C_2: Finger millet + green gram (4:2), C_3: Sole green gram and second factor is nutrient levels contains N_1:100% Recommended dose of fertilizer (RDF), N_2: 75% RDF + Soil application of *Azospirillum* @ (2 kg ha^{-1}) and Phosphate solubilizing bacteria @ (2 kg ha^{-1}), N_3: 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS, N_4: 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS, N_5: 75% RDF + 25% RDN through FYM, N_6: 50% RDF + 50% RDN through FYM. The obtained results showed that the intercropping of finger millet and green gram C_2 recorded higher growth attributes *viz*., plant height, number of tillers, number of branches and dry matter plant^{-1} for finger millet and green gram. Among the different nutrient levels. N1: 100% RDF recorded highest growth attributes followed by N_2: 75% RDF + Soil application of *Azospirillum* @ (2 kg ha^{-1}) and Phosphate solubilizing bacteria @ (2 kg ha^{-1}) and N_3: 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS for both crops. Interaction effect between intercropping and nutrient levels was found significant in plant height, number of branches, dry matter accumulation of both crops.

Keywords: Finger millet, green gram, intercropping, interaction, fertilizers, nutrient levels

Introduction
Cereal-legume intercropping represents a sustainable agricultural practice that enhances overall cropping system productivity by optimizing the use of essential resources such as sunlight, soil moisture, temperature, and nutrients (Foley *et al*., 2011) [3]. Beyond resource efficiency, intercropping is widely recognized as an eco-functional strategy that contributes to dietary diversification, mitigates the risk of crop failure due to adverse biotic and abiotic stresses, improves yield stability, and offers higher economic returns compared to sole cropping systems (Tsubo *et al*., 2005; Bitew *et al*., 2019) [16, 2]. the integration of crops with similar ecological adaptability is crucial, especially in regions susceptible to environmental stresses. Finger millet (FM) and green gram (GG), for instance, have demonstrated considerable tolerance to drought conditions, indicating their potential as a compatible intercropping pair for cultivation in drought-prone areas. Finger millet *(Eleusine coracana* L.) commonly known as ragi, is one of the most important small millets cultivated predominantly in the dryland regions of India. It is primarily grown on red soils, but its adaptability to a wide range of soil types and ago-climatic conditions makes it a resilient crop under both rainfed and marginal environment. Green gram (*Vigna radiata* L. Wilczek), commonly known as moong, is an important annual legume belonging to the family Fabaceae. It is widely recognized for its high protein content, with good digestibility, making it a valuable dietary component in both human and animal nutrition. In the present agricultural scenario, the increasing demand for high-quality, nutrient-rich food and the need to maintain soil health have emerged as critical factors in sustainable food production. The excessive and imbalanced use of chemical inputs has led to nutrient mining, degradation of soil

fertility, and a decline in crop productivity, ultimately compromising the longterm sustainability of agricultural systems. Fertilizers alone are insufficient to sustain long-term land productivity in modern agricultural systems (Perli *et al*., 2022) [12]. The incorporation of integrated organic inputs such as farmyard manure (FYM), vermicompost, and biofertilizers provides not only essential nutrients but also acts as a source of complexing agents that enhance nutrient availability. s. Preparations such as Panchagavya, Jivamrut, and Sanjivak—formulated from cow-derived products like dung, urine, milk, curd, and ghee, along with legume flour and jaggery—have shown promising effects on plant growth, yield, and quality. These liquid formulations are rich in macro- and micronutrients, vitamins, essential amino acids, and plant growth-promoting substances such as indole acetic acid (IAA) and gibberellic acid (GA), in addition to hosting beneficial microbial populations (Somasunderam *et al*., 2009) [15]. Biofertilizers offer a simple, cost-effective, and environmentally safe method for enhancing nitrogen availability in crops such as green gram and finger millet, primarily through symbiotic nitrogen fixation. So these organic nutrients should also supply to crop along with inorganic fertilizers. It also enhanced soil fertility and productivity. Therefore, keeping these in mind field experiment was conducted to study the performance of finger millet and green gram intercropping under different nutrient levels under *kharif* conditions.

Materials and Methods

Experimental site

The field experiment was carried out during *Kharif*, 2024 at the Zonal Agricultural Research Station, Shendapark, Kolhapur. The topography of the experimental field was fairly uniform and levelled. The average annual rainfall is 1151.6 mm, with 67 rainy days, which received 80 per cent from south-west monsoon in June to September, while the remaining quantity is received in the months of October and November from north-east monsoon. The annual mean maximum temperature ranges between 25.4 ºC to 33.7 ºC while, the annual mean minimum temperature varies from 12.5 ºC to 21.9 ºC.

