

# Yield and growth performance of selected vetch species under rain-fed conditions at three locations of Dessie Zuria District, Amhara Region, Ethiopia

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## Research and Full Length Article

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## Abstract:

This study was designed to investigate adaptation of five vetch species in terms of their growth and yield performance under rain fed conditions at Dessie Zuria district, South Wollo Zone, Amhara Region, Ethiopia. An experimental trial was conducted using a randomized complete block design with four replications on three locations of Gelisha, Teabsite and Adey in 2021. The collected data were analyzed using SAS Software and means comparison was made using the Tukey method. Data were collected for day to seedling emergence, days to maturity, pods number per plant, branches number per plant, plant height, thousand seed weight, grain yield and biomass yield. Results showed significant differences between locations for days to emerge, days to maturity, plant height, 1000 grains weight and grain yield, Significant differences were observed between species for all the traits ( $P < 0.01, 0.05$ ). The species  $\times$  location interaction effect was significant for days to seedling emerge ( $P < 0.05$ ). For maturity date, *Vicia dasycarpa* and *V. villosa* with 143.33 and 176.33 days to maturity were as early and late maturing species, respectively. For branches number per plant, the highest and lowest values of 7.84 and 3.83 were obtained in *V. dasycarpa* and *V. villosa*, respectively. The higher number of pods per plant was obtained in *V. benghalensis*. The highest numbers of seeds per pod and thousand seeds weight were recorded in *V. dasycarpa*. For plant height, the higher and lower values of 147.57 and 104.25 cm were obtained in *V. dasycarpa* and *V. benghalensis*, respectively. The grain yield ranged from 565 and 294 kg/ha. The herbage yield ranged from 17.49 to 31.39 t/ha. In comparison between locations, the higher values of all traits were obtained in Gelisha. Based on yield and growth performance, the species of *V. kohak* and *V. dasycarpa* were recommended for cultivation in Dessie Zuria district.

**Keywords:** Yield; Vetch species; Rain-fed Conditions; Ethiopia

## 1. Introduction

In many developing countries, livestock play an important role in the livelihoods of most small-scale farmers as sources of food in the form of meat and milk, services (transport and draught power), cash income, manure (for soil fertility management and fuel) and as store of wealth and hedge against inflation (Sere et al., 2008). Ethiopia has a huge livestock population in Africa estimated about 70 million heads of cattle, 42.9 million sheep, 52.40 million goats, 10.8 million donkeys, 2.5 million horses, 0.38 million mules, 8.1 million camels, 56.9 million chickens and 6.98 million beehives

(CSA, 2021).

The livestock subsector has an enormous contribution to Ethiopia's national economy and livelihoods of many Ethiopians. However, the productivity of the livestock resources and the benefits obtained from the sector do not proportionate with the high livestock population due to various constraints that include poor nutrition and disease prevalence (Asfaw et al., 2011; Alemayehu and Getnet, 2012). Among these constraints, the issues related to feed shortage are the most severe ones in livestock farming in almost all parts of Ethiopia (Adugna, 2007). Livestock feed

resources in Ethiopia are 54.54% mainly grazing, 31.13% crop residue, 7.35% hay, 2.03% agro-industrial by products, 4.37% concentrate 0.57% improved fodder/pasture (CSA, 2021). The majority livestock production system in Ethiopia mainly depends upon the poor pastureland and crop residues, which are usually insufficient to support the best production because of these sources of forage, has low protein, energy, vitamin, mineral and poor digestibility (CSA, 2021). One of the alternatives to improve livestock feeding and thereby their productivity could be the cultivation of improved forage and offer to animals during critical periods in their production cycle when other sources of feeds are in short supply (Getnet and Ledin, 2001). Introduction of cultivated fodder legumes such as vetch in the mixed crop livestock production with crop dominated farming system is a key factor to improve both the quality and quantity of livestock feed resource (Eshetie et al., 2018). Smallholder farmers in Dessie Zuria have depended on mixed crop-livestock subsistence farming as a means of survival for many years. Livestock provides these farmers meat and milk, draught power for crop cultivation and transport, and also can be sources of organic fertilizers as well as an important asset that could be converted to monetary means during abed times to avert risks. Natural pasture and crop residues which provide the bulk of livestock feed are poor in quality. As a result, their intake is limited and it is difficult to fulfill the maintenance requirements of livestock (DZWAO, 2022). In order to mitigate such nutritional issues and improve the livestock productive performance of *Dessie Zuria* district, it is imperative to introduce different cultivars of vetch forage crops and evaluate the high-quality and yield of vetch species in the existing crop-livestock production system. Therefore, the objectives of this study were to investigate productive and adaptive vetch species in terms of their growth and yield performance under rain fed conditions at Dessie Zuria district, South Wollo Zone, Ethiopia.

## 2. Materials and methods

### 2.1 Geographic location of the study area

The study was conducted in *Dessie Zuria* District, South Wollo Zone, Amhara Regional state. The study area is bordered in the North by *Kutaber*, in the South by *Albiko* and *Woreilla*, in the East by *Qallu* district and in the West by *Tenta* and *Legambo* districts (DZWAO, 2022). The district is geographically located between 11°09'60" N to 11°15'0" N latitude and 39°19'60" E to 39°45'0" E longitude and Altitude of the district ranges from 1600 to 3800 m (asl) (Fig. 1) (DZWAO, 2022). The livestock population of the district is 110,867 cattle, 154,136 Sheep, 48072 goats, 166,717 chickens, 42,930 equine and 5,106 honeybee hives. The major feed resources in the area are natural pasture, crop residues and improved forage (DZWAO, 2022). The rainfall pattern is bimodal relying on the short rain from mid-January to March, and in the summer, it rains from mid-June to mid-September (DZWAO, 2022). The annual mean rainfall is 1072 mm, and annual temperature ranges from 15.1 °C to 27.5 °C (DZWAO, 2022).

