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Influence of genotypes and row spacing on growth, forage yield and seed quality of Desmanthus (*Desmanthus virgatus* (L.) Willd.)

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Abstract
The field experiment was conducted during the Kharif season of 2024 at the Grass Breeding Scheme, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahilyanagar (Maharashtra) to evaluate the influence of genotypes and row spacing on growth, forage yield and seed quality of Desmanthus (*Desmanthus virgatus* (L.) Willd.). The treatments consisted of four genotypes (V1: RHDV-19-4, V2: RHDV-19-10, V3: RHDV-19-11, V4: RHDV-19-13) and three row spacings (S1: 30 cm, S2: 45 cm, S3: 60 cm) laid out in a Factorial Randomized Block Design (FRBD) with three replications. The genotype RHDV-19-4 (V1) consistently outperformed the other genotypes, recording the higher green fodder yield (238.91 q ha^{-1}), dry matter yield (74.59 q ha^{-1}), crude protein yield (14.55 q ha^{-1}), crude protein content (19.48%) and dry matter percentage (31.07%). With respect to spacing, the wider row spacing of 60 cm (S3) proved most favorable for forage production, registering the higher green fodder yield (259.15 q ha^{-1}), dry matter yield (79.59 q ha^{-1}) and crude protein yield (15.20 q ha^{-1}). However, genotype × spacing interaction for forage traits was statistically non-significant. For seed yield, V1 (RHDV-19-4) recorded the higher mean seed yield (187.30 kg ha^{-1}), while the spacing of 45 cm (S2) proved optimal (174.46 kg ha^{-1}). The genotype × spacing interaction was significant, with V1 (RHDV-19-4) at 30 cm spacing (S1) producing the maximum absolute seed yield (190.60 kg ha^{-1}). In terms of seed quality, wider spacing (60 cm) recorded superior performance in 1000-seed weight (4.88 g), germination percentage (91.84%) and seedling vigour indices (SVI-I: 969.17; SVI-II: 1993.39). Genotype V1 (RHDV-19-4) also exhibited the best seedling vigour (SVI-I: 929.39; SVI-II: 1924.33). It can be concluded that Desmanthus genotype RHDV-19-4 sown at 30 cm spacing is most suitable for quality seed production, while the same genotype at 60 cm spacing is ideal for achieving higher green forage yield during the Kharif season.

Keywords: Desmanthus, Genotypes, Row spacing, Forage yield, Seed yield, Seed quality, Seedling vigour

Introduction
Livestock rearing and agriculture are closely interlinked in India, forming the foundation of rural livelihoods and serving as vital sources of income and nutritional security (Saxena *et al*., 2020) [25]. Mixed crop livestock farming systems, which integrate crop production with animal husbandry, are a defining feature of Indian agriculture and play a critical role in sustaining smallholder farmers (Herrero *et al*., 2010) [11]. Despite India's leading position in global milk production and livestock numbers, the sector continues to face a persistent challenge in the form of feed and fodder scarcity (Roy *et al*., 2021) [23]. Current estimates reveal a 35.6% deficit in green fodder, 10.5% in dry crop residues, and as high as 44% in concentrate feed ingredients, severely constraining livestock productivity and profitability (Parthasarathy, 2024) [22]. The limited allocation of cultivable land for fodder production, with only about 4% devoted to this purpose, further aggravates the deficit. Addressing this fodder gap requires the strategic cultivation of high-yielding, nutritious, and climate-resilient forage crops (Mitra *et al*., 2024) [19]. Among various forage legumes, *Desmanthus virgatus* (L.) Willd., commonly known as hedge lucerne, has emerged as a promising perennial fodder species due to its adaptability, persistence, and nutritional value.

