SAARC J. Agric., 24(1): 185-202 (2026) *DOI: https://doi.org/10.3329/sja.v24i1.89389*

SAARC Journal of Agriculture

Journal Homage: https://www.banglajol.info/index.php/SJA

Effect of Spacing on the Growth and Yield of Mung Bean (*Vigna radiata*) Varieties in Sunwal, Nawalparasi West, Nepal

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ABSTRACT

Mung bean productivity in western Terai, Nepal is challenged by conventional management practices and is influenced by plant spacing and variety. A field experiment was conducted at Nawalparasi West, Nepal, from March to June 2024, to assess the effects of spacing and variety on mung bean growth, yield and profitability. The experiment was laid out in a split-plot design with three replications, comprising two spacing levels (20 cm×10 cm and 15 cm×15 cm) as the main-plot factor and five varieties (Pratigya, BARI mung-4, SML665, VC6173 and Pant-5) as the sub-plot factor. Data on phenology, growth parameters, yield attributes and profitability were recorded and analyzed. Spacing significantly influenced plant height, leaf number, plant dry matter and weed dry matter during early growth stages, and stover yield at harvest, with wider spacing (20 cm × 10 cm) promoting greater vegetative growth, biomass and stover yield. Seed yield was significantly affected by variety, with BARI mung-4 recording the highest yield, statistically at par with Pratigya, Pant-5 and VC6173, while SML665 recorded the lowest. The spacing×variety interaction was also significant for seed yield, with BARI mung-4 and VC6173 producing significantly higher seed yield under wider spacing and Pratigya under narrower spacing. Harvest index showed no significant differences. Profitability parameters did not differ significantly across treatments, though VC6173 recorded numerically higher gross margin and benefit-cost ratio. BARI mung-4 is recommended under wider spacing and Pratigya under narrower spacing, to enhance mung bean yield and profitability in western Terai, Nepal.

Keywords: Mung bean, Profitability, Plant spacing, Seed yield, Variety

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Received:20.04.2026 *Accepted: 30.06.2026*

Introduction

Nepal's economy is predominantly agrarian, with agriculture employing about two-thirds of the population and serving as a primary source of livelihood, particularly due to the country's varied topography and climatic diversity (Liu et al., 2023; MoALD, 2024a). Mung bean (*Vigna radiata*) is an important legume with rapid growth, high nutritive value and soil enrichment value, especially, for biological nitrogen fixation (Diatta et al., 2024; Pataczek et al., 2018). The plant grows under tropical to subtropical warm-season climates; matures quickly at ideal temperatures of 28 to 30°C; and tolerates 600 to 1000 mm (average) annual rainfall (Kumari, 2023). Grown widely in Asia, the mung bean, with culinary, nutritional and agronomic value, is high in protein and contains easily digestible essential amino acids, including lysine, as well as numerous vitamins and minerals (Balaso, 2024; Dahiya et al., 2015; Nair et al., 2013). Mung bean is cultivated on 12,000 ha with a total production of 6,500 metric tons and an average productivity of 500 kg ha^{-1} (MoALD, 2024a). Cultivation is largely confined to the eastern and central Terai of Nepal, accounting for only 4 percent of the total grain legume area in the country (Neupane et al., 2023). In Sunwal Municipality, its cultivation, however, remains underutilized. Limited awareness among farmers about improved legume varieties combined with suboptimal agronomic practices such as irregular fertilizer application, seed broadcasting and inadequate management of soil moisture, often results in poor germination, uneven crop stand, increased weed infestation and ultimately low yields in Nepal (Chapagain et al., 2023; Dessalegn et al., 2022; Pokhrel & Poudel, 2025; Regmi et al., 2023). In the same vein, NARC has released high-yielding varieties like 'Pusa Baishakhi' for Inner Terai and 'Kalyan', 'Pratikshya' and 'Pratigya' for Terai and mid-hill regions; but farmers have limited information about the suitable varieties for the particular region or the significance of appropriate plant geometry which is crucial for maximizing light interception, nutrient utilization and overall plant health (Joshi et al., 2024; MoALD, 2024b). Nepal's agro-climatic environment demands optimal sowing time and geometry, and delayed planting may result in yield loss (Neupane et al., 2023). Moreover, lying fallow between wheat harvest and monsoon rice transplantation provides a window for the integration of mung bean as a profitable catch crop to promote food security and farmers' income (Gharti et al., 2014). Given the existing knowledge gap, this study aims to scientifically assess the optimal spacing and high-yielding varieties to enhance the productivity and profitability of mung bean in Sunwal, Nawalparasi West, Nepal.