### 2.2 Experimental Design

The study was conducted at three locations (Teabsite, Adey and Gelisha) with five vetch species, namely; *Vicia villosa*, *V. dasycarpa*, *V. benghalensis*, *V. kohak*, and *V. sativa*. The vetch species seed was provided from *Debrebrahan* Agricultural Research Center and the *V. sativa* was provided from *Dessie Zuria* local farmer. The experimental treatments were laid out using the Randomized Complete Block Design (RCBD) with four replications, each block had five experimental units (plots), and each treatment was randomly assigned to each. The spacing between blocks and plots was 1.5m and 1m, respectively. The plot size of each experimental units was 7.2 m<sup>2</sup> (2.4×3 m) (Aklilu and Alemayehu, 2007) and the seed was uniformly drilled with an intra-row spacing of 30 cm. The seeds of species were sown according to their recommended seeding rates; 30 kg/ha for *V. villosa*, *V. dasycarpa* (Gezahagn et al., 2013);

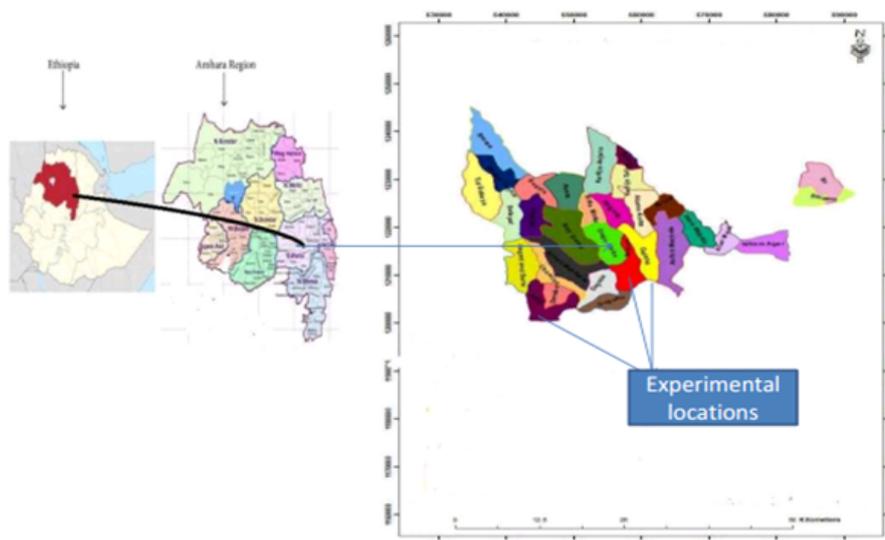


Figure 1. Map of the study area.

25 kg/ha for local species (*V. sativa*) and *V. benghalensis* (Alemu, 2019) and 40 kg/ha for *V. kohak* (Zulfiqar et al., 2006). Sowing time was done at the 20th May 2021 when the rain was assured for successful germination.

### 2.3 Data Collection

Generally, each plot had  $2.4 \times 3\text{m}$  ( $7.2\text{ m}^2$  area), eight rows per each plot. The two rows next to the boarder rows were used for green forage yield similarly, the two rows prior to two middle rows were used to collect data on number of branches per plant, plant height, number of pods per plant, number of seeds per pod and 1000 seeds weight. The remaining two rows (middle) were for determination of seed yield. Half of the plants in the plot set flower were counted from days of sowing to the date when plants reach its own growth stage. Six plants were randomly taken from each plot and their height from the ground to the tip of the plant was recorded at the time of 50% flowering, thereafter the average values were estimated. Number of pods per plant and number of seeds per pod were estimated using six plants that were randomly taken and uprooted at seed ripening stage. For the number of pods, six pods were randomly taken and seeds number per pod were counted. For number of branches per plant, at 50% flowering stage, six plants were randomly taken per plot, and the average results from each measurement were recorded. The biomass yield was recorded at 50% flowering stage for each plot in the field immediately using a 0.1 g scale of a balance. Vetch species was harvested at ground level at the optimum seed harvesting time and total seed yield was determined threshing with sack and winnowing.

### 2.4 Statistical Analysis

Analysis of variance (ANOVA) procedures using the general linear model (GLM) of SAS 9.1 2008 software were used.

The F-test for homogeneity of variance was carried out. Tukey multiple comparison test at the 5% significance level was used for comparison of treatment means.

## 3. Result and Discussion

### 3.1 ANOVA and means of vetch species

Results showed significant differences between locations for day to emerge, days to maturity, plant height, 1000 grains weight and grain yield and significant differences between species for all the traits ( $P < 0.01, 0.05$ ). The species  $\times$  location interaction effect was significant for day to emerge, days to maturity and grain yield ( $P < 0.01, 0.05$ ) (Table 1). The highest number of seeds per pod was recorded in Gelisha experimental location whereas the lowest number of seeds per pods was recorded in Adey experimental location (Table 2). This experimental locations had a relative elevation difference; increment of the elevation led to raise occurrence of the frost. The highest number of branches was recorded in Gelisha, however, there was no significant difference between Tebasite and Adey locations (Table 2). This could be due to elevation differences. The highest plant height (136cm) was recorded in Gelisha, whereas the shortest plant height (115cm) was recorded in Adey experimental location (Table 2); this could be attributed to the difference of elevation and soil fertility.

The result of ANOVA showed that there was a significant difference for all the traits in vetch species (Table 1). The early date of seedling emergence was recorded in *V. villosa* (7.5 days) than the other vetch species. The variation in the date of seedling emergence of vetch species could be due to seasonal variation and genotypes of vetch species (Table 3). *V. dasycarpa* was of early maturing (143.3 days) significantly whereas *V. kohak* (160.9 days) and (158.8 days) were an intermediate maturing and *V. villosa* (176.2 days)

**Table 1.** Combined ANOVA for yield and growth performance of five vetch species in three locations.

SOV	DF	Day to emerge	Days to maturity	Pod no. per plant	Branch no. per plant	Plant height	Seed number per pod	1000 grain weight	Grain yield	Biomass yield
Location	2	**	**	ns	ns	*	ns	**	**	ns
Species	4	**	**	**	**	**	**	**	*	**
Species $\times$ Location	8	*	ns	ns	ns	ns	ns	ns	ns	ns

ns, \*, \*\*: not significant and significant at 5% and 1% probability level, respectively.