Soil characters

The soil of the experimental plot was sandy clay loam, low in available Nitrogen (196 kg ha^{-1}), medium in available phosphorus (35.3 kg ha^{-1}) and low in available potassium (194 kg ha^{-1}). The status of organic carbon content (0.67%) was high. The electrical conductivity and pH values were 0.11 dSm^{-1} and 6.74 respectively.

Experimental set-up

The experiment was laid out in a Factorial Randomized Block Design (FRBD) comprising eighteen treatment combinations, each replicated three times. The treatment details are as follows:

A)	**Intercropping**		
1	C_1	:	Sole Finger millet
2	C_2	:	Finger millet + Green gram (4:2)
3	C_3	:	Sole Green gram
B)	**Nutrient Levels**		
1	N_1	:	100% Recommended dose of fertilizer (RDF)
2	N_2	:	75% RDF + Soil application of *Azospirillum* @2 kg ha^{-1} and Phosphate solubilizing bacteria @ 2 kg ha^{-1}
3	N_3	:	75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS
4	N_4	:	75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS
5	N_5	:	75% RDF + 25% RDN through FYM
6	N_6	:	50% RDF + 50% RDN through FYM

For the sowing of seed, very small furrow lines were opened with the help of marker at a distance of 30 cm between the row and sowing of the crop was done on 13th July, 2024. The recommended seed rate of 15 kg ha^{-1} for green gram and 5 kg ha^{-1} for finger millet was used. Each gross plot measured 4.8 m × 6.0 m, and the net plot area was maintained at 3.6 m × 4.8 m. Crop fertilized with application of N, P_2O_5 and K_2O at the time of sowing. The application of N through urea, P_2O_5 through single super phosphate and K_2O through muriate of potash. All foliar spray was uniformly sprayed using of knapsack with flat-fan nozzle.

Observation to be recorded

Growth observations for finger millet *viz*., plant height (cm), number of tillers (m^{-1} row length), dry matter $plant^{-1}$ were recorded at regular intervals 15, 30, and 60, 90 days after sowing (DAS), and at harvest and growth parameters such as plant height (cm), number of branches $plant^{-1}$, dry matter (g) $plant^{-1}$ were recorded at regular intervals 15, 30, 45, 60 DAS, and at harvest for green gram. Data on yield and yield-contributing traits were collected after crop harvest.

Results and Discussion

A) Growth Attributes of Finger Millet

1. Plant Height

a) Effect of Intercropping

Intercropping significantly influenced the plant height of finger millet at all growth stages. The intercropping of finger millet and green gram in a 4:2 ratio (C_2) consistently resulted in the tallest plants, (28.12 cm, 42.87 cm, 102.85 cm, 113.36 cm) at 30, 60, 90 DAS and at harvest, respectively. while sole finger millet cultivation (C_1) recorded the shortest plants (25.88 cm, 40.68 cm, 94.09 cm, 102.95 cm) at 30, 60, 90 DAS and at harvest, throughout the growing period. The superior plant height observed under intercropping of finger millet and green gram in a 4:2 ratio (C_2) can be attributed to the complementary use of resources by the two crops. Differences in rooting depth and growth patterns between finger millet and green gram likely minimized competition, improved the microenvironment, enhanced root interactions, and contributed to better soil fertility. Additionally, nitrogen fixation by green gram may have facilitated finger millet growth, promoting more efficient utilization of available resources. These results align with the findings of Willey (1979) [17], Girish, (2004) [5].

Table 1: Mean plant height (cm) of finger millet as influenced by various treatments

Treatments	Mean plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
Intercropping				
C_1 - Sole Finger Millet	25.88	40.68	94.09	102.95
C_2- Finger millet + Green gram (4:2)	28.12	42.87	102.85	113.36
S.Em±	0.60	0.54	0.98	1.16
CD @ 5%	1.76	1.59	2.86	3.40
Nutrient levels				
N_1-100% Recommended dose of fertilizer (RDF)	30.97	44.45	107.33	118.68
N_2-75% RDF + Soil application of *Azospirillum* @ 2 kg ha^{-1} and Phosphate solubilizing bacteria @ 2 kg ha^{-1}	25.53	40.82	95.28	104.36
N_3-75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS	30.51	44.23	104.24	115.01
N_4-75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS	29.14	43.56	102.57	113.03
N_5- 75% RDF + 25% RDN through FYM	24.05	40.16	92.76	101.37
N_6- 50% RDF + 50% RDN through FYM	21.83	37.42	88.63	96.46
S.Em±	1.04	0.94	1.69	2.01
CD @ 5%	3.06	2.75	4.96	5.89
Interaction: C × N				
S.Em±	1.47	1.32	2.39	2.84
CD @ 5%	NS	NS	7.01	8.33
General Mean	27.00	41.77	98.47	108.15