Materials and Methods

Experimental site and experimental details

The field experiment was conducted in Sunwal Municipality-1, Nawalparasi West, Nepal during the year 2024. Geographically, this site lies at an elevation of 131 meters to 1,023 meters above sea level in the Nawalparasi West District of Lumbini Province of Nepal, experiencing a humid subtropical climate with mean temperatures of 28.6 ºC in May and 14.6 ºC in January, and an average annual rainfall of approximately 1,654 mm (ENPHO, 2023).

The experiment was laid out in a split-plot design with three replications. Spacing served as the main plot factor, comprising two levels: S1 = 20 cm × 10 cm and S2 = 15 cm × 15 cm. The closer spacing (15 cm × 15 cm) was similar to common farmer practice, while the wider spacing (20 cm × 10 cm) was expected to improve light penetration, aeration and reduce intra-plant competition. These two levels were selected to compare the agronomic effects of closer versus wider plant spacing within the resource and land constraints of the trial. Five mung bean varieties (V1= Pratigya, V2= BARI mung-4, V3= Pant-5, V4= SML665 and V5= VC6173) were assigned as sub-plot factors. A total of 30 experimental units (2.4 m × 2.4 m) spaced at 0.5 m were prepared based on the experimental layout. The field was prepared by ploughing, followed by leveling, and all weeds and clods were removed one week before sowing. A recommended dose of 20:20:20 kg ha^{-1} N_2:P_2O_5: K_2O was applied basally using urea, DAP and MoP. Farmyard manure (FYM) was applied at 10 t ha^{-1}. Irrigation was provided through pipes, with an initial flooding applied after seedling establishment to ensure uniform germination, followed by supplemental irrigation as needed based on visual soil moisture assessment and rainfall patterns during the cropping period. Harvesting was done starting around 60 DAS when most pods turned black or brown. Due to asynchronous pod maturity, multiple pickings were conducted.

Data collection

To evaluate the performance of various treatments on the growth and yield of mung bean, data were collected at an interval of 15 days starting from 15 DAS (Days after sowing), from five tagged plants from each experimental unit. Plant height was recorded using a scale from the ground level. The number of leaves and branches per plant was counted until maturity. Fresh weight of two sample plants per plot was recorded at each observation before wilting and dry matter per square meter was determined by oven-drying. Weed biomass was sampled using a 0.5 m² quadrat, and both fresh and dry weights were measured. Yield parameters were recorded at maturity from five randomly selected plants per plot and average values were computed. After harvest, plants from each plot were threshed separately and seeds were cleaned by winnowing. Seed yield was recorded at 12% moisture content and expressed in kg ha^{-1}. Thousand-seed weight was determined by weighing 1,000 randomly selected dry seeds using a weighing balance. Biological yield was recorded by weighing the above-ground biomass at 0% moisture content. Harvest index was calculated as the ratio of economic yield to biological yield.

Profitability analysis

The cultivation cost was estimated based on prevailing local rates for labor, fertilizers and other inputs, and expressed as total cost per hectare (NRs ha^{-1}). Gross return (NRs ha^{-1}) was calculated by multiplying seed and stover yields with their respective market prices. Gross margin was obtained by subtracting the total production cost from the gross return. The benefit-cost ratio (B:C) was computed as the ratio of gross return to total variable cost.

Statistical analysis

Data were systematically entered and arranged regarding the various observed parameters in MS Excel. The analysis of variance was carried out using a statistical tool (R-Studio). Differences among treatment means were compared using Duncan Multiple Range Test (DMRT) at 5% level of significance (Gomez & Gomez, 1984).

Results and Discussions

Biometrical observation

Plant height

The plant height of mung bean was significantly influenced by spacing at 45 DAS and by varieties at 60 DAS (Table 1). At 45 DAS, plant height was significantly greater at 20 cm × 10 cm than at 15 cm × 15 cm. It is consistent with the study of Birhanu et al. (2018), who reported greater mung bean plant height under wider inter-row spacing (20 cm) combined with narrower intra-row spacing (10 cm). This is attributed to reduced inter-plant competition for soil nutrients and improved light interception, enhancing photosynthetic efficiency. Significant genotypic variation was visible at 60 DAS, with BARI mung-4 and Pant-5 recording the greatest plant height, statistically at par with each other, and SML665 the shortest. These results partly agree with Singh et al. (2011), who reported that certain varieties such as SML134 are genetically shorter in stature. No significant differences in plant height were observed at 15 or 30 DAS for either spacing or varieties; similarly, spacing had no effect at 60 DAS, nor did varieties at 45 DAS.