**Table 2.** Means comparisons between locations for yield and growth performance.

Location	Day to emerge	Days to maturity	Pod no. per plant	Branch no. per plant	Plant height (cm)	Seed number per pod	1000 grain weight (g)	Seed yield (kg/ha)	Biomass yield (ton/ha)
Adey	16.0 a	169.40 a	39.83 a	5.31 a	115.91 b	2.71 a	44.27 b	391 b	27.34 a
Tebasite	15.0 a	162.85 a	40.56 a	5.77 a	127.60 ab	3.04 a	48.91 ab	443 a	27.48 a
Gelisha	12.9 b	154.15 b	42.21 a	6.39 a	136.72 a	3.21 a	54.73 a	456 a	29.18 a

Means of column followed by the same letters do not differ by the Tukey test ( $P < 0.05$ ).

**Table 3.** Means comparisons between species.

Species name	Day to emerge	Days to maturity	Pod no. per plant	Branch no. per plant	Plant height (cm)	Seed no. per pod	1000 grain weight (g)	Grain yield (kg/ha)	Biomass yield (ton/ha)
<i>V. villosa</i>	7.58 c	176.25 a	30.19 c	3.83 c	125.59 b	2.48 c	41.93 c	294 c	27.09 b
<i>V. benghalensis</i>	17.25 a	170.33 a	56.38 a	3.70 c	104.25 c	2.57 c	30.49 d	343 c	17.49 c
<i>V. dasycarpa</i>	14.58 b	143.33 c	43.95 b	7.84 a	147.57 a	3.62 a	66.78 a	5.65 a	32.91 a
<i>V. kohak</i>	16.50 a	160.91 b	32.48 c	7.61 a	125.63 b	2.99 b	51.05 b	419 b	35.69 a
<i>V. sativa</i>	17.41 a	158.83 b	38.78 b	6.14 b	130.75 b	3.00 b	56.27 b	526 a	26.84 b
<b>Mean</b>	<b>14.66</b>	<b>161.93</b>	<b>40.36</b>	<b>5.82</b>	<b>126.76</b>	<b>2.93</b>	<b>49.30</b>	<b>429</b>	<b>28.00</b>

Means of column followed by the same letters do not differ by the Tukey test ( $P < 0.05$ ).

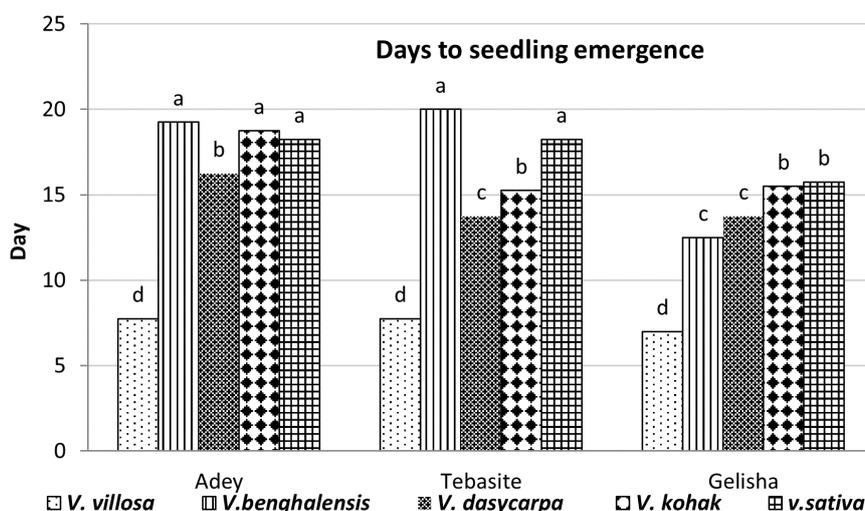
and *V. benghalensis* (170.3 days) as late maturity groups (Table 3). The variation of date of forage harvesting of vetch species could be due to genotypes of vetch species and sowing seasons.

*V. benghalensis* significantly had the shortest vetch species whereas *V. dasycarpa* had the tallest vetch species (Table 3). This could be the variation of the genotype of vetch species. The highest and lowest number of branches per plant was recorded in *V. kohak* and *V. villosa*, respectively (Table 3). The number of pods per plants of vetch species was significantly higher on *V. benghalensis* than the other vetch species (Table 3). The variation of number pod per plant might be due to vetch genotype, maturity date and sowing seasons. The highest number of seeds per pod was recorded in *V. dasycarpa*, followed by *V. sativa* and *V. kohak* contrary to *V. benghalensis*. The *V. villosa* had the lowest seed number per pod (Table 3); this might be due to maturity and genotype effects of vetch species. Late maturing vetch species had lower number of seed per pod because it was influenced by frost during late flowering to pod-fill stages. The highest and lowest thousand seed weight was recorded in *V. dasycarpa* and *V. benghalensis*, respectively (Table 3). The variation for thousand seed weight could be due to

environmental factor, inherent variations of grain size and maturity time of vetch species. The highest seed yield was recorded in *V. dasycarpa* (366 kg/ha), and *V. sativa* (300 kg/ha) whereas *V. villosa* (257 kg/ha) and *V. benghalensis* (248 kg/ha) had lower seed yield (Table 3). This might be due to the effect of sowing season, environmental factor, maturity time and number of seeds per pod of vetch species. The green forage yield is one of the most important traits on forage crop. The forage yield of vetch species were ranged from 17.49 to 31.39 t/ha with a mean of 26.17 t/ha. The highest and lowest amounts of green forage yield with average values of 32.91 and 17.49 t/ha were obtained in *V. kohak* and *V. benghalensis*, respectively (Table 3). The variation of green forage yields could be due to maturity time, morphological characteristic and sowing seasons of vetch species.

### 3.2 Means of species in location

The effects of species  $\times$  location interaction were significant on day to emerge ( $P < 0.01, 0.05$ ) (Table 1). However, we presented the means of all traits in five species in three locations in Figs. 2 to 9. The *V. benghalensis* was early germinating at Gelisha experimental location; however, it was



**Figure 2.** Means of date of emergence in 5 species in three locations. Means of column followed by the same letters do not differ by the Tukey test ( $P < 0.05$ ).

late emerging at Adey and Tebasite experimental locations. This might be genotypes of vetch species exhibiting highly specific response within a particular environment; others are uniform in performance over a range of environments. Therefore, it could be implicated that selection of better performing genotypes at one environment may not be applied to another environment.

