



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(7): 179-187
Received: 10-05-2026
Accepted: 15-06-2026

MS Kashid
M.Sc. Scholar, Department of
Agronomy, RSCM College of
Agriculture, Kolhapur,
Maharashtra, India

RH Shinde
Associate Professor, Department of
Agronomy, College of Agriculture,
Pune, Maharashtra, India

YG Ban
Breeder, AICRP on Small millets,
Zonal Agricultural Research
Station, Shendapark, Kolhapur,
Maharashtra, India

VB Gedam
Agronomist, Regional Sugarcane
and Jaggery Research Station,
Kolhapur, Maharashtra, India

Effect of intercropping and different nutrient levels on yield and yield attributes of finger millet and green gram

MS Kashid, RH Shinde, YG Ban and VB Gedam

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i7c.5916>

Abstract

A field experiment entitled “Performance of Finger Millet and Green Gram Intercropping under Different Nutrient Levels” was conducted during the Kharif season of 2024 at the Zonal Agricultural Research Station, Shendapark, Kolhapur. The study was laid out in a Factorial Randomized Block Design (FRBD) with three replications, comprising 18 treatment combinations. Two factors were evaluated in the experiment. The first factor consisted of three cropping systems, viz., C₁-Sole finger millet, C₂-Finger millet + green gram (4:2), and C₃-Sole green gram, whereas the second factor comprised six nutrient management treatments (N₁-N₆). The findings indicated that the finger millet + green gram (4:2) intercropping system (C₂) produced superior yield attributes of both crops, including number of earheads m⁻¹ row length, grain yield m⁻¹ row length, test weight, number of pods plant⁻¹, number of seeds pod⁻¹, seed yield plant⁻¹, and seed index. However, the highest grain and straw yields of finger millet (27.37 and 34.38 q ha⁻¹, respectively) and the highest seed and stover yields of green gram (13.87 and 29.90 q ha⁻¹, respectively) were obtained under sole cropping. Among the nutrient management treatments, application of 100% RDF (N₁) resulted in the highest yield attributes and yields of both crops. The interaction between cropping systems and nutrient levels significantly influenced number of earheads m⁻¹ row length, grain yield m⁻¹ row length, number of pods plant⁻¹, and seed yield plant⁻¹. The maximum grain, straw, seed, and stover yields were recorded under sole finger millet and sole green gram supplied with 100% RDF (N₁).

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

Introduction

Cereal-legume intercropping is a sustainable farming practice that improves the efficient use of sunlight, water, and soil nutrients, resulting in higher productivity, greater yield stability, and better economic returns than sole cropping (Foley *et al.*, 2011; Tsubo *et al.*, 2005; Bitew *et al.*, 2019) [5, 18, 2]. Finger millet (*Eleusine coracana* L.) and green gram (*Vigna radiata* L. Wilczek) are a suitable intercrop combination for rainfed and drought-prone regions because of their drought tolerance. Finger millet is an important dryland cereal, whereas green gram is a protein-rich legume that contributes to nutritional security. The excessive and imbalanced use of chemical fertilizers has reduced soil fertility and threatened the sustainability of crop production. Since chemical fertilizers alone cannot maintain long-term soil productivity (Perli *et al.*, 2022) [15], integrating them with organic sources such as farmyard manure (FYM), vermicompost, biofertilizers, Panchagavya, Jivamrut, and Sanjivak is essential to improve soil health, nutrient availability, and crop productivity. Therefore, the present study was undertaken during the kharif season to evaluate the performance of finger millet-green gram intercropping under different nutrient management practices.

Material and methods Experimental site

The experiment was conducted during the Kharif 2024 season at the Zonal Agricultural Research Station, Shendapark, Kolhapur. The region experiences an average annual rainfall of 1151.6 mm with nearly 67 rainy days. The annual mean maximum temperature varies between 25.4°C and 33.7°C, while the annual mean minimum temperature ranges from 12.5°C to 21.9°C.

Soil characters

The soil of the experimental field was classified as sandy clay loam. It was low in available

Corresponding Author:

MS Kashid
M.Sc. Scholar, Department of
Agronomy, RSCM College of
Agriculture, Kolhapur,
Maharashtra, India

nitrogen (196 kg ha⁻¹) and potassium (194 kg ha⁻¹), while the available phosphorus content (35.3 kg ha⁻¹) was in the medium range. The soil had a high organic carbon content (0.67%). The soil pH and electrical conductivity were 6.74 and 0.11 dS m⁻¹, respectively.

Experimental detail

The experiment was conducted using a Factorial Randomized Block Design (FRBD) consisting of eighteen treatment combinations with three replications. The first factor comprised three intercropping systems, namely C₁: Sole finger millet, C₂: Finger millet + green gram (4:2 row ratio), and C₃: Sole green gram. The second factor included six nutrient levels (N₁, N₂, N₃, N₄, N₅, and N₆). Prior to sowing, shallow furrows were prepared using a marker, maintaining a row spacing of 30 cm. The crops were sown on 13 July 2024. Seed rates of 5 kg ha⁻¹ for finger millet and 15 kg ha⁻¹ for green gram were adopted as per the recommended practices. The gross plot size was 4.8 m × 6.0 m, while the net plot size was maintained at 3.6 m × 4.8 m.

Observation to be recorded

Yield attributes and yield of finger millet viz., number of ear head (m⁻¹ row length), number of fingers ear head⁻¹, grain yield (m⁻¹ row length), test weight (1000) grains (g), grain yield (q ha⁻¹) and straw yield (q ha⁻¹) observations recorded after harvest. Yield attributes characters of green gram viz., number of pods plant⁻¹, length of pod (cm), number of seeds pod⁻¹, seed yield plant⁻¹ (g), seed index (100 seeds) recorded after harvest.