Table 1. Average plant height of mung bean as influenced by spacing and varieties at Sunwal, Nawalparasi 2024

Treatment	15 DAS	30 DAS	45 DAS	60 DAS
Spacing (cm)				
20×10	5.45	11.42	22.16^{a}	49.92
15×15	5.18	10.41	20.33^{b}	48.77
SEm (±)	0.13	0.50	0.91	0.57
LSD (= 0.05)	ns	ns	0.84	ns

Treatment	15 DAS	30 DAS	45 DAS	60 DAS
CV, %	9.10	11.80	2.50	12.50
Varieties				
Pratigya	5.47	11.48	21.30	48.05[c]
BARI mung-4	5.31	11.00	20.99	52.48[a]
Pant-5	5.61	11.62	21.34	52.15[a]
SML665	5.00	9.57	21.19	44.85[d]
VC6173	5.18	10.91	21.41	49.20[b]
SEm (±)	0.10	0.36	0.07	1.40
LSD (= 0.05)	ns	ns	ns	0.86
CV, %	13.3	15.7	5	11.30
Grand mean	5.317	10.91	21.25	49.34

Note: CV, Coefficient of Variance; DAS, Days after Sowing; ns: Non-Significant; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance.

Number of leaves

The number of leaves per plant of mung bean was significantly affected by plant geometry at 60 DAS only (Table 2). A significantly greater number of leaves per plant was recorded under 20 cm × 10 cm spacing at this stage, likely due to reduced inter-plant competition for light, nutrients and space. These findings are in agreement with Hasan et al. (2018), who reported no significant varietal differences in leaf number, while wider spacing resulted in a greater number of leaves per plant compared to closer spacing. Similarly, Roy et al. (2023) noted that wider spacing promotes better leaf development by reducing resource competition, whereas closer spacing induces plant stress that limits leaf production. No significant differences were observed in leaf number at earlier growth stages (15, 30 and 45 DAS) for either spacing or varieties, and variety had no significant effect even at 60 DAS.

Table 2. Average number of leaves of mung bean as influenced by spacing and varieties at Sunwal, Nawalparasi 2024

Treatment	15 DAS	30 DAS	45 DAS	60 DAS
Spacing (cm)				
20×10	3.44	5.90	14.28	22.16[a]
15×15	3.40	6.05	13.64	20.33[b]
SEm (±)	0.02	0.073	0.32	0.91
LSD (= 0.05)	ns	ns	ns	0.84
CV, %	9.6	13.5	16.9	2.5

Treatment	15 DAS	30 DAS	45 DAS	60 DAS
Varieties				
Pratigya	3.33	5.76	13.90	21.30
BARI mung-4	3.46	5.90	14.86	20.99
Pant-5	3.43	6.13	13.53	21.34
SML665	3.36	5.66	13.76	21.19
VC6173	3.50	6.43	13.73	21.41
SEm (±)	0.03	0.13	0.23	0.07
LSD (= 0.05)	ns	ns	ns	ns
CV, %	7.9	14.4	7.9	5
Grand mean	3.42	5.98	13.96	21.25

Note: CV, Coefficient of Variance; DAS, Days after Sowing; ns: Non-Significant; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance.

Number of branches

Although there was no statistically significant difference in the number of branches per plant of mung bean on any of the observed days, a slightly higher number of branches was recorded at 15 cm × 15 cm spacing on 45 DAS and at 20 cm × 10 cm spacing on 60 DAS (Table 3). This result aligns with Hasan et al. (2018), who similarly found no significant effect of variety or spacing on branches per plant. In contrast, Tehulie et al. (2021) reported a significant influence of spacing and variety on branching, attributing it to increased inter-plant competition under closer spacing. This difference is due to the narrower spacing range tested in the present study, which may not have induced sufficient competitive effects on branching. At both 45 and 60 DAS, Pratigya numerically recorded the highest number of branches, although the difference was not statistically significant. These results suggest that branching in mung bean may be relatively stable across varieties and spacing, possibly reflecting strong genetic control over branching traits (Yoseph, 2022), though responses may vary under different agronomic or environmental conditions.