b) Effect of Nutrient Levels

The mean plant height (cm) of finger millet was influenced significantly by various nutrient levels at all growth stage of crops. Application of 100% RDF (N_1) recorded significantly higher plant height which was at par with application of 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS (N_3) and 75% RDF + Soil application of *Azospirillum* (2 kg ha $^{-1}$) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS (N_4). While, significantly lowest plant height was recorded with the application of 50% RDF + 50% RDN through FYM (N_6) at all growth stages of crop. The increase in plant height was positively correlated with the level of fertilizer application. This growth enhancement is likely attributed to improved nutrient uptake and a more abundant nutrient supply, which in turn may have boosted photosynthetic activity. Such stimulation likely accelerated processes of cell division and elongation, contributing to increased plant height. These outcomes are in agreement with previous studies conducted by Parjane (2024) [11] and Prashanth *et al*. (2019) [13].

c) Effect of Interaction

The interaction between intercropping and nutrient levels significantly affected the mean plant height of finger millet at all growth stages, except at 30 and 60 days after sowing (DAS). The treatment C_2N_1, which combined intercropping with 100% recommended fertilizer dose (RDF), achieved the greatest plant height at 90 DAS (110.19 cm) and at harvest (122.09 cm). These findings align with those of Gadallah and Gabra (2015) [4].

Table 1A: Effect of interactions on mean plant height (cm) of finger millet at 90 DAS and at harvest as influenced by various treatments

Intercropping / Nutrient Levels	90 DAS			At harvest		
	C_1	C_2	Mean	C_1	C_2	Mean
N_1	104.47	110.19	107.33	115.28	122.09	118.68
N_2	85.51	105.04	95.28	92.76	115.96	104.36
N_3	104.78	103.70	104.24	115.66	114.37	115.01
N_4	102.36	102.79	102.57	112.78	113.28	113.03
N_5	86.62	98.90	92.76	94.08	108.66	101.37
N_6	80.78	96.47	88.63	87.14	105.79	96.46
Mean	94.09	102.85	98.47	102.95	113.36	108.15
S.Em±	2.39			2.84		
CD @ 5%	7.01			8.33		

2. Mean Total Number of Tillers (Effective + Non- effective) (m^{-1} row length)

a) Effect of Intercropping

Mean total number of tillers of finger millet was significantly influenced by intercropping at 30 and 60 DAS. Intercropping of finger millet + Green gram (4:2) (C2) consistently recorded the highest total number of tillers at 60 DAS (68.55), while sole finger millet (C_1) recorded the lowest total number of tillers at 60 DAS (35.73) due to complementary utilization of resources. These results align with the findings of Willey (1979) [17], Ananthi (2024) [1].

Table 2: Mean number of tillers (Effective + non- effective) (m^{-1} row length) of finger millet as influenced by various treatments

Treatments	Mean number of tillers (m^{-1} row length)			
	30 DAS		60 DAS	
	m^{-1} row length	lakh ha^{-1}	m^{-1} row length	lakh ha^{-1}
Intercropping				
C_1 - Sole Finger Millet	32.14	10.71	35.73	11.91
C_2- Finger millet + Green gram (4:2)	38.55	8.57	68.55	15.23
S.Em±	1.10	0.29	1.66	0.44
CD @ 5%	3.23	0.85	4.87	1.28
Nutrient levels				
N_1-100% Recommended dose of fertilizer (RDF)	44.06	12.07	64.83	16.94
N_2-75% RDF + Soil application of *Azospirillum* @ 2 kg ha^{-1} and Phosphate solubilizing bacteria @ 2 kg ha^{-1}	34.93	9.58	52.04	13.46
N_3-75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS	41.26	11.29	60.12	15.69
N_4-75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS	39.31	10.81	56.26	14.77
N_5- 75% RDF + 25% RDN through FYM	31.05	8.37	46.97	12.30
N_6- 50% RDF + 50% RDN through FYM	21.48	5.72	32.63	8.27
S.Em±	1.91	0.50	2.87	0.76
CD @ 5%	5.59	1.47	8.43	2.22
Interaction: C × N				
S.Em±	2.70	0.71	4.07	1.07
CD @ 5%	NS	NS	NS	NS
General Mean	35.35	9.64	52.14	13.57