### 3.3 Days to seedling emergence

Date of seeding emergence of vetch species is presented in Fig. 2. The mean date of seedling emergence of vetch species (14.66 days) (Table 3) was lower than that of Teshale et al. (2020) who reported 8 days at Midland of East Guji Zone. This might be the variation of agro ecology, sowing season and genotypes of vetch species. Stanisavljević et al. (2018) showed that seed coats were the main factor to limiting emerge vetch species because it regulated the absorption of water and air from the environment during seed germination time; the current finding was in line with Stanisavljević et al. (2018). Li et al. (2017) indicated that large grain size of vetch species was early germinating than small grain size vetch species in Qing Tibetan Plateau, China. It explained that within larger grain size, there was a great store of nutrients, which provided a stronger initial growth of seedlings. However, the current finding was contradict with Li et al. (2017) because the seed size of all early emerging vetch species was smaller than the later ones.

### 3.4 Days to maturity

Days to forage harvesting of vetch species are presented in Fig. 3. Gezahagn et al. (2016) indicated that late maturing vetch species were staying green for longer period so farmers get green feed for their livestock for longer period. However, the current finding is contradicted with Gezahagn et al. (2016) because the study area is highland and the occurrence of frost was higher from the late October to early December; therefore, late maturing vetch species was reached at this critical time and led to postpone the flowing stage even green forage yield. Day to forage harvesting of vetch species was within the range of 143.3 to 176.3 days and on the average mean of 162.16 days (Table 3) and higher than that reported by Gezahagn et al. (2013) which was 101.1 days at Holleta and 112 days in Ginich, respectively. This might be attributed to the difference of genotype, elevation, environmental factors and agronomic practice adopted.

### 3.5 Plant Height

The variation of plant height on forage vetch was attributed to the variation of rainfall, soil nutrients, and seasons of growing and adaptability of the species in different environmental conditions (Usman et al., 2019). The plant heights of vetch species is presented in Figure 4, the difference between taller and shorter plant of vetch species in the current finding was 43.31 cm, and the mean plant height of vetch species was 126.76 cm (Table 3), which was greater than that observed by Demirkan et al. (2018) as 115 to 129 cm at Turkey and lower than (131 cm in Ginich) that was reported by Gezahagn (2018). This variation was attributed to the

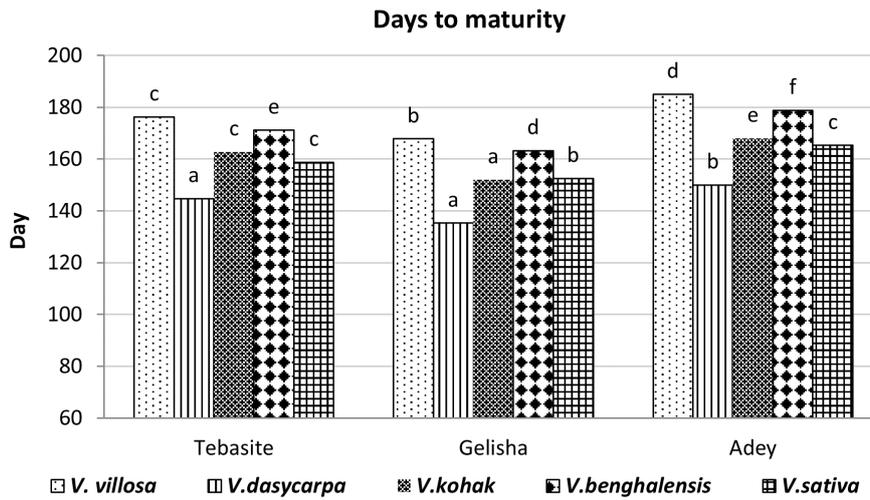
variation of rainfall, soil nutrients, and seasons of growing and adaptability of the species in different environmental conditions. Kassahun and Wasihun (2015) reported that late and intermediate maturing vetch species had higher plant height than early maturing vetch species; the result of the current finding was disagreed by Kassahun and Wasihun (2015) finding because in the present study, early mature vetch species had higher plant height than late maturing vetch species.

### 3.6 Number of branches per plant

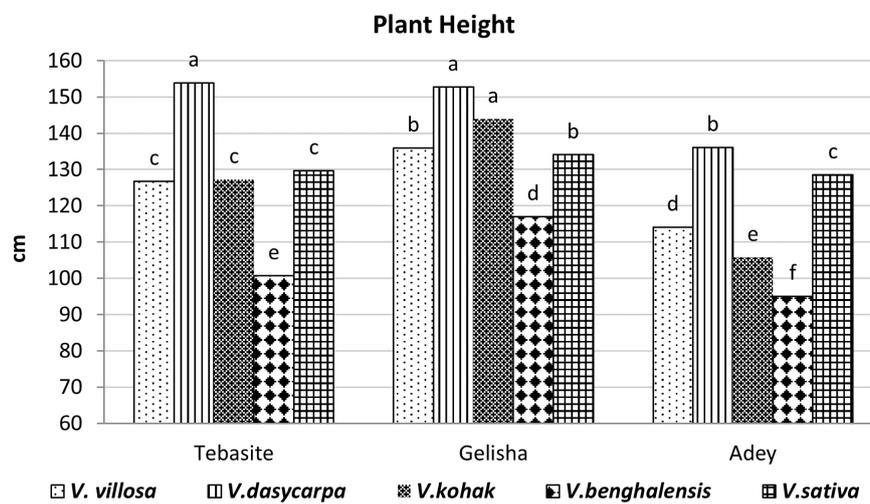
The numbers of branches of vetch species is presented in Fig. 5. Number of branches of vetch species in the current finding were higher than the results reported by Alemu (2019) 2.8 for *dasycarpa*, 3.1 for *V. villosa* and 2.9 for *V. benghalensis* at the Gumara Maksegnit watershed North Gondar, Ethiopia and lower than Gezahagn (2018) who reported that 10.1 in *V. villosa* 10.8 for *V. dasycarpa*, and 14.5 for *V. villosa* 13.8 for *V. dasycarpa* at Holleta and Ginich, respectively. This might be due to the genotypes of vetch species exhibiting a highly specific response to a particular environment (soil, rainfall and temperature) and others are uniform in performance over a range of environments. Therefore, it could be implicated that selection of better performing genotypes at one environment may not be related to other environments. Gezahagn (2018) showed the mean number of branches per plants of vetch species at Holleta and Ginich were 7.5 and 10.1, respectively. The mean number of branches per plant in the in the current finding was 5.82 (Table 3) which is lower than the result of Gezahagn (2018); this could be due to a variation in environmental factors such as soil characteristics, moisture and temperature. Usman et al. (2019) indicated that late maturing vetch species had a higher number of branches per plant at Highland of Guji Zone, Bore, Ethiopia. It implicated as the age of the plant is increasing; there is a possibility for emergence of new branches; however, the current finding is contradicted with Usman et al. (2019) because the maturity time of vetch species prolonged the availability of rain decrease and the occurrence of frost is high in the study area. Therefore, the development and the formation of new branches were reduced.