Results and discussion

A) Yield Attributes Characteristics of Finger Millet

1. Mean Number of Earhead (m⁻¹ row length)

a) Effect of Intercropping

The mean number of ear heads per metre row length of finger millet was significantly affected by the intercropping systems. As presented in Table 1, the finger millet + green gram (4:2)

intercropping system (C₂) produced the highest number of ear heads per metre row length (36.57), whereas the sole finger millet treatment (C₁) recorded the lowest value (32.22). The increased number of ear heads under the intercropping system may be attributed to more efficient utilization of growth resources, particularly nutrients, moisture, and light, resulting from the complementary growth habits of finger millet and green gram. Moreover, the inclusion of green gram, a leguminous crop, might have improved the availability of nitrogen in the rhizosphere through biological nitrogen fixation, thereby promoting better crop growth and ear head development in finger millet. These results are in agreement with the findings of Willey (1979) [19], who reported that intercropping enhances resource-use efficiency and improves overall crop productivity.

b) Effect of Nutrient Levels

The mean number of ear heads per metre row length of finger millet was significantly influenced by the different nutrient management treatments at harvest. The application of 100% RDF (N₁) resulted in the highest number of ear heads per metre row length, which was statistically 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 at 15 and 30 DAS (N₃) and 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of Panchagavya 3% at 15 and 30 DAS (N₄). The lowest number of ear heads per metre row length was recorded under 50% RDF + 50% RDN through FYM (N₆), which was significantly inferior to the other treatments. Similar observations were also reported by Parjane *et al.* (2024) [14]. The superior performance of 100% RDF (N₁) may be attributed to the adequate and balanced supply of essential nutrients throughout the crop growth period. An optimum nutrient supply enhances vegetative growth, promotes tiller production, improves photosynthetic activity, and ensures better translocation of assimilates to the developing ear heads, resulting in a greater number of ear heads per unit row length.

Table 1: Yield attributing characters of finger millet at harvest as influenced by various treatments

Treatments	No. of earhead (m ⁻¹ row length)	No. of fingers earhead	Grain yield (m ⁻¹ row length)	Test weight (g)
Intercropping				
C ₁ - Sole Finger millet	32.22	4.84	91.29	2.24
C ₂ - Finger millet + Green gram (4:2)	36.57	6.27	97.23	2.56
S.Em±	0.64	0.13	1.16	0.08
CD @ 5%	1.87	0.39	3.39	0.23
Nutrient levels				
N ₁ -100% Recommended dose of fertilizer (RDF)	41.55	6.96	101.67	2.86
N ₂ -75% RDF + Soil application of <i>Azospirillum</i> @2 kg ha ⁻¹ and Phosphate solubilizing bacteria @ 2 kg ha ⁻¹	33.57	5.26	92.85	2.42
N ₃ -75% RDF + Soil application of <i>Azospirillum</i> (2 kg ha ⁻¹) and PSB (2 kg ha ⁻¹) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS	38.51	6.60	100.13	2.63
N ₄ -75% RDF + Soil application of <i>Azospirillum</i> (2 kg ha ⁻¹) and PSB (2 kg ha ⁻¹) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS	38.35	6.29	99.97	2.52
N ₅ - 75% RDF + 25% RDN through FYM	31.64	4.65	91.18	2.10
N ₆ - 50% RDF + 50% RDN through FYM	22.74	3.60	79.77	1.86
S.Em±	1.11	0.23	2.00	0.14
CD @ 5%	3.25	0.68	5.87	0.41
Interaction: C × N				
S.Em±	1.56	0.33	2.83	0.20
CD @ 5%	4.59	0.96	8.30	NS
General Mean	34.39	5.56	94.26	2.40

c) Effect of Interaction

interaction between intercropping and nutrient levels had a significant effect on the mean number of earhead (m⁻¹ row length) of finger millet at harvest, as shown in Table 1A. The treatment

combination C2N1, which involved intercropping with 100% RDF, recorded highest number of earhead (m^{-1} row length) (42.15). Similar results were found by Gadallah and Gabra (2015) [6].

2. Mean Number of fingers earhead⁻¹

Effect of Intercropping

The mean number of fingers per ear head of finger millet was significantly influenced by the intercropping systems. The finger millet + green gram (4:2) intercropping system (C₂) recorded the highest number of fingers per ear head (6.27), while the sole finger millet treatment (C₁) recorded the lowest value (4.84). The higher number of fingers under intercropping may be attributed to better utilization of available resources and improved crop growth. These findings are in accordance with Willey (1979) [19]

Effect of Nutrient Levels

The mean number of fingers per ear head of finger millet was significantly influenced by different nutrient levels at harvest.

Application of 100% RDF (N₁) recorded the highest number of fingers per ear head, which was statistically at par with N₃ (75% RDF + *Azospirillum* + PSB + 2% 19:19:19 foliar spray) and N₄ (75% RDF + *Azospirillum* + PSB + 3% Panchagavya foliar spray). The lowest number of fingers per ear head was recorded under N₆ (50% RDF + 50% RDN through FYM). The superior performance under 100% RDF may be attributed to the balanced and adequate supply of essential nutrients, which promoted better growth and reproductive development of finger millet. Similar results were reported by Parjane *et al.* (2024) and Prashanth *et al.* (2019) [14, 16].

Effect of Interaction

The interaction between intercropping and nutrient levels had a significant effect on the mean number of fingers earhead⁻¹ of finger millet at harvest, as shown in Table 1A. The treatment combination C₂N₁ which involved intercropping with 100% RDF, recorded highest number of fingers earhead⁻¹ (7.38). Similar results were found by Willey (1979) [19].

