Research Article

Evaluation of Field Pea (*Pisum sativum* L.) Varieties for Yield and Yield-Related Traits

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Abstract | Field pea (*Pisum sativum* L.) is one of the leguminous crops that is rich in protein and essential amino acids. A field experiment was conducted during the 2019 cropping season consisting of eight (Bursa, Burkitu, Adi, Herena, Hortu, Letu, T/shaman, and Weyib) improved field pea varietiesand one local variety at west Showa zone Oromia region to identify high yielding varieties. The experiment was carried out using a randomized complete block design with two replications at Babich, Goda Hora, Chelia Rafiso Alenga, EjersaLafo, and Goromti locations. Data on yield and yield-related traits such as harvest index, above-ground biomass, number of seed per pods, and hundred seed weights were recorded. Analysis of variance combined over five locations manifested significant differences among varieties, environment, environment, and varieties interaction for grain yield and other yield-related traits. The combined mean of grain yield of varieties indicated that Bursa (3.03 t/ha), Adi (2.84t/ha) and Weyib (2.83 t/ha) varieties had the highest grain yield advantage over the other tested varieties without significant difference among the order, whereas Burkitu (2.3 t/ha), Herena (2.35 t/ha) and Hortu (2.39 t/ha) varieties manifested low grain yield. Generally, it is better if the work is repeated in the future for more justification since it was only one season experiment and the grain yield stability test of the higher yield varieties is advisable before recommending the varieties for large-scale production at the studied area.

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Introduction

Field pea (*Pisum sativum* L.) is a self-pollinated diploid (2n=14) annual cool-sseason pulse crop. It is also a major food legume with a valuable and cheap source of protein having essential amino acids that have high nutritional value for resource-poor households (Nawab, 2008; Getachew, 2019). It is widely grown in the cooler temperate zones and in the highlands of tropical regions of the world. The crop is cultivated in a wide range of soil types from light sandy loam to heavy clays but does not toler-

ate saline and waterlogged soil conditions (Ceyhan and Avci, 2015; Endres et al., 2016). The crop has the potential of growing in variable ranges of altitudes from1450-3200 m.a.s.l, where the annual rainfall is in the ranges of 400-100mm. The crop has a crucial role in the human diet as a protein source (23-25 %) (Bastianelli et al., 1998).

Field pea is among the major cool-season pulse crop grown on the second ranks of worldwide pulse production (Cherinet and Tazebachew, 2015; Muoni et al., 2019). The crop occupies the fourth rank of pulse crops production next to faba bean, haricot bean and chickpea in area coverage 219,927.59 ha with average yield productivity of 1.71 t/ha in Ethiopia (CSA, 2021). The crop has ecological and economic importance in Ethiopian highlands as it plays a significant role in soil fertility amendment and as a break crop. It is suitable for rotation systems to minimize the negative impacts of cereal-based mono-cropping (Fikere et al., 2014; Muoni et al., 2019).

Despite its importance, the average national productivity (1.7 t/ha) is very low (CSA, 2021) when compared with the crop potential yield (3.556 t/ha) and (4.17 t/ha) research finding in Ethiopia reported by Tolasa et al. (2013) and Mogiso (2017) respectively- and the higher yielder (7-8 t/ha) reported at some European countries (Smykal et al., 2012), this is due to very limited availability of improved seeds and most pulse crops are grown from unimproved cultivars with low genetic potential. In contrast to the release of many improved pulse varieties which are adapted to a wide of rainfall, soil, and altitude regimes, the use of certified improved seeds by farmers is very low (Boere et al., 2015; Mogiso, 2017). To increase yield per unit area of the Oromia region seed of superior varieties must be multiplied and provided to the farmers. Because, availability of quality seed of improved field pea varieties at sufficient quantity is one of the major constraints to increase productivity (Ali et al., 2021).

Since developing a variety takes a long time, as an immediate solution it is recommended to provide the seed of existing improved varieties to the farmers (Tariku et al., 2020). Even though West Showa is a potential area for field pea production, field pea producers in the area cannot afford improved variety as other cereal crops. Therefore, the study was initiated to select higher yield improved field pea varieties for the West Showa zone farming community and other similar agroecology areas. The result of this finding gives valuable information for field pea producers and it also gives direction for researchers and field pea breeders to focus on genotype by environment interaction, while releasing improved variety.