Table 3. Average number of branches of mung bean as influenced by spacing and varieties at Sunwal, Nawalparasi 2024

Treatment	45 DAS	60 DAS
Spacing (cm)		
20×10	2.92	5.93
15×15	3.28	5.54
SEm (±)	0.18	0.19
LSD (= 0.05)	ns	ns

Treatment	45 DAS	60 DAS
CV, %	14.1	16.9
Varieties		
Pratigya	3.30	6.30
BARI mung-4	3.20	5.60
Pant-5	3.10	5.40
SML665	2.66	5.63
VC6173	3.23	5.76
SEm (±)	0.11	0.15
LSD (= 0.05)	ns	ns
CV, %	21.1	18.5
Grand mean	3.1	5.74

Note: CV, Coefficient of Variance; DAS, Days after Sowing; ns: Non-Significant; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance.

Number of nodules

Number of nodules per plant did not differ significantly among spacing or varieties at either 30 or 60 DAS (Table 4). Mean values ranged from 32.46 to 34.90 at 30 DAS and from 36.56 to 37.40 at 60 DAS under different spacing, while among varieties, values ranged from 32.41 to 35.25 at 30 DAS and from 33.83 to 39.75 at 60 DAS. These findings are consistent with Rasul et al. (2012), who also reported no significant effect of inter-row spacing or variety on nodulation in mung bean. This confirms the findings by Habibi et al. (2026) that nodule formation in mung bean is likely governed more strongly by rhizobial symbiotic activity and prevailing soil conditions than by plant geometry or genotype.

Table 4. Average number of root nodules of mung bean as influenced by spacing and varieties at Sunwal, Nawalparasi 2024

Treatment	30 DAS	60 DAS
Spacing (cm)		
20×10	32.46	37.40
15×15	34.90	36.56
SEm (±)	1.21	0.41
LSD (= 0.05)	ns	ns
CV, %	6.9	9.5
Varieties		
Pratigya	33.91	37.33

Treatment	30 DAS	60 DAS
BARI mung-4	32.58	39.75
Pant-5	32.41	33.83
SML665	35.25	33.83
VC6173	34.25	38.33
SEm (±)	0.53	1.30
LSD (= 0.05)	ns	ns
CV, %	20.3	13.2
Grand mean	33.68	36.98

Note: CV, Coefficient of Variance; DAS, Days after Sowing; ns: Non-Significant; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance.

Plant dry matter (g m^{-2})

Plant dry matter was significantly influenced by both spacing and variety at 30 DAS, with higher dry matter observed at 20 cm × 10 cm spacing (Table 5). Among varieties, Pratigya and VC6173 recorded the highest dry matter, statistically at par with BARI mung-4 and SML665, while Pant-5 recorded the lowest, likely due to its lower leaf count and reduced photosynthetic efficiency. At 45 DAS, spacing continued to significantly affect plant dry matter, with wider spacing showing higher values, while varietal differences were not significant. By 60 DAS, no statistically significant differences in plant dry matter were observed for either spacing or variety, suggesting that early growth stages are more responsive to spatial arrangement and genetic variability in dry matter accumulation. Plant dry matter decreased at 60 DAS as compared to 45 DAS in Pratigya and Pant-5, likely due to early maturity and heat-induced senescence limiting further biomass accumulation, a pattern similarly documented in wheat under high-temperature conditions (Sevilmis, 2018). These findings are consistent with Charan et al. (2024), who reported significantly higher dry matter accumulation in mung bean under wider row spacing, attributed to improved light interception and enhanced nutrient availability, leading to increased photosynthetic activity. The relatively small increment in dry matter between 45 and 60 DAS may similarly be explained by early partitioning of biomass toward floral development and terminal heat stress, which constrained vegetative growth during this period.

Table 5. Plant dry matter of mung bean as influenced by spacing and varieties at Sunwal, Nawalparasi 2024

Treatment	30 DAS	45 DAS	60 DAS
Spacing (cm)			
20×10	49.82[a]	283.13[a]	263.15

Treatment	30 DAS	45 DAS	60 DAS
15×15	45.40^{b}	222.47^{b}	260.99
SEm (±)	2.20	30.32	1.07
LSD (= 0.05)	1.27	60.32	ns
CV, %	1.7	15.2	3
Varieties			
Pratigya	53.84^{a}	267.94	247.86
BARI mung-4	47.46^{ab}	243.76	277.11
Pant-5	41.30^{b}	270.23	263.60
SML665	45.39^{ab}	248.60	264.95
VC6173	50.03^{a}	233.45	256.81
SEm (±)	2.11	7.09	4.82
LSD (= 0.05)	9.33	ns	ns
CV, %	16	19.4	17.6
Grand mean	47.61	252.80	262.07

Note: CV, Coefficient of Variance; DAS, Days after Sowing; ns: Non-Significant; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance.