b) Effect of Nutrient Levels

The mean total number of tillers of finger millet was influenced significantly by different nutrient levels at all growth stage of crops. Application of 100% RDF (N_1) recorded significantly higher total number of tillers (m^{-1} row length) which was at par with application of 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS (N_3) and 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS (N_4). While, significantly lowest total number of tillers (m^{-1} row length) was recorded with the application of 50% RDF + 50% RDN through FYM (N_6) at all growth stages of crop. Higher tiller numbers observed with increased fertilizer application may result due to the enhanced nutrient availability provided by foliar application of fertilizers and nutrients. These results align with the findings of Parjane (2024) [11] and Prashanth *et al.* (2019) [13].

c) Effect of Interaction

There was no significant influence of the interaction between intercropping and nutrient levels on the mean number of tillers (m^{-1} row length) in finger millet.

3. Mean Dry matter (g) plant^{-1}

a) Effect of Intercropping

Dry matter plant^{-1} (g) was significantly affected by intercropping at all stages except 30 DAS. The finger millet + green gram (4:2) combination (C_2) consistently showed the highest dry matter accumulation (16.00, 48.64, 67.22 g) at 60, 90 and at harvest respectively, likely due to the efficient and complementary use of resources. In contrast, the lowest accumulation was recorded in the sole finger millet (C_1). These results are in agreement with the findings of Willey (1979) [17] and Kiroriwal and Yadav (2013) [9].

Table 3: Mean dry matter (g) plant^{-1} of finger millet as influenced by various treatments

Treatments	Mean dry matter (g) plant^{-1}			
	30 DAS	60 DAS	90 DAS	At harvest
Intercropping				
C_1 - Sole Finger Millet	1.21	13.04	36.55	56.32
C_2- Finger millet + Green gram (4:2)	1.21	16.00	48.64	67.22
S.Em±	0.02	0.21	1.44	1.27
CD @ 5%	NS	0.61	4.23	3.73
Nutrient levels				
N_1-100% Recommended dose of fertilizer (RDF)	1.23	17.07	55.00	72.87
N_2-75% RDF + Soil application of *Azospirillum* @ 2 kg ha^{-1} and Phosphate solubilizing bacteria @ 2 kg ha^{-1}	1.21	13.57	37.90	56.95
N_3-75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS	1.22	16.28	50.61	69.36
N_4-75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS	1.22	16.14	48.25	67.45
N_5- 75% RDF + 25% RDN through FYM	1.20	12.73	34.33	53.80
N_6- 50% RDF + 50% RDN through FYM	1.20	11.32	29.48	50.19
S.Em±	0.03	0.36	2.50	2.20
CD @ 5%	NS	1.05	7.33	6.46
Interaction: C × N				
S.Em±	0.04	0.51	3.53	3.12
CD @ 5%	NS	NS	10.36	9.14
General Mean	1.21	14.52	42.60	61.77

b) Effect of Nutrient Levels

The mean dry matter plant^{-1}(g) of finger millet was influenced significantly by different nutrient levels at all growth stage of crops. Application of 100% RDF (N_1) recorded significantly highest dry matter accumulation which was at par with application of 75% RDF + Soil application of *Azospirillum* (2kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS (N_3) and 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS (N_4). While, significantly lowest dry matter accumulation plant^{-1} was recorded with the application of 50% RDF + 50% RDN (N_6) through FYM at all growth stages of crop. The increase in dry matter accumulation plant^{-1} was observed in the experiment is directly proportional to fertilizer and its effect on vegetative growth of finger millet. Similar results were found by Prashanth *et al*. (2019) [13].

c) Effect of Interaction

The interaction between intercropping and nutrient levels had a significant effect on the mean dry matter plant^{-1} (g) of finger millet at all growth stages, except at 30 and 60 DAS, as shown in Table 3A. The treatment combination C_2N_1, which involved intercropping with 100% RDF, recorded the maximum dry matter accumulation at 90 DAS (59.06 g) and at harvest (76.48 g).

Similar results found by Gadallah and Gabra (2015) [4], Willey (1979) [17].