Materials and Methods

Description of the Study Sites

The field experiment was conducted during the 2019 main cropping season from June to December at five locations (Babich, Goda Hora, CheliaRafisoAlenga, EjersaLafo, and Goromti) of West Showa Zone Oromia Region. (Table 1 and Figure 1).

Plant Materials

Eight improved field pea varieties released from federal and regional research centers were obtained from Holeta Agricultural Research Center (HARC) and Sinana Agricultural Research Center (SARC) and one local variety which was popularly used by local farmers of the Goremti site was used in the study. Description of the 9 varieties and their sources are given in Table 2.

Experimental Design and Procedure

The experiment was carried out in a Randomized Complete Block Design (RCBD) with two factors and

Table 1: *Agro-climatic descriptions of the study site of West Showa zone, Oromia region Ethiopia.*

Name of testing site	Altitude (m.a.s.l.)	Location		Rainfall (mm)	Temperature(°C)		Soil type	Agro-ecologies
		Latitude	Longitude		Min	Max	Loam soil	Transitional highland
Goda Hora	1938	8°51'N	37°27'E	700-1400	12	29	Red soil	Transitional highland
Babich	2532	8°58'N	37°30'E	700-1400	12	26	Loam soil	Transitional highland
Goromti	2560	8°55'N	37°55'E	500-1600	10	28	Loam soil	Transitional highland
Ejersalafo	2254	9°02'N	37°14'E	750-1170	9.3	23.8	Red soil	Transitional highland
Chelia RA	3128	8°58'N	37°28'E	900-1600	12	25	Loam soil	Highland

Sources: *From each WANO 2019, RA=RafisoAlenga.*

replications across five locations. The selected location is a major field pea producer of the study area. Each variety was sown in 9 rows of 2m length with 20cm inter-row spacing and 10cm intra row spacing between plants and 100kg blended Nitrogen, phosphorus, sulfur, and boron (NPSB) fertilizer $ha^{-1}$was applied at the planting time. At all locations the land was ploughed three times by oxen and no irrigation supplement was implemented. Other agronomic management practices were also carried out at all sites following standard recommendations.

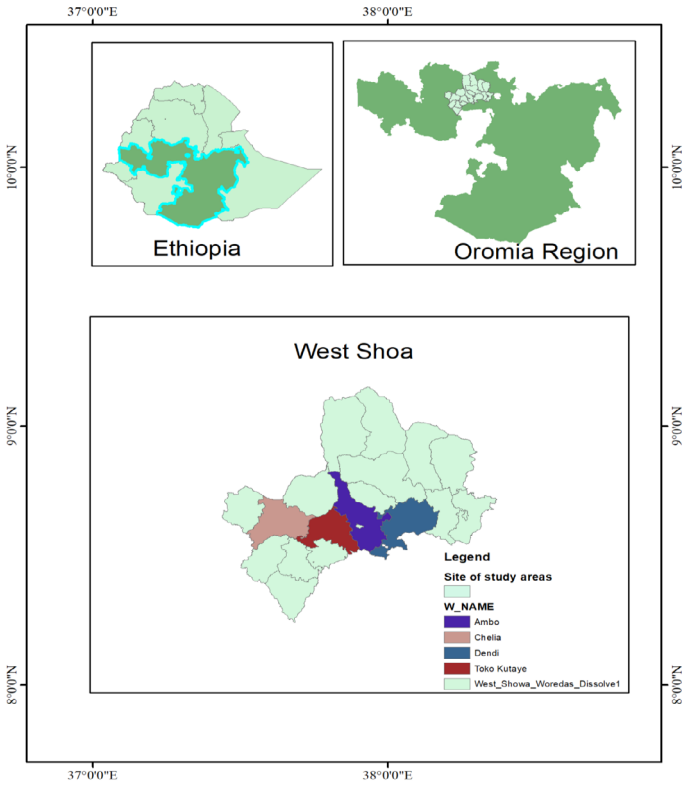

Figure 1: *Location map of Ejersalafo, Ambo, Babichand cheliya districts in West Showa zone.*
Sources: *from ARC GIS 2020.*

Table 2: *Description of the field pea (Pisum sativum L.) varieties used in the experiment.*