Table 1A: Effect of interactions on mean number of ear head (m^{-1} row length) and number of fingers earhead⁻¹ of finger millet as influenced by various treatments

Intercropping Nutrient Levels	Number of Earhead (m^{-1} row length)			Number of fingers earhead ⁻¹		
	C ₁	C ₂	Mean	C ₁	C ₂	Mean
N ₁	40.95	42.15	41.55	6.54	7.38	6.96
N ₂	32.87	34.27	33.57	4.68	5.83	5.26
N ₃	36.23	40.78	38.51	6.11	7.08	6.60
N ₄	36.66	40.05	38.35	5.90	6.69	6.29
N ₅	29.66	33.63	31.64	3.63	5.67	4.65
N ₆	16.95	28.53	22.74	2.22	4.98	3.60
Mean	32.22	36.57	34.39	4.84	6.27	5.56
S.Em±	1.56			0.33		
CD @ 5 %	4.59			0.96		

Mean grain yield (m^{-1} row length)

Effect of Intercropping

The mean grain yield per metre row length of finger millet was significantly influenced by the intercropping systems. The finger millet + green gram (4:2) intercropping system (C₂) recorded the highest grain yield (97.23 g m^{-1} row length), while the sole finger millet treatment (C₁) produced the lowest yield (91.29 g m^{-1} row length). The higher yield under intercropping may be attributed to better utilization of available resources and complementary interactions between the component crops. These findings are in agreement with Willey (1979) and Ananthi (2024) [19, 1].

Effect of Nutrient Levels

The mean grain yield per metre row length of finger millet was significantly influenced by different nutrient levels at harvest. Application of 100% RDF (N₁) recorded the highest grain yield, which was statistically at par with N₃ (75% RDF + *Azospirillum*

+ PSB + 2% 19:19:19 foliar spray) and N₄ (75% RDF + *Azospirillum* + PSB + 3% Panchagavya foliar spray). The lowest grain yield was recorded under N₆ (50% RDF + 50% RDN through FYM). The higher grain yield under 100% RDF may be attributed to the balanced and adequate supply of essential nutrients, which promoted better crop growth, photosynthetic efficiency, and translocation of assimilates to the grains. Similar findings were reported by Parjane *et al.* (2024) [14].

Effect of Interaction

The interaction between intercropping and nutrient levels had significant effect on the mean grain yield m^{-1} row length as shown in Table 1B. The treatment combination C₂N₁, which involved intercropping with 100% RDF, recorded the maximum grain yield m^{-1} row length (102.69 g). Similar results were found by Gadallah and Gabra (2015) [6].

Table 1B: Effect of interactions on mean grain yield (m^{-1} row length) of finger millet as influenced by various treatments

Intercropping Nutrient Levels	C ₁	C ₂	Mean
N ₁	100.65	102.69	101.67
N ₂	92.15	93.55	92.85
N ₃	97.85	102.40	100.13
N ₄	98.28	101.67	99.97
N ₅	89.43	92.92	91.18
N ₆	69.40	90.15	79.77
Mean	91.29	97.23	94.26
S.Em±	2.83		
CD @ 5 %	8.30		

Mean Test Weight

Effect of Intercropping

Mean test weight of finger millet was significantly influenced by intercropping. Finger millet + green gram (4:2) (C₂) recorded the highest test weight of finger millet due to complementary use of resources (2.56 g) while treatment sole finger millet (C₁) recorded the lowest test weight (2.24 g). These results align with the findings of Willey (1979) [19].

Effect of Nutrient Levels

The mean test weight of finger millet was influenced significantly by different nutrient levels harvest. Application of 100% RDF (N₁) recorded significantly maximum test weight 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 (N₃) 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). Similar result was reported by Dimple *et al.* (2022) [4] as he noted that increase in test weight was observed in the experiment may be due to the favourable effects of fertilizer-application

Effect of Interaction

The interaction between intercropping and nutrient levels had no significant effect on the mean test weight of finger millet.

Yield Studies of Finger Millet

Grain yield (q ha⁻¹)

Effect of Intercropping

The mean grain yield of finger millet (q ha⁻¹) was significantly influenced by the intercropping systems. The sole finger millet treatment (C₁) recorded the highest grain yield (27.37 q ha⁻¹),

whereas the finger millet + green gram (4:2) intercropping system (C₂) recorded a comparatively lower grain yield (21.27 q ha⁻¹). The higher yield under sole cropping was mainly due to the greater plant population per unit area compared to the intercropping system. These findings are in agreement with Singh and Arya (1999) and Nigade *et al.* (2014) [17, 11].

Effect of Nutrient Levels

The mean grain yield of finger millet (q ha⁻¹) was significantly influenced by different nutrient levels at harvest. Application of 100% RDF (N₁) recorded the highest grain yield, which was statistically at par with N₃ (75% RDF + *Azospirillum* + PSB + 2% 19:19:19 foliar spray) and N₄ (75% RDF + *Azospirillum* + PSB + 3% Panchagavya foliar spray). The lowest grain yield was recorded under N₆ (50% RDF + 50% RDN through FYM). The higher grain yield under 100% RDF may be attributed to the balanced and adequate supply of essential nutrients, which enhanced crop growth, yield attributes, and dry matter accumulation, resulting in increased grain production. Similar findings were reported by Parjane *et al.* (2024) [14].

Effect of Interaction

As shown in Table 2A, the interaction between intercropping systems and nutrient levels had a significant influence on the mean grain yield (q ha⁻¹) of finger millet. The treatment combination C₁N₁, which involved sole cropping of finger millet with 100% of the recommended dose of fertilizers (RDF), recorded the highest grain yield of 30.76 q ha⁻¹. This increase in yield can be attributed to the higher plant density and the adequate supply of nutrients, both of which likely contributed to improved plant growth and productivity. Similar findings were reported by Gadallah and Gabra (2015) [6].