### 3.7 Number of pods per plants

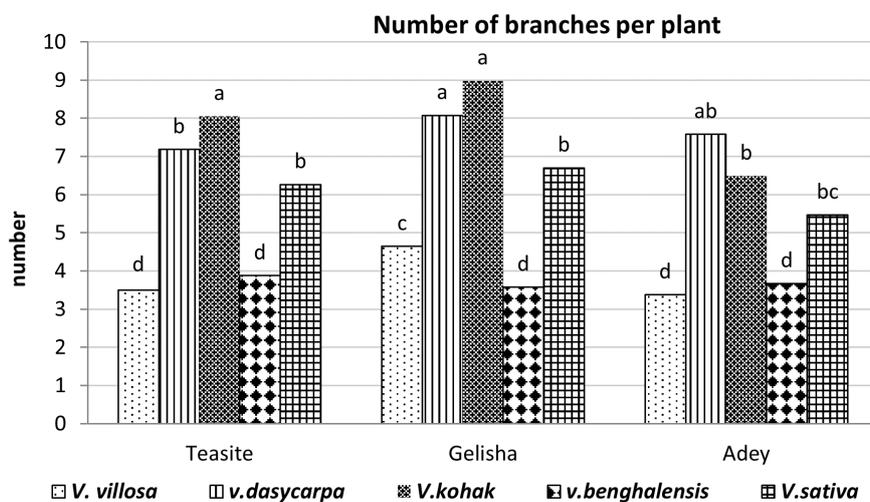
The number of pod per plants of vetch species in the current finding is presented in Fig. 6. The mean number of pod per plant value (40.87) obtained from vetch species in the current finding (Table 3) was comparable with the reports of Grela et al. (2021), which was 40.9 for different European countries. Our finding was higher than the values reported by Alemu (2019), which was 8.8 at Gumara-Maksegnit watershed, North Gondar, Ethiopia. This variation might be an environmental factor, sowing seasons and the genotypes of vetch, which was tested. Gezahagn (2017) reported that the branching performance of the vetch species has a direct effect on number of pods per plant, if vetch species with a higher branching performance had a higher number of pods per plant. However, the current finding was disagreeing with Gezahagn (2017) findings. Whereas in the current finding, the number of branches in *V. benghalensis* was the



**Figure 3.** Mean days to maturity of vetch species in three locations. Means of column followed by the same letters do not differ by the Tukey test ( $P < 0.05$ ).



**Figure 4.** Mean plant heights of vetch species in three locations. Means of column followed by the same letters do not differ by the Tukey test ( $P < 0.05$ ).



**Figure 5.** The Mean number of per plants of vetch species in three locations. Means of column followed by the same letters do not differ by the Tukey test ( $P < 0.05$ ).

lowest, but the number of pods per plant was higher.

### 3.8 Numbers of seed per pods

The numbers of seed per pods of vetch species is presented in Fig. 7. Usman et al. (2019) indicated that early maturing vetch species produced a large number of seed per pod than late maturing species; the result of the current finding is in line with Usman et al. (2019). Gezahagn (2017) reported that the overall mean number of seeds per pod of vetch species at Holleta and Ginich were 4.8 and 5.2 seed per pods, respectively. The result of the current finding was 2.99 (Table 3), which is lower than Gezahagn (2017) finding; this might be the variation of elevation, environmental factors, genotype of vetch species, and sowing seasons.

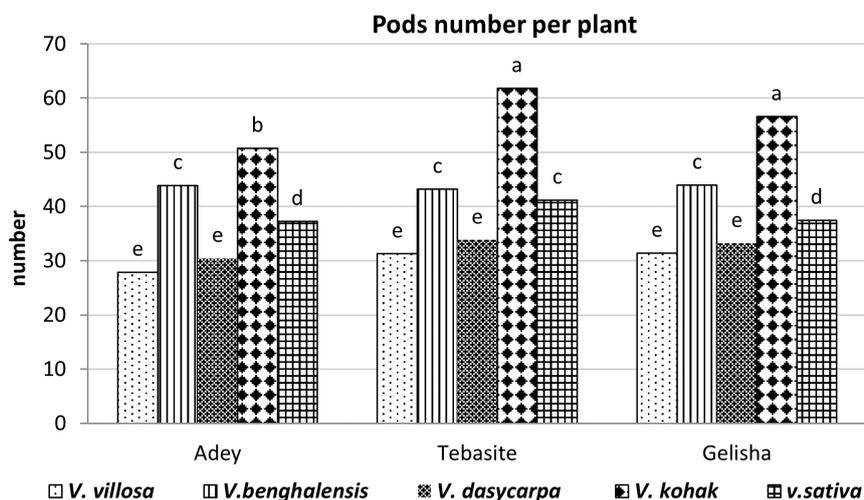
### 3.9 Thousand seed weight

Thousand seed weight of vetch species is presented in Fig. 7. Our finding is in line with Stanisavljević et al. (2018). Gezahagn (2017) indicated early maturing vetch species had a