Table 3A: Effect of interactions on mean dry matter (g) plant^{-1} of finger millet at 90 DAS and at harvest as influenced by various treatments

Intercropping / Nutrient Levels	90 DAS			At harvest		
	C1	C2	Mean	C1	C2	Mean
N_1	50.94	59.06	55.00	69.26	76.48	72.87
N_2	24.05	51.75	37.90	46.77	67.14	56.95
N_3	51.39	49.84	50.61	68.74	69.98	69.36
N_4	47.95	48.55	48.25	66.60	68.29	67.45
N_5	25.63	43.03	34.33	45.37	62.23	53.80
N_6	19.36	39.60	29.48	41.20	59.18	50.19
Mean	36.55	48.64	42.60	56.32	67.22	61.77
S.Em±	3.53			3.12		
CD @ 5%	10.36			9.14		

B) Growth Studies of Green Gram

1. Mean plant height (cm)

a) Effect of Intercropping

Intercropping significantly influenced the plant height of green gram at all growth stages. The intercropping of finger millet and green gram in a 4:2 ratio (C_2) consistently resulted in the tallest plants, (14.66 cm, 40.03 cm, 102.85 cm, 63.36 cm and 65.26 cm) at 30, 45, 60 DAS and at harvest, respectively. while sole green gram cultivation (C_3) recorded the shortest plants (13.44 cm, 37.30 cm, 52.95 cm, 54.54 cm) at 30, 45, 60 DAS and at harvest, throughout the growing period. The superior plant height observed under intercropping of finger millet and green gram in a 4:2 ratio (C_2) can be attributed to the complementary use of resources by the two crops. Differences in rooting depth and growth patterns between finger millet and green gram likely minimized competition, improved the microenvironment, enhanced root interactions, and contributed to better soil fertility. These results align with the findings of Willey (1979) [17], Girish, (2004) [5].

Effect of Nutrient Levels

The mean plant height (cm) of green gram was influenced significantly by different nutrient levels at all growth stage of crops. Application of 100% RDF (N_1) recorded significantly tallest plant height which was at par with application of 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS (N_3) and 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS (N_4). While, significantly shortest plant height was recorded with the application of 50% RDF + 50% RDN through FYM (N_6) at all growth stages of crop. The increase in plant height was directly proportional to fertilizer application and its effect on vegetative growth of green gram. Similar results found by Khamparia *et al*., (1981) [8], Yein *et al*., (1981) [18], Patel *et al*., (2017) [10], Kalkute *et al*., (2019) [7].

Table 4: Mean plant height (cm) of green gram as influenced by various treatments

Treatments	Plant Height (cm)			
	30 DAS	45 DAS	60 DAS	At harvest
Intercropping				
C_3 - Sole Green gram	13.44	37.30	52.95	54.54
C_2- Finger millet + Green gram (4:2)	14.66	40.03	63.36	65.26
S.Em±	0.19	0.65	1.16	1.19
CD @ 5%	0.55	1.91	3.40	3.50
Nutrient levels				
N_1-100% Recommended dose of fertilizer (RDF)	15.30	40.81	68.68	70.74
N_2-75% RDF + Soil application of *Azospirillum* @ 2 kg ha^{-1} and Phosphate solubilizing bacteria @ 2 kg ha^{-1}	13.96	37.22	54.36	55.99
N_3-75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS	14.94	40.38	65.01	66.96
N_4-75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS	14.48	40.18	63.03	64.92
N_5- 75% RDF + 25% RDN through FYM	13.16	36.83	51.37	52.91
N_6- 50% RDF + 50% RDN through FYM	12.45	36.59	46.46	47.85
S.Em±	0.33	1.13	2.01	2.07
CD @ 5%	0.96	3.30	5.89	6.07

Interaction: C × N				
S.Em±	0.46	1.59	2.84	2.93
CD @ 5%	NS	NS	8.33	8.58
General Mean	14.05	38.67	58.15	59.90

b) Effect of Interaction

As shown in Table 4A. the interaction between intercropping and nutrient levels had a significant impact on the mean plant height of green gram at all growth stages, except at 30 and 45 days after sowing (DAS). The highest plant height was recorded under the treatment combination C_2N_1, which included intercropping with 100% recommended dose of fertilizers (RDF), measuring 72.09 cm at 60 DAS and 74.25 cm at harvest. Similar results found by Gadallah and Gabra (2015) [4], Willey (1979) [17].