Table 2: Grain and straw yield (q ha⁻¹) of finger millet as influenced by various treatments

Treatments	Grain yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)
Intercropping		
C ₁ - Sole Finger millet	27.37	34.38
C ₂ - Finger millet + Green gram (4:2)	21.27	27.94
S.E.m±	0.34	1.08
CD @ 5%	1.01	3.17
Nutrient levels		
N ₁ -100% Recommended dose of fertilizer (RDF)	27.37	38.39
N ₂ -75% RDF + Soil application of <i>Azospirillum</i> @2 kg ha ⁻¹ and Phosphate solubilizing bacteria @ 2 kg ha ⁻¹	25.22	29.63
N ₃ -75% RDF + Soil application of <i>Azospirillum</i> (2 kg ha ⁻¹) and PSB (2 kg ha ⁻¹) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS	26.33	34.02
N ₄ -75% RDF + Soil application of <i>Azospirillum</i> (2 kg ha ⁻¹) and PSB (2 kg ha ⁻¹) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS	24.31	33.07
N ₅ - 75% RDF + 25% RDN through FYM	23.32	29.23
N ₆ - 50% RDF + 50% RDN through FYM	19.95	22.62
S.E.m±	1.75	1.87
CD @ 5%	27.37	5.50
Interaction: C × N		
S.E.m±	0.84	2.65
CD @ 5%	2.48	7.77
General Mean	24.32	31.16

Straw yield (q ha⁻¹)

Effect of Intercropping

Mean straw yield (q ha⁻¹) of finger millet was significantly influenced by the cropping system. Sole finger millet (C₁) recorded the highest straw yield (34.38 q ha⁻¹), which may be attributed to the higher plant population under sole cropping, whereas the finger millet + green gram intercropping system (C₂) recorded the lowest straw yield (27.94 q ha⁻¹). These findings are

in agreement with Singh and Arya (1999) and Nigade *et al.* (2014) [17, 11].

Effect of Nutrient Levels: The mean straw yield (q ha⁻¹) of finger millet at harvest was significantly influenced by different nutrient management treatments. Application of 100% RDF (N₁) recorded the highest straw yield, which was statistically 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 at 15 and 30 DAS (N₃) and 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 3% Panchagavya at 15 and 30 DAS (N₄). The lowest straw yield was recorded with 50% RDF + 50% RDN through FYM (N₆). The higher straw yield under N₁ may be attributed to the adequate supply of nutrients, which promoted better vegetative growth and biomass production. Similar findings were reported by Parjane (2024) [14].

Effect of Interaction

The interaction between intercropping and nutrient levels had significant effect on the mean straw yield (q ha⁻¹) as shown in Table 2A. The treatment combination C₁N₁, which involved sole finger millet with 100% RDF, recorded the maximum straw yield (44 q ha⁻¹). These findings are in alignment with the results reported by Gadallah and Gabra (2015) [6].

Table 2A: Effect of interaction on grain and straw yield (q ha⁻¹) of finger millet as influenced by various treatment

Nutrient Levels	Grain yield (q ha ⁻¹)			Straw yield (q ha ⁻¹)		
	C ₁	C ₂	Mean	C ₁	C ₂	Mean
N ₁	30.76	22.82	26.79	44.00	32.77	38.39
N ₂	27.82	20.79	24.31	33.89	25.36	29.63
N ₃	29.90	22.76	26.33	37.55	30.49	34.02
N ₄	28.52	21.93	25.22	36.46	29.68	33.07
N ₅	25.99	20.65	23.32	33.41	25.05	29.23
N ₆	21.20	18.70	19.95	20.97	24.28	22.62
Mean	27.37	21.27	24.32	34.38	27.94	31.16
S.Em±	0.84			2.65		
CD @ 5 %	2.48			7.77		

Yield attributing characters of green gram

Mean Number of Pods Plant⁻¹

Effect of Intercropping

The mean number of pods plant⁻¹ in green gram was significantly influenced by the cropping system. The finger millet + green gram intercropping system (4:2) (C₂) recorded the highest number of pods plant⁻¹ (19.95), which may be attributed to better utilization of available resources and improved crop growth under intercropping. In contrast, sole green gram (C₃) recorded the lowest number of pods plant⁻¹ (18.31). These findings are in accordance with the results of Murali *et al.* (2014) and Dhima *et al.* (2007) [10, 3].

Effect of Nutrient Levels

The mean number of pods plant⁻¹ in green gram was significantly affected by different nutrient management treatments. The application of 100% RDF (N₁) produced the highest number of pods plant⁻¹, which was statistically comparable with 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹)

+ foliar spray of 2% 19:19:19 at 15 and 30 DAS (N₃) and 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 3% Panchagavya at 15 and 30 DAS (N₄). The lowest number of pods plant⁻¹ was recorded under 50% RDF + 50% RDN through FYM (N₆). The improved pod production under N₁ may be due to the sufficient availability of nutrients, which enhanced plant growth and reproductive performance. These findings are in agreement with Patel *et al.* (1984), Jamro *et al.* (1995), and Patel *et al.* (2017) [13, 7, 12].

Effect of Interaction: The mean number of pods plant⁻¹ in green gram was significantly affected by the interaction between cropping systems and nutrient management treatments. The highest number of pods plant⁻¹ (22.30) was recorded under finger millet + green gram (4:2) intercropping with 100% RDF (C₂N₁). This improvement may be attributed to the combined influence of adequate nutrient availability and better resource use under the intercropping system. These results are consistent with the findings of Gadallah and Gabra (2015) [6].