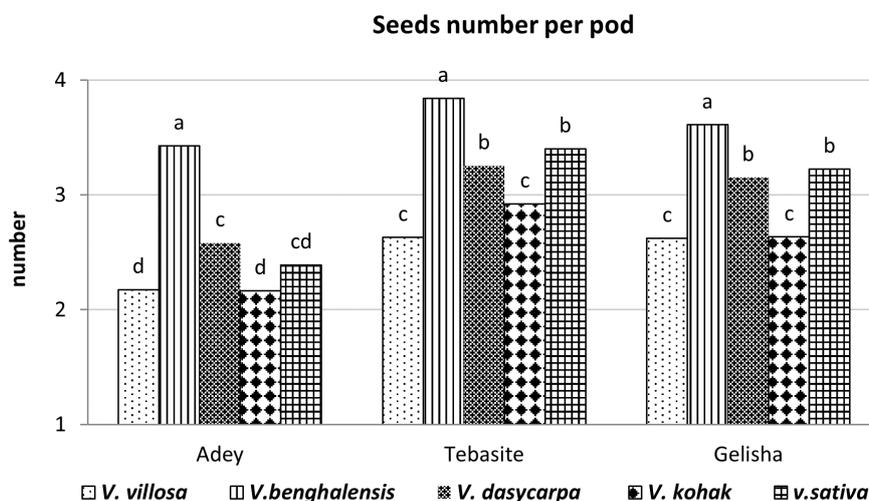
shorter grain filling period than late maturing vetch species and early maturing species had comparatively higher thousand seed weight than intermediate to late maturing species; the current finding agrees with Gezahagn (2017) finding. Mikić et al. (2013) showed thousand-grain mass of vetch species in Siberia was 61 g. The mean weight of seed thousands of vetch species in the current finding is 49 g. (Table 3), which is lower than Mikić et al. (2013) findings. This variation could be agro ecology, sowing seasons, agronomic practice and environmental factors such as temperature, soil type and physiochemical qualities of the soil.

### 3.10 Seed Yield

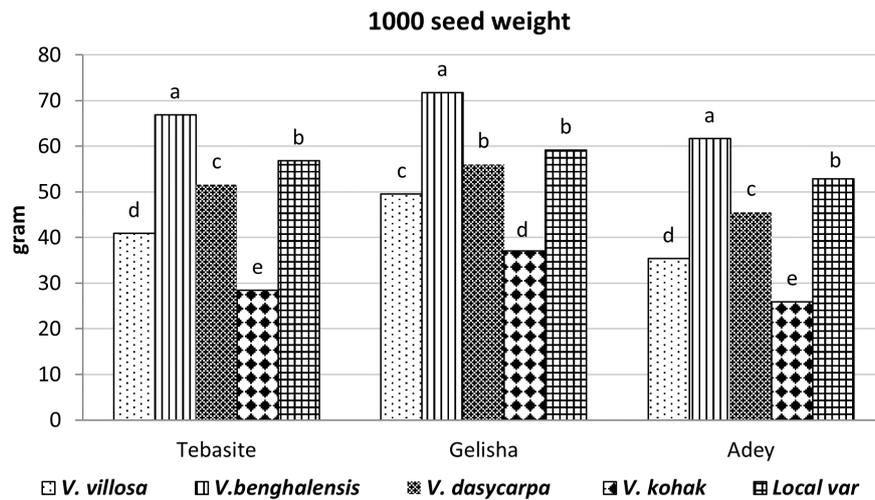
The seed yield of vetch species is presented in Fig. 9. In the study area, one of the main problems was the production of vetch species seeds for the next forage production season because the occurrence of frost is higher especially at the end of late October to early December. Gezahagn et al. (2019) indicated that early and late maturing vetch



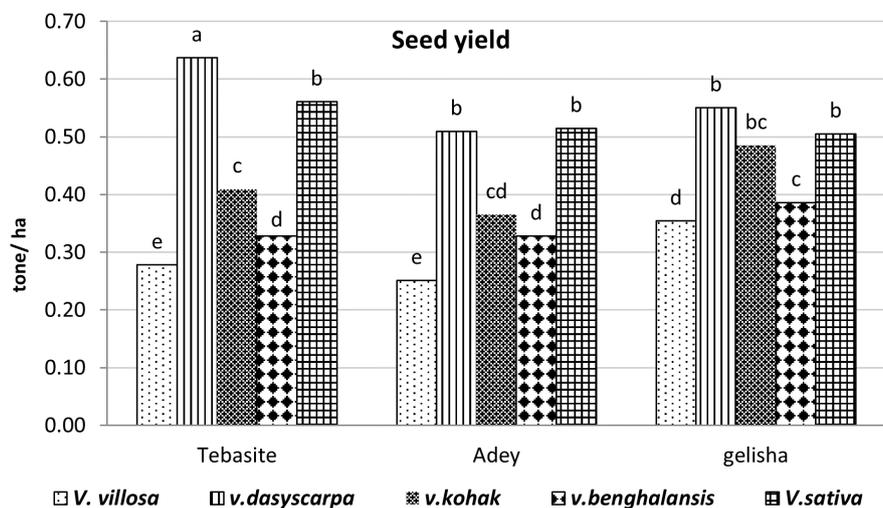
**Figure 6.** Means of number of pods per plants of vetch species in three locations. Means of column followed by the same letters do not differ by the Tukey test ( $P < 0.05$ ).



**Figure 7.** Number of seeds per pod of vetch species in three locations. Means of column followed by the same letters do not differ by the Tukey test ( $P < 0.05$ ).



**Figure 8.** Means of thousand seed weight of vetch species in three locations. Means of column followed by the same letters do not differ by the Tukey test ( $P < 0.05$ ).