It is well-suited to tropical and subtropical climates, demonstrates exceptional drought tolerance through its deep root system, and can establish on marginal soils with low fertility (Maass *et al*., 2019) [17]. Additionally, Desmanthus contributes to sustainable agriculture through biological nitrogen fixation, improving soil fertility and reducing the dependence on synthetic fertilizers (Giller, 2001) [10]. Its resilience to adverse factors such as drought, frost, fire, and poor soil conditions enhances its suitability for dryland farming systems (Francis, 2003) [9]. Nutritionally, Desmanthus forage is highly palatable, rich in crude protein, and maintains its feeding value over extended periods compared to grasses, making it particularly useful during dry seasons when the nutritive value of other fodder species declines. It also supports improved digestibility and reduces reliance on costly concentrate feeds (Kuchenmeister *et al.*, 2013 & Charmley *et al.*, 2025) [15, 6]. Furthermore, the crop exhibits good seed production potential, ensuring ease of propagation and scope for wider adoption among smallholder farmers (Hopkinson & English, 2004) [12].

The species possesses considerable genetic diversity across accessions, which influences traits such as plant height, tillering ability, biomass production, and seed yield (Costa *et al*., 2017; Calado *et al*., 2016) [7, 5]. Harnessing this diversity offers opportunities for selection and breeding of superior genotypes suited to different environments (Humphreys, 1975) [13]. Alongside genetic factors, agronomic practices such as row spacing significantly influence crop performance by affecting light interception, resource use, and plant architecture (Donald, 1963; Willey & Heath, 1969) [8, 27]. Closer spacing often favors early canopy cover and biomass accumulation, while wider spacing may improve individual plant growth, root development, and seed quality. However, genotype-specific responses to plant density remain underexplored in Desmanthus, particularly under Indian semi-arid conditions (Kavita *et al*., 2015) [14].Although several studies have established the potential of Desmanthus as a valuable forage legume, limited information is available on the combined influence of genotype and spacing on growth, forage yield, and seed quality. Generating such knowledge is essential for developing tailored agronomic recommendations to optimize fodder production, enhance nutritional quality, and ensure sustainable seed propagation for wider adoption of superior genotypes. Therefore, the present investigation entitled “Effect of Genotypes on Growth, Yield and Seed Quality of Desmanthus [*Desmanthus virgatus* (L.) Willd.]” was undertaken during the Kharif season of 2024 at MPKV, Rahuri, to study the interactive effects of genotypes and row spacings on the crop’s performance.

Materials and Methods

The field experiment entitled “Effect of Genotypes on Growth, Yield and Seed Quality of Desmanthus [*Desmanthus virgatus* (L.) Willd.]” was carried out during the Kharif season of 2024 at the Grass Breeding Scheme, Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri. The experiment was laid out in a Factorial Randomized Block Design (FRBD) with three replications. The treatments included Genotypes: V1 (RHDV-19-4), V2 (RHDV-19-10), V3 (RHDV-19-11), V4 (RHDV-19-13) Row spacings: S1 (30 cm), S2 (45 cm), S3 (60 cm) Row spacings: S1 (30 cm), S2 (45 cm), S3 (60 cm). The recommended package of practice was undertaken for conduct of experiment. Growth and yield parameters: Plant height (before forage cut and at seed harvest), Number of tillers per plant (before forage cut and at seed harvest), Number of branches per plant, Green forage yield (q ha^{-1}), Dry matter yield (q ha^{-1}), Crude protein yield (q ha^{-1}), Dry matter content (%), Crude protein content (%), Seed yield (kg ha^{-1}). The seed quality parameters viz., 1000-seed weight (g), Germination (%) worked out as per ISTA rules (Anon., 2010), Seedling shoot and root length (cm), Seedling dry weight (mg), Vigour indices (I and II) were computed by adopting the formula as suggested by Abdul Baki and Anderson (1973). Data were analyzed using analysis of variance (ANOVA) as per the procedure of Steel and for FRBD. The critical difference (CD) was worked out at 5 % level significance.