The plant dry matter of mung bean was significantly influenced by the interaction of spacing and varieties (Figure 2). At wider spacing i.e., 20 cm × 10 cm, Pratigya had the highest plant dry matter and was statistically at par with BARI mung-4, SML665 and VC6173. The plant dry matter at such spacing was significantly higher than Pant-5. At narrower spacing i.e., 15 cm × 15 cm, Pratigya had the highest plant dry matter and was statistically similar with BARI mung-4, Pant-5, SML665 and VC6173.

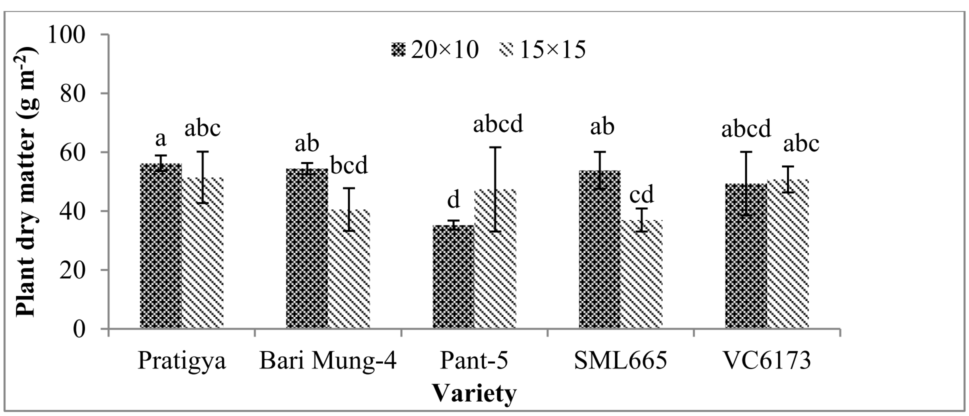

Fig. 2. Plant dry matter (g m^{-2}) of mung bean as influenced by spacing and varieties

Weed dry matter (g m^{-2})

Weed dry matter was significantly influenced by spacing at both 20 and 40 DAS, with higher weed biomass recorded under the wider 20 cm × 10 cm spacing compared to 15 cm × 15 cm at both stages (Table 6). Varietal differences in weed dry matter were significant only at 20 DAS, with BARI mung-4 and Pant-5 recording the highest weed biomass, statistically at par with Pratigya and VC6173, while SML665 recorded the lowest. No significant differences in weed dry matter were observed for either spacing or variety at 60 DAS, indicating that early-stage canopy development and plant geometry play a more critical role in weed suppression than later growth stages, when canopy closure likely reduced weed growth. These findings align with Chauhan (2017), who reported that narrower row spacing in mung bean reduces weed biomass due to limited space and light availability for weed proliferation.

Table 6. Weed dry matter of mung bean as influenced by spacing and varieties at Sunwal, Nawalparasi 2024

Treatment	20 DAS	40 DAS	60 DAS
Spacing (cm)			
20×10	21.79^{a}	154.67^{a}	43.54
15×15	14.21^{b}	140.00^{b}	37.48
SEm (±)	3.79	7.34	3.03
LSD (= 0.05)	5.54	6.34	ns
CV, %	19.6	2.7	11.7
Varieties			
Pratigya	17.72^{ab}	148.14	41.44
BARI mung-4	19.17^{a}	148.03	39.59
Pant-5	18.77^{a}	149.63	39.15
SML665	16.15^{b}	149.68	42.83
VC6173	18.17^{ab}	141.20	39.54
SEm (±)	2.17	1.57	0.70
LSD (= 0.05)	5.4	ns	ns
CV, %	9.9	7.2	12.1
Grand mean	18.00	147.34	40.51

Note: CV, Coefficient of Variance; DAS, Days after Sowing; ns: Non-Significant; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance.

The weed dry matter of mung bean was significantly influenced by the interaction of spacing and varieties (Figure 3). At wider spacing i.e., 20 cm × 10 cm, Pant-5 had the highest weed dry matter and was statistically similar with BARI mung-4 and

VC6173. The weed dry matter at wider spacing was significantly higher than Pratigya and SML665. While at narrower spacing i.e., 15 cm × 15 cm, Pratigya had the highest weed dry matter and was statistically at par with BARI mung-4, Pant-5 and VC6173. The weed dry matter at narrower spacing was significantly higher than SML665.