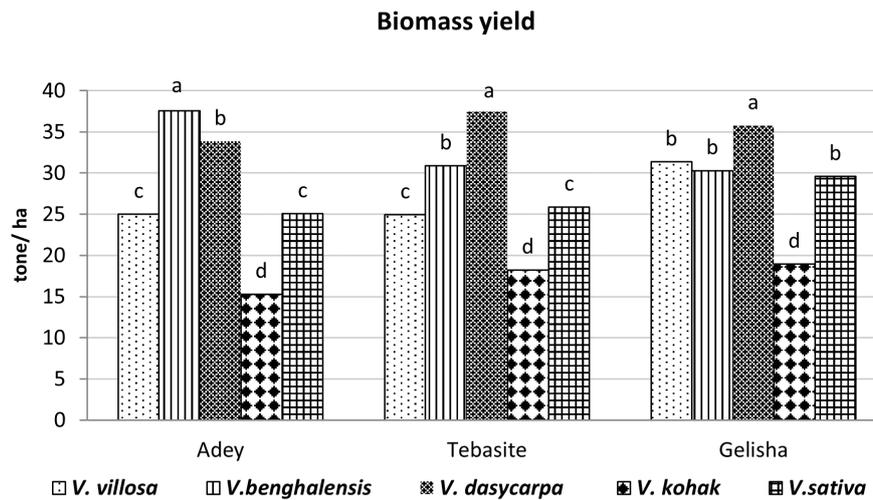
**Figure 9.** The mean seed yields of vetch species in three locations. Means of column followed by the same letters do not differ by the Tukey test ( $P < 0.05$ ).

species produce a higher seed yield in the central highlands of Ethiopia; the current finding was contradicted with Gezahagn et al. (2019) finding. However, tested Vetch species of the current study had an intermediate growth habit, meaning it is possible to go flowers, immature and mature pods at the same plant at the same time; the seeds found in the immature pods of late maturing vetch species were severely damaged by frost and the seed yield was reduced. Early maturing vetch should be grown for seed production in the study area due to the earliness to escape frost months. Mikić et al. (2013) reported that in order to obtain desirable vetch seed production farmer intended sowing seasons. Sowing season has dramatic effect on seed yields of vetch species because optimum-sowing time gives successful seed yields of vetch species (Usman et al., 2019). Gezahagn (2018) reported that the mean seed yield of vetch species at Holleta and Ginich was 0.6 t/ha and 2.7 t/ha, respectively; similarly, Teshale et al. (2020) reported the mean seed yield of vetch species at Midland of East Guji Zone, Adola, South-

ern Oromia was 1.87 t/ha. The mean seed yield of vetch species in the current finding was low (430 kg/ha) (Table 3), which was lower than the result of Teshale et al. (2020) and Gezahagn (2018) This variation might be the variation of vetch genotype, agro ecology, elevation, sowing seasons and environmental factors.

### 3.11 Aerial Biomass Yield

The green forage yield of vetch species is presented in Fig. 10. Gezahagn et al. (2019) reported that intermediate to late maturing vetch species gave relatively higher green forage yield than the early maturing vetch species. This could be explained in terms of the longer duration of growth, which probably enabled the late maturing species to take full advantage of the best growing conditions. The current study is contradicting with Gezahagn et al. (2019) findings because it fails to address the issue of frost. Wiering (2018) indicated frost damaging morphological parts of vetch through excessive freezing, especially in stem, leaves



**Figure 10.** The mean biomass yield of vetch species in three locations. Means of column followed by the same letters do not differ by the Tukey test ( $P < 0.05$ ).

and flowers; the current finding is in line with Wiering (2018). Tilahun et al. (2017) reported that vetch species has been of more branches with superior plant height that could produce more green forage yield. The current finding is in agreement with Tilahun et al. (2017) finding. Teshale et al. (2020) showed that the mean biomass yield of vetch species at Midland of East Guji Zone, Adola, and Southern Oromia was 2.4 t/ha, and in the current study, it was higher than that reported by Teshale et al. (2020). This might be the variation of rainfall, physiochemical properties of the soil and sowing season and the agro-ecology variation.

#### 4. Conclusion

In the area, inadequate supply and poor quality of the feeds were the major constraint to livestock production. The aim of the study was to investigate productive and adaptive vetch species in terms of their growth and yield performance at Dessie Zuria district. Generally, in vetch species, environmental factor, morphological fraction, and maturity time affected the growth and yield performance of tested vetch species in the study area. *V. villosa* was early germinated whereas *V. kohak*, *V. sativa*, *V. dasycarpa* and *V. benghalensis* were not statistically significant for time of germination. The mean date of seedling emergence for vetch species was 13.4 days and this date varied across location. The vetch variety of *V. dasycarpa* was an early maturing and *V. kohak* and local species (*V. sativa*) were an intermediate whereas *V. villosa* and *V. benghalensis* were late maturing species. The mean of plant height of vetch species was 126.7 cm. The tallest plants were recorded by *V. dasycarpa* and the shortest vetch species were *V. benghalensis*. Early maturing vetch variety had higher green forage yield and seed yield than late maturing vetch species in the study area. The seed yield and its related component were also highly influenced by maturity time, environmental factor and genetic structure of vetch species. Hence, comparatively higher seed yield was recorded by *V. dasycarpa* and *V. sativa* whereas the lowest seed yield was recorded by *V. villosa* and *V. benghalensis*. The highest number of pods per plant was obtained from

*V. benghalensis*; however, due to the influence of frost, it produces a lower seed yield whereas *V. villosa*, and *V. kohak* had the lowest number of pods per plant in the study area. *V. dasycarpa* gave the highest number of seeds per pod whereas *V. benghalensis* and *V. villosa* had lower number of seeds per pod in the study area. In a comparison between locations, the higher values of all traits were obtained in Gelisha followed by Tebasite and Adey, respectively. Based on yield and growth performance, the species of *V. kohak* and *V. dasycarpa* were recommended for cultivation Dessie Zuria district.

#### 5. Recommendations

Based on growth and productivity performance, *V. dasycarpa* and *V. kohak* could be recommended for farmers in Dessie Zuria and other areas having similar agro-ecologies and soil type. Time of sowing was influenced by experimental site, variety, maturity and end use. To obtain high quality of production without the interruption of frost, the sowing time of late and early maturing vetch species in the study area should be at the end of March to mid-April and mid-April to early May.

##### Authors Contributions

All authors have contributed equally to prepare the paper.