Table : 1 Effect of *Desmanthus* genotypes and Spacings on Growth and yield parameters during *Kharif* season

Treatments	Plant height before cutting (cm)	No. of tillers per plant before cutting	No. of branches per plant	GFY (q ha^{-1})	DMY (q ha^{-1})	CPY (q ha^{-1})	Dry matter %	Crude protein %	Plant height at harvesting of seed (cm)	No. of tillers per plant at harvesting of seed	Seed yield (kg ha^{-1})
A) Genotypes											
V_1 - RHDV-19-4	135.63	12.76	17.87	238.91	74.59	14.55	31.07 (33.88)	19.48 (26.19)	99.11	11.16	187.30
V_2 - RHDV-19-10	116.85	10.48	15.35	206.60	59.51	10.67	28.67 (32.37)	17.83 (24.98)	83.01	9.58	140.48
V_3 - RHDV-19-11	132.82	12.41	17.41	234.08	68.36	12.37	29.21 (32.71)	18.08 (25.17)	96.70	10.92	178.52
V_4 - RHDV-19-13	120.09	10.64	16.09	212.18	64.34	12.08	30.23 (33.36)	18.62 (25.56)	85.79	9.70	151.18
S.E.(m)±	3.43	0.39	0.51	7.25	2.56	0.43	0.45 (3.82)	0.27 (2.96)	3.06	0.36	5.29
CD at 5%	10.07	1.15	1.50	21.26	7.50	1.26	1.30 (6.56)	0.79 (5.08)	8.97	1.06	15.52
B) Spacings											
S_1 - 30cm	147.40	9.09	14.17	188.05	54.59	9.66	28.93 (32.54)	17.65 (24.84)	109.20	8.35	157.16
S_2 - 45cm	125.58	11.35	16.63	221.62	65.93	12.40	29.77 (33.07)	18.78 (25.68)	90.50	10.05	174.46
S_3 - 60cm	106.06	14.27	19.23	259.15	79.59	15.20	30.69 (33.64)	19.08 (25.90)	73.77	12.62	161.50
S.E.(m)±	2.97	0.34	0.44	6.277	2.22	0.37	0.39 (3.56)	0.23 (2.76)	2.65	0.31	4.58

CD at 5%	8.72	0.10	1.30	18.41	6.50	1.09	1.13 (6.10)	0.68 (4.73)	7.77	0.92	13.44
Interaction											
S.E.(m)±	5.95	0.68	0.89	12.55	4.43	0.75	0.77 (5.03)	0.46 (3.90)	5.30	0.63	9.17
CD at 5 %	NS	1.99	2.60	NS	NS	NS	NS	NS	NS	1.83	26.88

*Figures in parenthesis indicate arcsine transformed values.