Table 3: Yield attributing characters of green gram at harvest as influenced by various treatments

Treatments	No. of pods plant ⁻¹	Length of pod (cm)	No. of seeds Pod ⁻¹	Seed Yield plant ⁻¹	Wt. of 100 seeds (g)
Intercropping					
C ₃ - Sole Green gram	18.31	7.22	8.79	4.96	4.78
C ₂ - Finger millet + Green gram (4:2)	19.95	7.99	10.84	5.73	4.81
S.Em±	0.31	0.16	0.17	0.09	0.01
CD @ 5%	0.91	0.48	0.51	0.25	0.02
Nutrient levels					
N ₁ -100% Recommended dose of fertilizer (RDF)	21.66	8.33	12.15	6.30	4.83
N ₂ -75% RDF + Soil application of <i>Azospirillum</i> @2 kg ha ⁻¹ and Phosphate solubilizing bacteria @ 2 kg ha ⁻¹	18.83	7.24	9.39	5.16	4.80
N ₃ -75% RDF + Soil application of <i>Azospirillum</i> (2 kg ha ⁻¹) and PSB (2 kg ha ⁻¹) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS	20.46	8.22	11.58	6.03	4.81
N ₄ -75% RDF + Soil application of <i>Azospirillum</i> (2 kg ha ⁻¹) and PSB (2 kg ha ⁻¹) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS	20.09	8.02	11.33	5.86	4.81
N ₅ - 75% RDF + 25% RDN through FYM	18.42	7.13	7.80	4.76	4.78
N ₆ - 50% RDF + 50% RDN through FYM	15.31	6.70	6.66	3.98	4.74
S.Em±	0.54	0.28	0.30	0.15	0.01
CD @ 5%	1.58	0.83	0.88	0.44	0.03
Interaction: C × N					
S.Em±	0.76	0.40	0.42	0.21	0.02
CD @ 5%	2.23	NS	NS	0.62	NS
General Mean	19.13	7.60	9.82	5.35	4.80

Mean Length of Pod (cm)

Effect of Intercropping

The mean pod length (cm) of green gram was significantly influenced by the cropping system. Finger millet + green gram (4:2) intercropping (C₂) recorded the maximum pod length (7.99 cm), which may be attributed to better utilization of available resources, whereas sole green gram (C₃) recorded the minimum pod length (7.22 cm). These findings are in agreement with Willey (1979) and Dhima *et al.* (2007) [19, 3].

Effect of Nutrient Levels

The mean pod length of green gram was significantly affected by different nutrient management treatments. The application of 100% RDF (N₁) produced the highest pod length, which was statistically comparable with 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 2% 19:19:19 at 15 and 30 DAS (N₃) and 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 3% Panchagavya at 15 and 30 DAS (N₄). The lowest pod length was observed under 50% RDF + 50% RDN through FYM (N₆). The enhanced pod length under N₁ may be due to sufficient nutrient availability, which favored better crop growth and pod development. These findings are in agreement with Patel *et al.* (2017) [12].

Effect of Interaction

The interaction between intercropping and nutrient levels had no significant effect on the mean length of pod (cm) of green gram.

Number of Seeds Pod⁻¹

Effect of Intercropping

The mean number of seeds pod⁻¹ in green gram was significantly affected by the cropping system. Finger millet + green gram (4:2) intercropping (C₂) recorded the highest number of seeds pod⁻¹ (10.84), which may be attributed to better utilization of available resources, resulting in improved pod filling. In contrast, sole green gram (C₃) recorded the lowest number of seeds pod⁻¹ (8.79). These findings are in agreement with the results of Willey (1979) and Dhima *et al.* (2007) [19, 3].

Effect of Nutrient Levels

The mean number of seeds pod⁻¹ in green gram was significantly affected by different nutrient management treatments. The application of 100% RDF (N₁) produced the highest number of seeds pod⁻¹, which was statistically comparable with 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) +

foliar spray of 2% 19:19:19 at 15 and 30 DAS (N₃) and 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 3% Panchagavya at 15 and 30 DAS (N₄). The lowest number of seeds pod⁻¹ was observed under 50% RDF + 50% RDN through FYM (N₆). The superior seed set under N₁ may be due to the adequate supply of nutrients, which enhanced crop growth and reproductive development. These findings are in agreement with Patel *et al.* (2017) [12].

Effect of Interaction

The interaction between intercropping and nutrient levels had no significant effect on the number of seeds pod⁻¹ of green gram.

Seed Yield Plant⁻¹

Effect of Intercropping

The mean seed yield plant⁻¹ of green gram was significantly affected by the cropping system. The finger millet + green gram (4:2) intercropping system (C₂) recorded the highest seed yield plant⁻¹ (5.73 g), probably due to more efficient utilization of growth resources under intercropping. On the other hand, sole green gram (C₃) recorded the lowest seed yield plant⁻¹ (4.96 g). These findings are consistent with those reported by Willey (1979) and Dhima *et al.* (2007) [19, 3].

Effect of Nutrient Levels

The mean seed yield plant⁻¹ of green gram was significantly affected by different nutrient management treatments. The application of 100% RDF (N₁) produced the highest seed yield plant⁻¹, which was statistically comparable with 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 2% 19:19:19 at 15 and 30 DAS (N₃) and 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 3% Panchagavya at 15 and 30 DAS (N₄). The increased seed yield plant⁻¹ under N₁ may be due to enhanced nutrient uptake, which promoted better crop growth and seed development. These findings are in agreement with Patel *et al.* (2017) [12].