##### Availability of Data and Materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

##### Conflict of Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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**References**

- Adugna T. (2007) Feed resources for producing export quality meat and livestock in Ethiopia (Examples from selected Woreda in Oromia and SNNP regional states).
- Aklilu M., Alemayehu M. (2007) Ethiopian Agricultural Research Institute, Ethiopia. *Desert*, no. 18
- Alemayehu M., Getnet A. (2012) The evaluation of forage seed production in Ethiopia. In: Getnet A., Mesfin, D., Jean H., Getachew, A., Solomon, M. & Alemayehu, M. (eds). Forage seed research and development in Ethiopia. *Addis Ababa*
- Alemu T. (2019) Adaptability of vetch (*Vicia* spp.) for potential feed production in Gumara- Maksegnit watershed, North Gondar, Ethiopia. *Livestock Research for Rural Development* 26 (7)
- Asfaw S., Shiferaw B., Simtowe F., Haile M. (2011) Agricultural technology adoption, seed access constraints and commercialization in Ethiopia. *Jour. Develop Agric. Eco.* 3 (9): 436–477.
- CSA (Central Statistical Agency) (2021) Agricultural Sample Survey 2021/2022. Report on Livestock and Livestock characteristics (Private Peasant Holdings). *CSA, Addis Ababa, Ethiopia*. 2:578.
- Demirkan A. K., Nizam I., Orak A., Şen C., Tenikecier1 H. S., Güler N., Ersoy H. (2018) Determination of some morphological characters and forage yield of vetch (*Vicia* sp) Genotypes collected from Thrace region of Turkey. *Int. Jour. Adv. Res.* 6 (11): 276–283. <https://doi.org/10.21474/IJAR01/7997>
- DZWAO (Dessie Zuria Woreda Agricultural Office) (2022) Dessie Zuria Woreda Livestock and Fishery Development Office (DZWLFD), Ethiopia.
- Eshetie A., Berhanu A., Yeshambel M. (2018) Evaluation of biomass yield and nutritional quality of oats–vetch mixtures at different harvesting stage under residual moisture in Fogera District, Ethiopia. *Agric & Food Secure* 7:3–10.
- Getnet A., Ledin I. (2001) Effect of variety, soil type and fertilizer on the establishment, growth, forage yield, quality and voluntary intake by cattle of oats and vetches cultivated in pure stands and mixtures. *Animal Feed Science and Technology*. 92:95–111.
- Gezahagn K. (2017) Evaluation of vetch species for yield, yield components and herbage quality in the central highlands of Ethiopia. *Acad. Res. J. Agri. Sci. Res.* 4 (6): 264–278.
- (2018) Morpho-agronomic performance of vetch species and their accessions grown under nitosol and vertisol conditions in the central highlands of Ethiopia. *Journal of Agriculture & Food Security* 7 (90): 1–14.
- Gezahagn K., Fekede F., Hussein M., Getnet A., Mengistu A., Alemayehu M., Mamaru T. (2019) Yield Performance and Nutritive Value of Vetch Species grown on nitsoil and vertisol Conditions in the Central Highlands of Ethiopia. *OMO International Journal of Science* 2 (1): 60–81.
- Gezahagn K., Getnet A., Fekede F., Mengistu A. (2016) Forage legumes in crop livestock mixed farming systems - A Review. *International Journal of Livestock Research* 6 (4): 1–18.
- Gezahagn K., Getnet A., Mengistu A., Fekede F. (2013) Forage nutritive values of vetch species and their accessions grown under nitosol and vertisol conditions in the central highlands of Ethiopia. *Livestock Research for Rural Development* 26 (1): 1–16.
- Grela E. R., Samolińska W., Rybiński W., Kiczorowska B., Kowalczyk-Vasilev E., Matras J., Wesołowska S. (2021) Nutritional and Anti-nutritional Factors in *Vicia sativa* L. *Seeds and the Variability of Phenotypic and Morphological Characteristics of Some Vetch in European Countries. Jour. Animals* 11. 11 (44) <https://doi.org/10.3390/ani11010044>
- Kassahun D., Wasihun H. (2015) Evaluation of Biomass Yield and Nutritional Value of Different Species of Vetch (*Vicia*). *Academic Journal of Nutrition* 4 (3): 99–105.
- Li R., Chen L., Wu Y., Zhang R., Abskin C. C., Abskin J. M. (2017) Effects of cultivar and maternal environment on seed quality in *Vicia sativa*. *Front. Plant Sci.* 8:14–11.
- Mikić A., Mihailović V., Čupina B., Vasiljević S., Milošević B., Katanski S., Matić R., Radojević V., Kraljević-Ablalić M. (2013) Agronomic characteristics related to grain yield and crude protein content in common vetch (*Vicia sativa*) accessions of diverse geographic origin, New Zealand. *Journal of Agricultural Research* 56 (4): 297–308.

- Sere C., Ayantunde A., Duncan A., Freeman A., Herrero M., Tarawali S., Wright I. (2008) Livestock production and poverty alleviation-challenges and opportunities in arid and semi-arid tropical rangeland based systems. In: the proceedings of multi-functional grasslands in a changing world. *XXI International Grassland Congress and VII International Rangeland Congress, China.*, 19–29.
- Stanisavljević R., Veljević N., Štrabnović R., Postić D., Aleksić G., Trkulja N., Knežević J., Dodig D. (2018) Seed quality of vetch (*Vicia sativa*) affected by different seed colors and sizes after various storage periods. *Int. J. Agric. Bio.* 20:2655–2660.
- Teshale J., Zinash A., Genet D. (2020) Performance Evaluation of Vetch of Varieties/Genotypes for Their Agronomic Performance and Nutritive Value in Selected Midland East Guji Zone, Adola, Southern Oromia and Ethiopia. *Asian Journal of Advanced Research and Reports* 9 (2): 54–59.
- Tilahun G., Asmare B., Mekuriaw Y. (2017) Effects of harvesting age and spacing on plant characteristics, chemical composition and yield of Desho grass (*Pennisetum pedicellatum* Trin.) in the highlands of Ethiopia. *Tropical Grasslands* 5 (2): 77–84.
- Usman S., Tamirat D., Bedasa E. (2019) Performance Evaluation of Improved Vetch Varieties/Accessions at the Highland of Guji Zone, Bore, Ethiopia. *Agri Res & Tech: Open Access Jour.* 20 (5): 00221.
- Wiering N. P. (2018) Winter hardiness and freezing tolerance in a hairy vetch collection. *Crop Science.* 58 (4): 1594–1604.
- Zulfiqar A., Shafiq Zahid M., Abshir M. (2006) Performance of vetch, *Vicia sativa* cultivars for fodder production under rain fed conditions of Pothwar region. *Jour. Agric. Res.* 44 (4): 291–297.