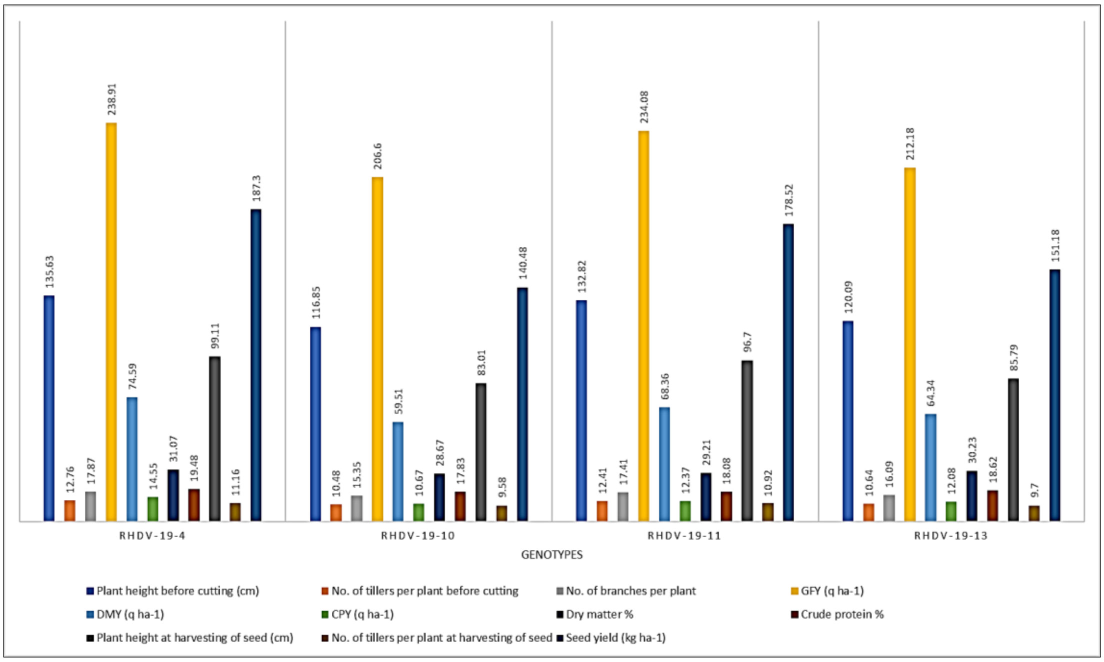

Fig 1: Effect of *Desmanthus* genotypes on Growth and yield parameters during *Kharif* season

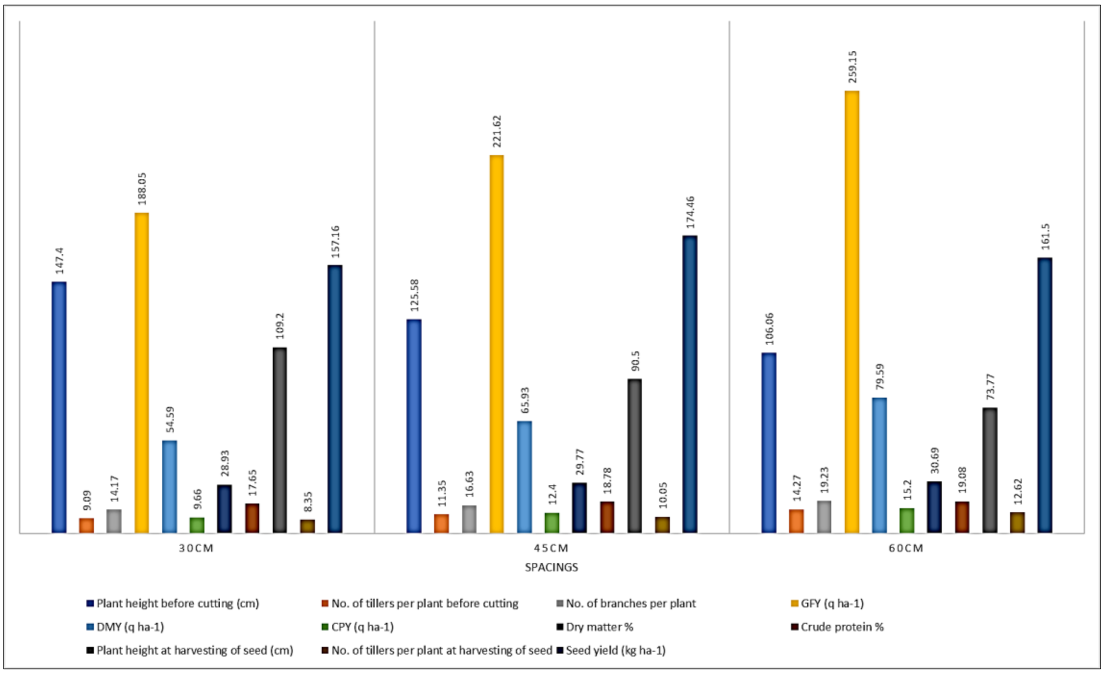

Fig 2: Effect of Spacings on Growth and yield parameters during *Kharif* season

Table 2: Effect of *Desmanthus* genotypes and Spacings on Seed quality parameters during *Kharif* season

Treatments	**1000 seed weight (g)**	**Seed germination %**	**Seedling shoot length (cm)**	**Seedling root length (cm)**	**Seedling dry weight (mg)**	**Seedling Vigour index I**	**Seedling Vigour index II**
A) Genotypes							
V_1 - RHDV-19-4	4.54	89.34 (70.95)	5.86	4.53	21.52	929.39	1924.33
V_2 - RHDV-19-10	4.04	87.16 (69.00)	5.69	3.72	19.69	821.29	1720.54
V_3 - RHDV-19-11	4.42	89.82 (71.40)	5.36	3.91	20.70	834.26	1859.98
V_4 - RHDV-19-13	4.11	86.60	6.48	3.83	21.08	894.35	1827.54