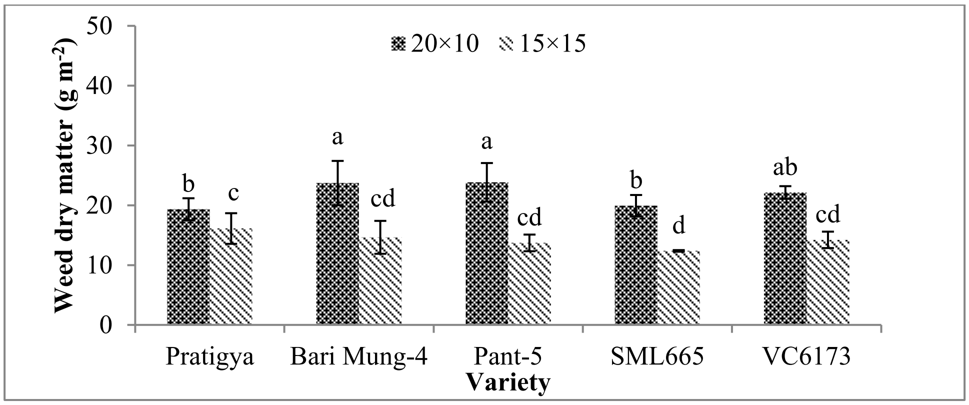

Fig. 3. Weed dry matter (g m^{-2}) of mung bean as influenced by spacing and varieties

Phenological parameter

Days to flowering

The days to flowering in mung bean were not significantly influenced by either plant spacing or varieties, with an average of 47.2 days (Table 7). This finding aligns with Neupane et al. (2023), who reported minimal effect of genotypic variation on physiological and harvest maturity stages under similar climatic conditions. The uniformity in flowering time across treatments suggests that environmental factors may have played a more dominant role than plant geometry or genetic variability in regulating reproductive onset in mung bean.

Yield attributing characters

Pods per plant and seeds per pod

Pods per plant and seeds per pod of the mung bean were not significantly influenced by either spacing or varieties (Table 7). Pods per plant ranged from 27.80 to 29.90 among varieties, while seeds per pod ranged from 10.90 to 11.13 across spacing and from 10.90 to 11.10 among varieties. These findings align with Neupane et al. (2023), who reported no significant effect of variety on pods per plant during total picking. This suggests that pod formation and seed setting were relatively stable across spatial arrangements and genetic backgrounds under the given environmental conditions, likely attributable to limited genotypic variability and consistent plant architecture among the tested varieties.

Pod weight (g)

Pod weight of mung bean was significantly influenced by varieties but not by spacing (Table 7). The highest pod weight was observed in variety VC6173, statistically at par with BARI mung-4, while the lowest pod weight was recorded in SML665. For spacing, pod weight ranged from 6.96 g (15 cm × 15 cm) to 7.05 g (20 cm × 10 cm), with no significant differences.

This is consistent with Gharti et al. (2014), who observed that varieties such as VC6173 and BARI mung-4 produced 10-50% larger seeds than local varieties, which may help explain the greater pod weight observed in the current study.

Thousand-seed weight (g)

Thousand-seed weight (TSW) of the mung bean was not significantly influenced by either spacing or varieties (Table 7). TSW ranged from 51.93 g to 53.73 g across spacing (15 cm × 15 cm and 20 cm × 10 cm, respectively), and from 51.33 g to 55.34 g across varieties, with BARI mung-4 and VC6173 representing the lower and upper ends of this range, respectively. This finding aligns with Neupane et al. (2023), who also reported no significant effect of variety on thousand-seed weight. This suggests that grain filling in mung bean may be governed more by intrinsic genetic factors than by pod weight or plant spacing, despite the significant varietal differences observed in pod weight.