Table 4A: Effect of interaction on plant height (cm) of green gram at 60 DAS and at harvest as influenced by various treatments

Intercropping / Nutrient Levels	60 DAS			At harvest		
	C3	C2	Mean	C3	C2	Mean
N_1	65.28	72.09	68.68	67.24	74.25	70.74
N_2	42.76	65.96	54.36	44.05	67.94	55.99
N_3	65.66	64.37	65.01	67.63	66.30	66.96
N_4	62.78	63.28	63.03	64.66	65.18	64.92
N_5	44.08	58.66	51.37	45.41	60.42	52.91
N_6	37.14	55.79	46.46	38.25	57.46	47.85
Mean	52.95	63.36	58.15	54.54	65.26	59.90
S.Em±	2.84			2.93		
CD @ 5%	8.33			8.58		

2. Mean Number of branches plant^{-1}

a) Effect of Intercropping

The mean number of branches plant^{-1} in green gram was significantly influenced by the intercropping system at all stages of growth. An intercropping involving finger millet + green gram in a 4:2 ratio (C_2) consistently recorded the highest number of branches plant^{-1} (7.73 at harvest). This increase can be attributed to the complementary resource utilization between the two crops, which likely reduced interspecific competition, improved microclimatic conditions, and enhanced nutrient availability, thereby promoting better vegetative growth. In contrast, the sole green gram treatment (C_1) recorded the lowest number of branches across all growth stages, possibly due to less efficient resource use and greater exposure to environmental stress. These findings are consistent with the observations reported by Willey (1979) [17] and Ananthi (2024) [1].

Table 5: Mean number of branches plant^{-1} of green gram as influenced by various treatments

Treatments	Number of branches plant^{-1}	
	30 DAS	45 DAS
Intercropping		
C_3 - Sole Green gram	2.00	7.03
C_2- Finger millet + Green gram (4:2)	2.23	7.73
S.Em±	0.05	0.11
CD @ 5%	0.15	0.32
Nutrient levels		
N_1-100% Recommended dose of fertilizer (RDF)	2.37	8.32
N_2-75% RDF + Soil application of *Azospirillum* @2 kg ha^{-1} and Phosphate solubilizing bacteria @ 2 kg ha^{-1}	2.01	7.32
N_3-75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS	2.30	7.93
N_4-75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS	2.14	7.83
N_5- 75% RDF + 25% RDN through FYM	2.00	7.02
N_6- 50% RDF + 50% RDN through FYM	1.88	5.87
S.Em±	0.09	0.19
CD @ 5%	0.27	0.56
Interaction: C × N		
S.Em±	0.13	0.27
CD @ 5%	NS	0.79
General Mean	2.12	7.38

b) Effect of Nutrient Levels

The mean number of branches plant^{-1} of green gram was influenced significantly by different nutrient levels at all growth stage of crops. Application of 100% RDF (N_1) recorded significantly higher number of branches plant^{-1} which was at par with application of 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS (N_3) and 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS (N_4). While, significantly lowest number of branches plant^{-1} was produced with the application of 50% RDF + 50% RDN through FYM (N_6) at all growth stages of crop. The increase in the number of branches per plant observed in the experiment could be due to the positive impact of fertilizer application, which promoted vegetative growth in green gram by ensuring adequate nutrient supply.

Similar results were reported by Patel *et al*., (2017) [10] and Jamro *et al*., (1995) [6].

c) Effect of Interaction

The interaction between intercropping and nutrient levels had significant effect on the mean number of branches plant^{-1} of green gram except at 30 DAS as shown in Table 5A. The treatment combination C_2N_1, which involved intercropping with 100% RDF, recorded the maximum number of branches plant^{-1} of green gram at 45 DAS (8.37). Similar results found by Similar results found by Gadallah and Gabra (2015) [4].

Table 5A: Effect of interaction on number of branches plant^{-1} of green gram at 45 DAS and at harvest as influenced by various treatments

Intercropping / Nutrient Levels	45 DAS		
	C_3	C_2	Mean
N_1	8.26	8.37	8.32
N_2	6.99	7.64	7.32
N_3	7.80	8.07	7.93
N_4	7.65	8.00	7.83
N_5	6.50	7.53	7.02
N_6	4.97	6.77	5.87
Mean	7.03	7.73	7.38
S.Em±	0.27		
CD @ 5%	0.79		

3.Mean Dry matter plant^{-1} (g)

a) Effect of Intercropping

Intercropping significantly affected the mean dry matter plant^{-1} in green gram. The finger millet + green gram (4:2) treatment (C_2) consistently exhibited the highest dry matter accumulation, which can be attributed to the efficient complementary use of resources by the two crops. Conversely, the sole green gram (C_3) showed the lowest dry matter accumulation, due to less optimized resource utilization. These results are in aligns with findings from Willey (1979) [17].