		(68.53)					
S.E.(m)±	0.06	0.89 (5.41)	0.11	0.06	0.32	12.57	34.37
CD at 5%	0.17	2.60 (9.28)	0.33	0.16	0.93	36.87	100.79
B) Spacings							
S_1 - 30cm	3.72	84.75 (67.02)	5.51	3.84	20.00	791.76	1695.58
S_2 - 45cm	4.23	88.10 (69.82)	5.70	3.94	20.55	848.54	1810.32
S_3 - 60cm	4.88	91.84 (73.40)	6.35	4.21	21.70	969.17	1993.39
S.E.(m)±	0.05	0.77 (5.03)	0.10	0.05	0.27	10.89	29.76
CD at 5%	0.15	2.25 (8.64)	0.28	0.14	0.80	31.93	87.29
Interaction							
S.E.(m)±	0.10	1.54 (7.12)	0.19	0.10	0.55	21.77	59.52
CD at 5 %	0.29	NS	NS	NS	NS	NS	NS

*Figures in parenthesis indicate arcsine transformed values.

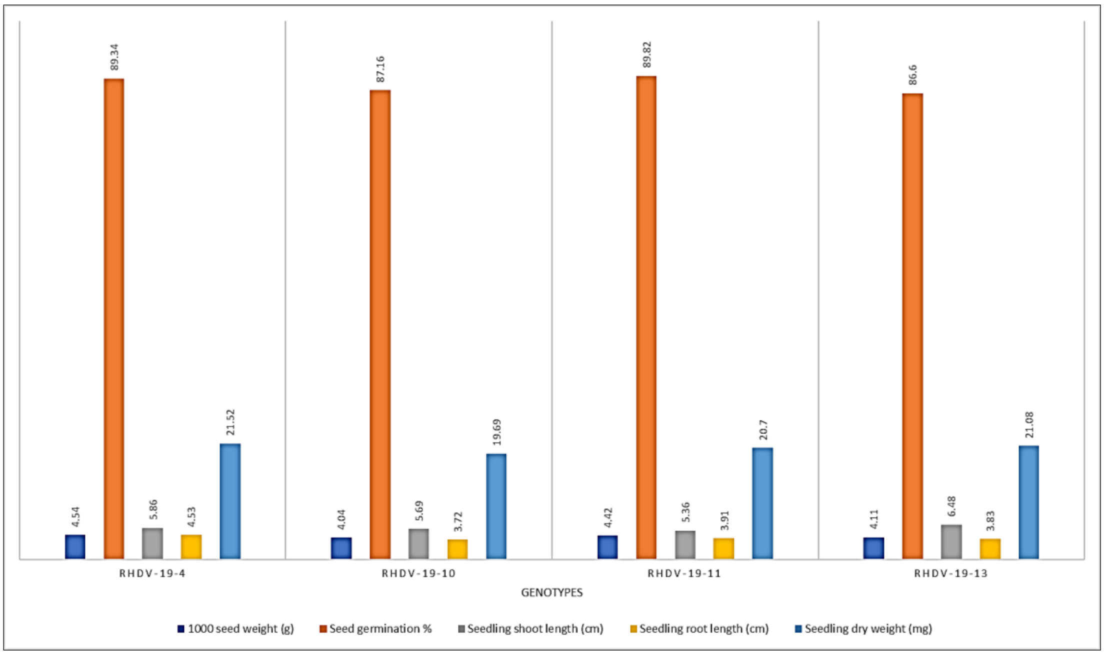

Fig 3: Effect of *Desmanthus* genotypes on Seed quality parameters during *Kharif* season