Table 7. Days to flowering, pods per plant, seeds per pod, pod weight (g) and thousand-seed weight (g) of mung bean as influenced by spacing and varieties at Sunwal, Nawalparasi 2024

Treatment	Days to flowering	Pods per plant	Seeds per pod	Pod Weight (g)	TSW (g)
Spacing (cm)					
20×10	47.26	28.72	10.90	7.05	53.73
15×15	47.13	28.22	11.13	6.96	51.93
SEm (±)	0.06	0.24	0.11	0.04	0.9
LSD (= 0.05)	ns	ns	ns	ns	ns
CV, %	0.8	6.2	7.9	6.1	7.3
Varieties					
Pratigya	47.33	27.80	11.06	7.08^{ab}	53.16
BARI mung-4	47.00	28.06	11.06	7.47^{a}	51.33
Pant-5	47.00	27.96	10.96	6.63^{ab}	52.67
SML665	47.33	29.90	11.10	5.96^{b}	51.67
VC6173	47.33	28.63	10.90	7.90^{a}	55.34
SEm (±)	0.08	0.38	0.03	0.33	0.70

Treatment	Days to flowering	Pods per plant	Seeds per pod	Pod Weight (g)	TSW (g)
LSD (= 0.05)	ns	ns	ns	1.33	ns
CV, %	1.4	12.4	4.8	15.5	11.7
Grand mean	47.2	28.47	11.02	7.01	52.83

Note: CV, Coefficient of Variance; DAS, Days after Sowing; ns: Non-Significant; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance.

Seed yield

The seed yield of mung bean was significantly influenced by variety but not by plant spacing (Table 8). The highest yield was recorded in BARI mung-4, statistically at par with Pratigya, Pant-5 and VC6173, while the lowest yield was recorded in SML665. Seed yield ranged from 957.48 to 1151.34 Kg ha^{-1} across spacing, with no significant difference.

These results align with Umar and Iqbal (2007), who reported a positive correlation between seed yield and plant dry matter at maturity, indicating that increased biomass accumulation enhances economic yield by supporting reproductive development. Similarly, Gharti et al. (2014) found that varieties such as VC6173 and BARI mung-4 produced about 25% higher seed yield than local varieties, reflecting the genotypic influence on yield observed in the present study.

Stover yield

Stover yield of mung bean was significantly influenced by spacing but not by variety (Table 8). Significantly higher stover yield was recorded at the 20 cm × 10 cm spacing compared to 15 cm × 15 cm. Among varieties, stover yield ranged from 1818.00 Kg ha^{-1} (Pratigya) to 2140.33 Kg ha^{-1} (Pant-5), with no statistically significant differences. The greater stover yield at wider spacing may be attributed to reduced competition for nutrients and enhanced photosynthate accumulation due to better light penetration.

Harvest index

Harvest index was not significantly affected by either spacing or variety (Table 8). Harvest index values ranged from 0.44 to 0.49 across spacing and from 0.43 to 0.48 among varieties, indicating statistically similar partitioning of biomass to economic yield across all treatments.

Table 8. Seed yield, stover yield and harvest index of mung bean as influenced by spacing and varieties at Sunwal, Nawalparasi 2024

Treatment	Seed Yield (Kg ha^{-1})	Stover Yield (Kg ha^{-1})	Harvest Index
Spacing (cm)			
20×10	957.48	2090.60[a]	0.44
15×15	1151.34	1930.26[b]	0.49
SEm (±)	96.92	80.16	0.02
LSD (= 0.05)	ns	75.65	ns
CV, %	12.8	2.4	14.6
Varieties			
Pratigya	1042.63[ab]	1818.00	0.48
BARI mung-4	1148.65[a]	1990.50	0.48
Pant-5	1022.29[ab]	2140.33	0.43
SML665	954.00[b]	2078.50	0.44
VC6173	1104.49[ab]	2024.83	0.47
SEm (±)	33.64	54.37	0.01
LSD (= 0.05)	157.53	ns	ns
CV, %	12.2	19.7	13.2
Grand mean	1054.41	2010.44	0.46

Note: CV, Coefficient of Variance; DAS, Days after Sowing; ns: Non-Significant; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance.

The seed yield of mung bean was significantly influenced by the interaction between spacing and variety (Figure 4). At narrower spacing i.e., 15 cm × 15 cm, Pratigya produced the highest seed yield which was statistically similar with VC6173, Pant-5 and BARI mung-4. While at wider spacing i.e., 20 cm × 10 cm, BARI mung-4 produced the highest seed yield which was statistically at par with VC6173 and Pant-5, and was significantly higher than Pratigya.