Table 6: Mean dry matter (g) plant^{-1} of green gram as influenced by various treatments

Treatments	Mean dry matter (g) plant^{-1}			
	30 DAS	45 DAS	60 DAS	At harvest
Intercropping				
C_3 - Sole Green gram	1.78	12.23	19.10	25.99
C_2- Finger millet + Green gram (4:2)	2.18	13.11	19.80	27.69
S.Em±	0.06	0.20	0.11	0.27
CD @ 5%	0.18	0.59	0.32	0.78
Nutrient levels				
N_1-100% Recommended dose of fertilizer (RDF)	2.38	13.57	20.39	28.72
N_2-75% RDF + Soil application of *Azospirillum* @ 2 kg ha^{-1} and Phosphate solubilizing bacteria @ 2 kg ha^{-1}	1.85	12.41	19.39	26.83
N_3-75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS	2.23	13.17	20.00	28.02
N_4-75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS	2.08	12.87	19.90	27.54
N_5- 75% RDF + 25% RDN through FYM	1.74	12.20	19.09	26.42
N_6- 50% RDF + 50% RDN through FYM	1.61	11.81	17.94	23.50
S.Em±	0.10	0.35	0.19	0.46
CD @ 5%	0.31	1.02	0.56	1.35
Interaction: C × N				
S.Em±	0.15	0.49	0.27	0.65
CD @ 5%	NS	NS	0.79	1.91
General Mean	1.98	12.67	19.45	26.84

b) Effect of Nutrient Levels

The mean dry matter plant^{-1} of green gram was influenced significantly by different nutrient levels at all growth stage of crop. Application of 100% RDF (N_1) recorded significantly highest dry matter accumulation which was at par with application of 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS (N_3) and 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS (N_4). While, significantly lowest dry matter accumulation plant^{-1} was recorded with the application of 50% RDF + 50% RDN through FYM (N_6) at all growth stages of crop. The increase in dry matter accumulation plant^{-1} was observed in the experiment is directly proportional to fertilizer-application and its effect on vegetative growth of green gram. Similar results found by Patel *et al.*, (2017) [10], Raju and Verma (1984) [14].

c) Effect of Interaction

The interaction between intercropping and nutrient levels had a significant effect on the mean dry matter accumulation plant^{-1} of green gram at all growth stages, except at 30 and 45 DAS, as shown in Table 11. The treatment combination C_2N_1, which involved intercropping with 100% RDF, recorded the maximum dry matter accumulation at 60 DAS (20.44 g) and at harvest (29.30 g).

Similar results found by Similar results found by Similar results found by Gadallah and Gabra (2015) [4].

Table 6A: Effect of interactions on mean dry matter (g) plant^{-1} of green gram at 60 DAS and at harvest as influenced by various treatments

Intercropping / Nutrient Levels	60 DAS			At harvest		
	C_3	C_2	Mean	C_3	C_2	Mean
N_1	20.33	20.44	20.39	28.14	29.30	28.72
N_2	19.06	19.71	19.39	26.38	27.28	26.83
N_3	19.87	20.14	20.00	27.50	28.54	28.02
N_4	19.72	20.07	19.90	27.30	27.78	27.54
N_5	18.57	19.60	19.09	25.70	27.14	26.42
N_6	17.04	18.84	17.94	20.92	26.08	23.50
Mean	19.10	19.80	19.45	25.99	27.69	26.84
S.Em±	0.27			0.65		
CD @ 5%	0.79			1.91		

Conclusion

The field experiment entitled "Performance of finger millet and green gram intercropping under different nutrient levels" was investigated during *kharif*, 2024 at the Zonal Agricultural Research Station, Kolhapur, during kharif season of 2024. Findings indicate that the highest plant height was observed for finger millet + green gram (4:2) intercropping (113.36 and 65.26 cm) for finger millet and green gram at harvest. However, intercropping of finger millet + green gram (4:2) give the best results for growth parameters of both crops such as number of tillers (68.55 m^{-1} row length), dry matter plant^{-1} (67.22 g) for finger millet and number of branches plant^{-1} (7.73), dry matter (g) plant^{-1} (27.69 g) for green gram crop likely due to complementary utilization of resources by both crops. Different nutrient levels significantly affected all the growth and yield attributes. The growth parameters of finger millet such as plant height (118.68 cm), number of tillers (64.83 m^{-1} row length), dry matter plant^{-1} (72.87 g) found to be significantly higher with application of nutrient level N_1 (100% RDF) which was at par with 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS (N_3) and 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS (N_4) as compare to lowest in 50% RDF + 50% RDN through FYM (N_6). The growth parameters of green gram as plant height (70.74 cm), number of branches plant^{-1}(8.32), dry matter plant^{-1} (28.72 g) found to be significantly higher with application of nutrient level N_1 (100% RDF) which was at par with 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS (N_3) and 75% RDF + Soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS (N4) as compare to lowest in 50% RDF + 50% RDN through FYM (N_6).