Effect of Interaction

The interaction between intercropping and nutrient levels had a significant effect on the mean number of seeds yield plant⁻¹ of green gram at harvest, as shown in Table 3A. The treatment combination C₂N₁, which involved intercropping with 100% RDF, recorded highest number of seeds yield plant⁻¹ (6.52 g) of green gram. Similar results found by Gadallah and Gabra (2015), Willey (1979) [6, 19].

Table 3A: Effect of interactions on number of pods plant⁻¹ and seed yield plant⁻¹ of green gram as influenced by various treatments

Intercropping Nutrient Levels	Number of Pods Plant ⁻¹			Seed Yield Plant ⁻¹		
	C ₃	C ₂	Mean	C ₃	C ₂	Mean
N ₁	21.03	22.30	21.66	6.08	6.52	6.30
N ₂	18.38	19.28	18.83	4.97	5.35	5.16
N ₃	20.37	20.54	20.46	5.84	6.22	6.03
N ₄	19.81	20.37	20.09	5.61	6.12	5.86
N ₅	17.70	19.14	18.42	4.25	5.26	4.76
N ₆	12.54	18.08	15.31	3.02	4.94	3.98
Mean	18.31	19.95	19.13	4.96	5.73	5.35
S.E.m±	0.76			0.21		
CD @ 5 %	2.23			0.62		

Weight of 100 seeds (g) a) Effect of Intercropping

The mean 100-seed weight of green gram was significantly influenced by the cropping system. Finger millet + green gram (4:2) intercropping (C₂) recorded the highest 100-seed weight,

which may be attributed to better utilization of available resources under intercropping, whereas sole green gram (C₃) recorded the lowest 100-seed weight. These findings are in agreement with the results of Willey (1979) and Dhima *et al.* (2007) [19, 3].

Effect of Nutrient Levels

The mean 100-seed weight of green gram was significantly affected by different nutrient management treatments. The application of 100% RDF (N₁) produced the highest 100-seed weight, which was statistically comparable with 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 2% 19:19:19 at 15 and 30 DAS (N₃) and 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 3% Panchagavya at 15 and 30 DAS (N₄). The enhanced 100-seed weight under N₁ may be due to sufficient nutrient availability, which favored better seed filling and development. These findings are consistent with those reported by Patel *et al.* (2017) and Manpreet *et al.* (2004) [12, 9].

Effect of Interaction

The interaction between intercropping and nutrient levels had no significant effect on the mean seed index of green gram.

Yield Studies of Green gram

Seed yield (q ha⁻¹)

Effect of Intercropping

The mean seed yield (q ha⁻¹) of green gram was significantly

affected by the cropping system. The highest seed yield (13.87 q ha⁻¹) was obtained under sole green gram (C₃), probably due to the greater plant population in the sole cropping system, while finger millet + green gram (4:2) intercropping (C₂) produced the lowest seed yield (5.92 q ha⁻¹). Similar findings were reported by Nigade *et al.* (2014) [11].

Effect of Nutrient Levels

The mean seed yield (q ha⁻¹) of green gram was significantly influenced by different nutrient management treatments. The application of 100% RDF (N₁) produced the highest seed yield, which was statistically comparable with 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 2% 19:19:19 at 15 and 30 DAS (N₃) and 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 3% Panchagavya at 15 and 30 DAS (N₄). The lowest seed yield was recorded under 50% RDF + 50% RDN through FYM (N₆). The superior seed yield under N₁ may be due to sufficient nutrient availability, which promoted better crop growth, enhanced yield-contributing traits, and increased seed production. Similar findings were reported by Patel *et al.* (1984), Manpreet *et al.* (2004), and Patel *et al.* (2017) [13, 9, 12].

Table 4: Seed and stover yield (q ha⁻¹) of green gram as influenced by various treatments

Treatments	Seed yield (q ha ⁻¹)	Stover yield (q ha ⁻¹)	Biological yield (q ha ⁻¹)	Harvest index (%)
Intercropping				
C ₃ - Sole Green gram	13.87	29.90	43.76	31.67
C ₂ - Finger millet + Green gram (4:2)	5.92	12.22	18.13	32.86
S.Em±	0.23	0.48	0.68	0.41
CD @ 5%	0.68	1.40	1.99	NS
Nutrient levels				
N ₁ -100% Recommended dose of fertilizer (RDF)	11.46	24.63	36.09	31.67
N ₂ -75% RDF + Soil application of <i>Azospirillum</i> @2 kg ha ⁻¹ and Phosphate solubilizing bacteria @ 2 kg ha ⁻¹	9.84	21.53	31.37	31.55
N ₃ -75% RDF + Soil application of <i>Azospirillum</i> (2 kg ha ⁻¹) and PSB (2 kg ha ⁻¹) + Foliar spray of 2% 19:19:19 @ 15 and 30 DAS	11.15	24.15	35.30	31.72
N ₄ -75% RDF + Soil application of <i>Azospirillum</i> (2 kg ha ⁻¹) and PSB (2 kg ha ⁻¹) + Foliar spray of Panchagavya 3% @ 15 and 30 DAS	10.66	22.60	33.26	32.42
N ₅ - 75% RDF + 25% RDN through FYM	9.04	18.50	27.54	33.06
N ₆ - 50% RDF + 50% RDN through FYM	7.20	14.93	22.13	33.25
S.Em±	0.40	0.83	1.18	0.71
CD @ 5%	1.19	2.43	3.45	NS
Interaction: C × N				
S.Em±	0.57	1.17	1.66	1.01
CD @ 5%	1.68	3.43	4.88	NS
General Mean	9.89	21.06	30.95	32.26

Effect of Interaction

The mean seed yield (q ha⁻¹) of green gram was significantly influenced by the interaction between cropping systems and nutrient management treatments. Among the treatment combinations, sole green gram with 100% RDF (C₃N₁) recorded the highest seed yield (16.10 q ha⁻¹). These findings are consistent with the results reported by Gadallah and Gabra (2015) [6].