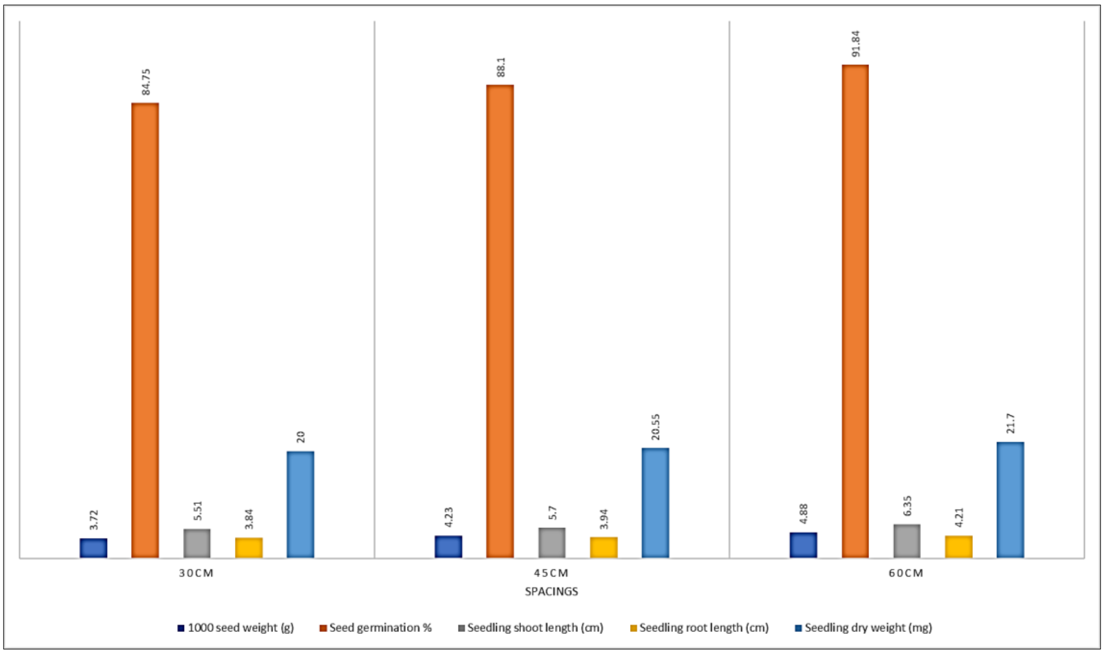

Fig 4: Effect of Spacings on Seed quality parameters during *Kharif* season

Result and Discussion

Growth and Yield Parameters

Significant variation was observed among genotypes and row spacings. Genotype V1 (RHDV-19-4) recorded the taller plants (135.63 cm), statistically comparable with RHDV-19-11 (132.82 cm), while RHDV-19-10 registered the shorter (116.85 cm). Among spacings, 30 cm (S1) produced the taller plants (147.40 cm), whereas wider spacing of 60 cm (S3) resulted in shorter plants (106.06 cm). This trend reflects the shade avoidance mechanism under denser planting, where competition for light induces elongation growth (Buxton, 2001; Yadav, 2003). Interaction effects were non-significant, suggesting consistent genotype performance across spacings. Genotype RHDV-19-4 (12.76) produced the maximum tillers per plant, on par with RHDV-19-11 (12.41). Wider spacing of 60 cm (S3) recorded the higher tiller number (14.27), while closer spacing suppressed tillering (9.09). Significant genotype × spacing interaction revealed that RHDV-19-4 at 60 cm spacing (14.54 tillers) expressed superior performance. Increased tillering under wider spacings is attributed to reduced apical dominance and improved resource availability, aligning with Singh (2000). Branching ability differed significantly among genotypes. RHDV-19-4 (17.87) and RHDV-19-11 (17.41) were superior, while RHDV-19-10 recorded the lower (15.35). Wider spacing of 60 cm promoted higher branching (19.23), confirming the role of reduced competition in enhancing lateral growth (Ali *et al*., 2009; Satpal *et al*., 2018) [24]. Interaction effects showed that RHDV-19-13 at 60 cm spacing (19.92) recorded the maximum branches. Genotypes RHDV-19-4 (238.91 q ha⁻¹) and RHDV-19-11 (234.08 q ha⁻¹) outperformed others. Spacing significantly influenced fodder yield, with wider spacing (60 cm) producing the maximum (259.15 q ha⁻¹). Although plant population density was lower, enhanced per-plant biomass compensated for yield loss. Similar observations were reported by Bode *et al*. (2018) [3]. Genotype × spacing interaction was non-significant. RHDV-19-4 (74.59 q ha⁻¹) produced the maximum DMY, followed by RHDV-19-11 (68.36 q ha⁻¹). Wider spacing of 60 cm yielded significantly higher dry matter (79.59 q ha⁻¹). The improvement is linked to greater leaf area, better photosynthetic activity, and resource utilization under wider spacing (Afolami, 2014; Mekonen *et al*., 2021) [1, 18]. Interaction effect was non-significant. RHDV-19-4 (14.55 q ha⁻¹) registered the highest CPY. Among spacings, 60 cm produced significantly more protein yield (15.20 q ha⁻¹). The increase is attributed to higher biomass production and efficient N assimilation (Zheng *et al*., 2016) [29]. Interaction was non-significant. Genotype RHDV-19-4 recorded the maximum DM% (31.07), while wider spacing of 60 cm also produced significantly higher values (30.69%). Higher DM% under