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References

1. Ananthi K, Gomathy M, Sabarinathan KG, Rajababu C. Small millets with legumes intercropping for climate smart agriculture. Int J Environ Sci Nat Resour. 2024;33(4):556373.
2. Bitew Y, Alemayehu G, Adego E, Assefa A. Boosting land use efficiency, profitability and productivity of finger millet by intercropping with grain legumes. Cogent Food Agric. 2019;5(1):1702826.
3. Foley JA, Ramankutty N, Brauman KA, Cassidy ES, Gerber JS, Johnston M, *et al*. Solutions for a cultivated planet. Nature. 2011;478(7369):337-342.
4. Gadallah RA, Gabra AM. Effect of intercropping patterns and nitrogen fertilization levels on yield and yield components of maize and soybean. Ann Agric Sci Moshtohor. 2015;53(2):187-197.
5. Girish KM. Studies on finger millet (*Eleusine coracana* G.) based intercropping system. Dharwad: Univ. Agric. Sci.; 2004.
6. Jamro S, Shinde C, Singh V. Effect of various levels of nitrogen, phosphorus and sulphur on the yield and quality of mustard in black gram-mustard cropping sequence. Crop Res Hisar. 1995;10(3):265-270.
7. Kalkute RM, Singh T, Namdeo KN. Influence of integrated nutrient management on growth, yield, quality and economics of black gram (*Vigna mungo* L.). Ann Plant Soil Res. 2019;21(3):289-292.
8. Khamparia SK, Sharma RK, Nakhtore CL. Effect of fertility levels and *Rhizobium* culture on growth and yield of summer mung varieties (*Vigna radiata* (L.) Wilczek). JNKVV Res J. 1981;15(4).
9. Kiroriwal A, Yadav RS. Effect of intercropping systems on intercrops and weeds. Int J Agric Food Sci Technol. 2013;4:643-646.
10. Patel HB, Shah KA, Barvaliya MM, Patel SA. Response of green gram (*Vigna radiata* L.) to different levels of phosphorus and organic liquid fertilizer. Int J Curr Microbiol Appl Sci. 2017;6(10):3443-3451.
11. Parjane SD, Gedam VB, Shende SM, Shinde RH. Growth and yield of summer finger millet (*Eleusine coracana*) as affected by foliar application of water-soluble fertilizers. Agric Sci Dig. 2024;1-8.
12. Perli VH, Tomar SS, Kasi RG, Deepsikha MK. Influence of organic manures and biofertilizers on the growth and yield of green gram (*Vigna radiata* L.). Pharma Innov J. 2022;11(6):141-144.
13. Prashanth DV, Krishnamurthy R, Naveen DV, Kumar LA, Harsha BR, Savitha M. Long-term effect of integrated nutrient management on growth and yield of finger millet (*Eleusine coracana* G.) in eastern dry zone of Karnataka, India. Int J Curr Microbiol Appl Sci. 2019;8(8).
14. Raju MS, Varma SC. Response of green gram (*Vigna radiata*) to *Rhizobium* inoculation in relation to nitrogen fertilizer. Legume Res. 1984;7(2):73-76.
15. Somasunderam E, Chandaragiri K, Meena S, Thiyagarajan TM, Sankaran N, Paneerselvam S. Response of green gram to varied levels of panchagavya foliar spray. Madras Agric J. 2003;90(130):169-172.
16. Tsubo M, Walker S, Ogindo HO. A simulation model of cereal-legume intercropping systems for semi-arid regions: I. Model development. Field Crops Res. 2005;93(1):10-22.
17. Willey RW. Intercropping—its importance and research needs. Part 1. Competition and yield advantages. Field Crop Abstr. 1979;32:1-10.
18. Yein BR, Harcharan S, Cheema SS, Singh H. Effect of combined application of pesticides and fertilizers on the growth and yield of mungbean (*Vigna radiata* L. Wilczek). Indian J Ecol. 1981;8(2):180-188.