Stover yield (q ha⁻¹)

Effect of Intercropping

The mean stover yield (q ha⁻¹) of green gram was significantly affected by the cropping system. The highest stover yield (29.90 q ha⁻¹) was recorded under sole green gram (C₃), likely due to higher plant density under sole cropping, while the finger millet + green gram (4:2) intercropping system (C₂) recorded the lowest stover yield (12.22 q ha⁻¹). These results are in agreement with Nigade *et al.* (2014) [11].

Effect of Nutrient Levels

The mean stover yield (q ha⁻¹) of green gram was significantly affected by different nutrient management treatments. The application of 100% RDF (N₁) resulted in the highest stover yield, which was statistically comparable with 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 2% 19:19:19 at 15 and 30 DAS (N₃) and 75% RDF + soil application of *Azospirillum* (2 kg ha⁻¹) and PSB (2 kg ha⁻¹) + foliar spray of 3% Panchagavya at 15 and 30 DAS (N₄). The lowest stover yield was recorded under 50% RDF + 50% RDN through FYM. The increased stover yield under N₁ may be due to improved nutrient availability, which enhanced vegetative growth and biomass production. These findings are in agreement with Patel *et al.* (2017), Manpreet *et al.* (2004), and Patel *et al.* (1984) [12, 9, 13].

Effect of Interaction: The mean stover yield (q ha⁻¹) of green

gram was significantly influenced by the interaction between cropping systems and nutrient management treatments, as shown in Table 4A. The highest stover yield (34.14 q ha^{-1}) was recorded under sole green gram with 100% RDF (C_3N_1). These results are consistent with the findings of Gadallah and Gabra (2015) [6].

Biological yield (q ha^{-1})

Effect of Intercropping

The mean biological yield (q ha^{-1}) of green gram was significantly influenced by the cropping system. Sole green gram (C_3) recorded the highest biological yield (43.76 q ha^{-1}), which may be attributed to higher plant density compared to finger millet + green gram (C_2), which recorded a lower biological yield (18.13 q ha^{-1}). The reduced plant population under intercropping likely resulted in lower total biomass production. These findings are consistent with Kumar and Ray (2020) [8].

Effect of Nutrient Levels

The mean biological yield (q ha^{-1}) of green gram was significantly affected by different nutrient management treatments. The application of 100% RDF (N_1) produced the highest biological yield, which was statistically comparable with 75% RDF + soil application of *Azospirillum* (2 kg ha^{-1}) and PSB (2 kg ha^{-1}) + foliar spray of 2% 19:19:19 at 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 3% Panchagavya at 15 and 30 DAS (N_4). The lowest biological yield was recorded under 50% RDF + 50% RDN through FYM (N_6).

Effect of Interaction

The interaction between intercropping and nutrient levels had significant effect on the mean biological yield (q ha^{-1}) as shown in Table 4A. The treatment combination C_3N_1 , which involved sole green gram with 100% RDF, recorded the maximum biological yield (50.25 q ha^{-1}).

Harvest Index (%)

Effect of Intercropping

The results indicated that intercropping did not significantly affect the mean harvest index of green gram.

Effect of Nutrient Levels

Variations in nutrient levels had no significant effect on the mean harvest index of green gram at harvest.

Effect of Interaction

The interaction between intercropping and nutrient levels had no significant effect on the mean harvest index of green gram

Table 4A: Effect of interaction on seed yield, stover yield and biological yield (q ha^{-1}) after harvest of green gram as influenced by various treatments

After harvest Intercropping Nutrient levels	Seed Yield (q ha^{-1})			Stover Yield (q ha^{-1})			Biological Yield (q ha^{-1})		
	C_3	C_2	Mean	C_3	C_2	Mean	C_3	C_2	Mean
N_1	16.10	6.82	11.46	34.14	15.12	24.63	50.25	21.93	36.09
N_2	14.35	5.33	9.84	31.75	11.31	21.53	46.10	16.64	31.37
N_3	15.59	6.71	11.15	34.06	14.24	24.15	49.65	20.95	35.30
N_4	14.81	6.51	10.66	32.07	13.13	22.60	46.88	19.63	33.26
N_5	12.91	5.17	9.04	26.71	10.29	18.50	39.63	15.46	27.54
N_6	9.43	4.97	7.20	20.65	9.21	14.93	30.08	14.18	22.13
Mean	13.87	5.92	9.89	29.90	12.22	21.06	43.76	18.13	30.95
S.E.m $\pm$	0.57			1.17			1.66		
CD @ 5 %	1.68			3.43			4.88		