wider spacing is due to improved canopy aeration and greater carbohydrate accumulation (Muttappanavar and Shekara, 2023) [21]. RHDV-19-4 was superior with 19.48% protein, significantly higher than all other genotypes. Spacing of 60 cm enhanced CP% (19.08), with decreasing trend under narrower spacings. Similar findings were reported by Kurubetta *et al*. (2006) and Mekonen *et al*. (2022) [16, 18]. RHDV-19-4 (99.11 cm) and RHDV-19-11 (96.70 cm) were taller, while closer spacing (30 cm) produced taller plants (109.20 cm) due to shade avoidance response. Interaction was non-significant. Genotypes differed significantly, with RHDV-19-4 (11.16) producing maximum tillers. Wider spacing of 60 cm promoted tillering (12.62). Significant interaction showed RHDV-19-13 (12.94) and RHDV-19-4 (12.83) at 60 cm spacing gave higher values. RHDV-19-4 (187.30 kg ha⁻¹) was superior, followed by RHDV-19-11 (178.52 kg ha⁻¹). Spacing of 45 cm produced the maximum seed yield (174.46 kg ha⁻¹), indicating its suitability for reproductive efficiency. Significant interaction showed RHDV-19-4 × 30 cm (190.60 kg ha⁻¹) as the best combination.

Seed Quality Parameters

Genotype RHDV-19-4 (4.54 g) recorded maximum test weight, on par with RHDV-19-11 (4.42 g). Spacing of 60 cm promoted higher seed weight (4.88 g). Interaction revealed RHDV-19-11 × 60 cm (5.06 g) as the best combination. RHDV-19-11 (89.82%) and RHDV-19-4 (89.34%) exhibited superior germination. Wider spacing of 60 cm resulted in the higher germination (91.84%), reflecting better seed development. Interaction was non-significant. Genotype RHDV-19-13 (6.48 cm shoot length) and RHDV-19-4 (4.53 cm root length) performed best. Wider spacing (60 cm) significantly improved both shoot (6.35 cm) and root length (4.21 cm), attributed to superior maternal environment. RHDV-19-4 recorded maximum dry weight (21.52 mg). Wider spacing (60 cm) produced superior seedlings (21.70 mg). Interaction effect was non-significant. Seedling vigour index I was highest in RHDV-19-4 (929.39), while spacing of 60 cm (969.17) significantly enhanced vigour. Similarly, seedling vigour index II was maximum in RHDV-19-4 (1924.33) and at 60 cm spacing (1993.39). Interaction effects were non-significant.

Conclusion

The genotype V1 (RHDV-19-4) was identified as the most promising, as it consistently recorded superior growth parameters such as greater plant height, higher tiller and branch numbers, and produced maximum green fodder yield, dry matter yield, crude protein yield, and seed yield. Among the spacings, 60 cm proved most effective for fodder yield and seed quality, while 45 cm spacing was optimal for seed yield. The interaction of RHDV-19-4 with 30 cm spacing recorded the higher seed yield. Genotype RHDV-19-4 also excelled in seed quality attributes, showing maximum vigour indices, whereas genotype V3 (RHDV-19-11) recorded the higher germination percentage.

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