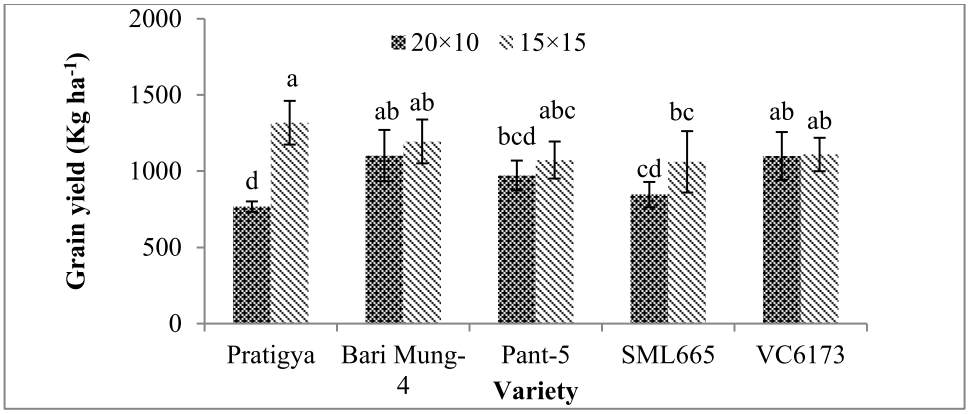

Fig. 4. Seed yield of mung bean as influenced by spacing and varieties

Profitability analysis

The financial parameters of mung bean, including gross return, gross margin and the benefit-cost (B:C) ratio, were not significantly influenced by spacing or varieties (Table 9). Across spacing, gross return ranged from NRs. 537,168.1 ha^{-1} to NRs. 585,192.3 ha^{-1}, gross margin ranged from NRs. 141,334.7 ha^{-1} to 204,405.3 ha^{-1} and the B:C ratio ranged from 1.36 to 1.49. Among varieties, gross return ranged from NRs. 537,454.2 ha^{-1} (Pratigya) to 582,742.5 ha^{-1} (BARI mung-4), gross margin ranged from NRs. 161,296.8 ha^{-1} (Pratigya) to 196,764.4 ha^{-1} (VC6173) and the B:C ratio ranged from 1.38 (BARI mung-4) to 1.53 (VC6173). Although these differences were not statistically significant, the numerically higher gross margin and B:C ratio recorded for VC6173 suggest a relatively favorable cost-return balance for this variety under the conditions of Nawalparasi West.

Table 9. Profitability of mung bean as influenced by spacing and varieties at Sunwal, Nawalparasi, 2024

Treatment	Gross return (NRs ha^{-1})	Gross margin (NRs ha^{-1})	B:C Ratio
Spacing (cm)			
20×10	537,168.1	141,334.7	1.36
15×15	585,192.3	204,405.3	1.49
SEm (±)	24,012.11	31,535.26	0.064
LSD (= 0.05)	ns	ns	ns
CV, %	15	49	23
Varieties			
Pratigya	537,454.2	161,296.8	1.39
BARI mung-4	582,742.5	161,735.5	1.38

Treatment	Gross return (NRs ha^{-1})	Gross margin (NRs ha^{-1})	B:C Ratio
Pant-5	543,750.9	161,806.5	1.39
SML665	573,371.7	182,746.7	1.43
VC6173	568,581.5	196,764.4	1.53
SEm (±)	8,760.83	7,241.57	0.028
LSD (= 0.05)	ns	ns	ns
CV, %	10.4	34	12.8
Grand mean	561,180.2	172,870	1.42

Note: CV, Coefficient of Variance; DAS, Days after Sowing; ns: Non-Significant; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance.

Conclusion

This study aimed to identify the optimal spacing and high-yielding mung bean varieties to enhance productivity and profitability in western Terai, Nepal. The results showed that seed yield was significantly influenced by variety, with BARI mung-4 recording the highest and SML665 the lowest yield overall. The significant spacing × variety interaction further revealed that BARI mung-4 and VC6173 performed best under wider spacing, while Pratigya performed best under narrower spacing, highlighting the need for variety-specific decisions. Wider spacing (20×10 cm) significantly improved vegetative growth, including plant height, leaves and dry matter accumulation, though this did not translate into a significant seed yield response. Profitability parameters did not differ significantly across treatments, although VC6173 numerically recorded the highest gross margin and benefit-cost ratio. Based on these findings, BARI mung-4 is recommended under 20 cm × 10 cm spacing, while Pratigya is recommended under 15 cm × 15 cm spacing to optimize mung bean yield and profitability under the agro-climatic conditions of western Terai, Nepal.

Acknowledgement

The authors wish to express their profound gratitude to the entire Agriculture Department of Sunwal Municipality and Ramnagar Technical and Management College, Agriculture and Forestry University (AFU) for their invaluable assistance in providing essential resources to complete this research. We would also like to acknowledge Mr. Sushil Neupane and Mr. Ajay B.K. for their assistance during various fieldwork activities.

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