Conclusion

All yield attributes of finger millet were significantly affected by intercropping. The finger millet + green gram (4:2) intercropping system recorded the highest number of ear heads (36.57 m^{-1} row length), number of fingers per ear head (6.27), grain yield (97.23 g m^{-1} row length), and test weight of 1000 grains (2.56 g) compared to sole finger millet. Similarly, yield attributes of green gram were also significantly influenced by intercropping. The finger millet + green gram (4:2) system recorded the highest number of pods per plant (19.95), pod length (7.99 cm), number of seeds per pod (10.84), seed yield per plant (5.73 g), and 100-seed weight (4.81 g) over sole green gram. However, the highest grain yield (27.37 q ha^{-1}) and straw yield (34.38 q ha^{-1}) in finger millet, and the highest seed yield (13.87 q ha^{-1}) and stover yield (29.90 q ha^{-1}) in green gram were obtained under sole cropping due to higher plant population density. The harvest index of green gram was not affected by intercropping. Yield attributes of finger millet, including number of ear heads (41.55 m^{-1} row length), number of fingers per ear head (6.96), grain yield (101.67 g m^{-1} row length), and test weight of 1000 grains (2.86 g), along with grain yield (27.37 q ha^{-1}) and straw yield (38.39 q ha^{-1}), were significantly higher under 100% RDF (N_1). This treatment was statistically 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 at 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 3% Panchagavya at 15 and 30 DAS (N_4), whereas the lowest values were recorded under 50% RDF + 50% RDN through FYM (N_6). A similar trend was observed in green gram, where N_1 recorded the highest number of pods per plant (21.66), pod length (8.33 cm), seeds per pod (12.15), seed yield per plant (6.30 g), 100-seed weight (4.83 g), seed yield (11.46 q ha^{-1}), stover yield (24.63 q ha^{-1}), and biological yield (36.09 q ha^{-1}), and remained at par with N_3 and N_4 . The interaction effects between cropping system and nutrient levels showed that the combination of finger millet + green gram (4:2) with 100% RDF (N_1) resulted in significantly higher plant height (122.09 cm), dry matter accumulation ($76.48 \text{ g plant}^{-1}$), number of ear heads (42.15 m^{-1} row length), number of fingers per ear head (7.38), and grain yield (102.69 g m^{-1} row length) in finger millet at harvest. However, sole finger millet with 100% RDF recorded the maximum grain yield (30.76 q ha^{-1}) and straw yield (44.00 q ha^{-1}). In green gram, the interaction of intercropping (4:2) with 100% RDF significantly improved plant height (74.25 cm), number of branches per plant (8.37), dry matter accumulation ($29.30 \text{ g plant}^{-1}$), number of pods per plant (22.30), and seed yield per plant (6.52 g). On the other hand, sole green gram with 100% RDF produced the highest seed yield (16.10 q ha^{-1}), stover yield (34.14 q ha^{-1}), and biological yield (50.25 q ha^{-1}) at harvest.

References

1. Ananthi K, Gomathy M, Sabarinathan KG, Rajababu C. Small Millets with Legumes Intercropping for Climate Smart Agriculture. *International Journal of Environmental Sciences and Natural Resources*. 2024;33(4):556373.
2. Bitew Y, Alemayehu G, Adegbo E, Assefa A. Boosting land use efficiency, profitability and productivity of finger millet by intercropping with grain legumes. *Cogent Food & Agriculture*. 2019;5(1):1702826.
3. Dhima KV, Lithourgidis AS, Vasilakoglou IB, Dordas CA. Competition indices of common vetch and cereal intercrops in two seeding ratios. *Field Crops Research*. 2007;100:249-256.
4. Dimple KT, Nagamani C, Chandrika V, Kumar AN, Sagar GK. Effect of Times of Sowing and Nitrogen Levels on Yield and Yield Attributes of Proso Millet (*Panicum miliaceum* L.). *Agricultural Science Digest*. 2022; DOI: 10.18805/ag.D-5622.
5. 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.
6. Gadallah RA, Gabra AM. Effect of intercropping patterns and nitrogen fertilization levels on yield and yield components of maize and soybean. *Annals of Agricultural Science, Moshtohor*. 2015;53(2):187-197.
7. 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 Research Hisar*. 1995;10(3):265-270.
8. Kumar B, Ray PK. Finger millet intercropping with legumes step towards increasing farmers income. *International Journal of Chemical Studies*. 2020;8(3):1038-1040.
9. Manpreet S, Sekhon HS, Jagrup S. Response of summer mungbean (*Vigna radiata* L.) genotypes to different phosphorus levels. *Environment and Ecology*. 2004;22(1):13-17.
10. Murali K, Sheshadri T, Byregowda M. Effect of pigeonpea transplanting on growth, yield and economics in sole and finger millet intercropping system under late sown conditions. *Journal of Food Legumes*. 2014;27(1):28-31.
11. Nigade RD, Gajbhiye PN, More SM. Integrated nutrient management studies in finger millet (*Eleusine coracana* L.). *Crop Research*. 2014;48:27-31.
12. Patel HB, Shah KA, Barvaliya MM, Patel SA. Response of green gram (*Vigna radiata* L.) to different level of phosphorus and organic liquid fertilizer. *International Journal of Current Microbiology and Applied Sciences*. 2017;6(10):3443-3451.
13. Patel RG, Patel MP, Patel HC, Patel RB. Effect of graded levels of nitrogen and phosphorus on growth, yield and economics of summer mungbean. *Indian Journal of Agronomy*. 1984;29(3):291-294.
14. 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. *Agricultural Science Digest*. 2024;1-8.
15. Perli VH, Tomar SS, Kasi RG, Deepsikha MK. Influence of organic manures and Bio-fertilizers on the growth and yield of green gram (*Vigna radiata* L.). *The Pharma Innovation Journal*. 2022;11(6):141-144.
16. 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. *International Journal of Current Microbiology and Applied Sciences*. 2019;8(8):1-10.
17. Singh RV, Arya M. Nitrogen requirement of finger millet (*Eleusine coracana*) + pulse intercropping system. *Indian Journal of Agronomy*. 1999;44(1):47-50.
18. Tsubo M, Walker S, Ogindo HO. A simulation model of cereal-legume intercropping systems for semi-arid regions: I. Model development. *Field Crops Research*. 2005;93(1):10-22.
19. Willey RW. Intercropping—It's Important and Research Needs. Part 1. Competition and Yield Advantages. *Field Crop Abstracts*. 1979;32:1-10.