Genotype	Source	Seed Size	Year released	Adaptation area(m.a.s.l)
Adi	HARC/EIAR	Medium	1996	2300-3000
Burkitu	HARC/EIAR	Medium	2009	1800-3000
Bursa	KARC/EIAR	Medium	2015	1900-3000
Herena	KARC/EIAR	Medium	2012	1800-3000
Hortu	KARC/EIAR	Medium	2012	1800-3000
Letu	KARC/EIAR	Medium	2010	1800-3000
Local	GUDER AREA	Medium	NA	1600-3000
T/shanan	SARC/OARI	Medium	2007	1800-3000
Weyibe	SARC/OARI	Medium	2017	1800-3000

Source*: Crop variety Register (2019).*

Data Collected
Data were collected from ten randomly selected plants of central rows on a plot basis on yield and yield-related traits.

Grain Yield (t/ha): The yield was measured from the harvestable central rows. Finally, yield per plot was converted to a per hectare basis and the average yield was recorded in $toneha^{-1}$.
Hundred Seed Weight: Random samples of 100 seeds were counted from the harvested plot yields immediately after grain moisture determination and were weighed in grams.
Number of Seeds per Pod: Five pods were randomly taken per plant from each of the ten plants after counting the numbers of seeds per pod were determined by the average of pods.
Biomass Yield (g/plot): The weight in grams of the above-ground parts of plants harvested from the plots after sun drying. Finally, the biological yield per plot were converted to a hectare basis and expressed in $quintalha^{-1}$.
Harvest Index (%): Calculated on a plot basis, as the ratio of dried grain yield weight adjusted to 10% moisture content by the biomass yield and multiplied by hundred.

$$Harvest\ Index(\%) = \frac{Seedyieldperplot}{Aerialbiomassperplot} \times 100$$

Data Analysis
The analysis of variance (ANOVA) for each location and combined analysis of variance over locations were performed following the standard procedure given by Gomez and Gomez (1984) using the SAS program (SAS Version,9.3). The homogeneity of error variance was tested using the F-max test method of Hartley (1950) prior to pooled analysis over locations. The F-test was used to detect significant effect while the mean separation was done using Least Significant Difference (LSD) at the 5% probability level.

Results and Discussion

Analysis of variance (ANOVA)
The combined analysis was carried out for the parameters viz., grain yield, number of seeds per pod, hundred seed weight, harvest index, above-ground biomass, and productive branch per plant at five locations. The combined analysis of variance over the five locations revealed significant differences for yield,

harvest index, above-ground biomass, thousand seed weight, and the number of seeds per pod among the tested varieties (Table 3). This may be due to the genetic composition of the tested varieties. The analysis of variance also manifested significant differences among the tested varieties, locations, and varieties into environmental interaction. This indicates that the tested locations have different potential for field pea crop production based on their agro-climatic characters (Table 1). Since yield is determined by many factors such as soil, climate, and agronomic conditions (Din et al., 2019).

These results agree with previous findings of Tolesa et al. (2013) and Rezene et al. (2014) which reported that genotypes, environments, and genotypes into environmental interaction were significantly different for grain yield of field pea. Inline with this, Tadele et al. (2018) reported highly significant variation of year, environment, genotypes, genotypes into environmental interaction for mean grain yield of combined data analysis in common bean genotypes. Similarly, Mogiso (2017) reported a significant difference among the tested improved varieties of field pea for over years.

Table 3: *Analysis of variance for combined data of yield and yield attributes of field pea varieties at five locations.*

SV	Df	Yield	HI	AGB	HSW	SPP
Block	1	36.20ns	35.22	0.43ns	2.13ns	0.07ns
Location	4	2574.12**	6225.44**	14314.01**	363.10**	4.99**
Variety	8	60.24**	213.62**	394.09**	5.065**	0.91**
Var *Loc	8	60.24**	139.14**	253.94*	4.67**	0.51ns
Error	44	539.17	453.97	5368.18	89.12	17.99
CV		13.31	8.50	14.31	7.19	12.29

and *:** *significance probability level at 0.05 and 0.01,* **ns:** *non-significant,* **Df:** *degree of freedom,* **GY:** *grain yield,* **HI:** *harvest index,* **AGB:** *above-ground biomass,* **HSW:** *hundred seed weight,* **SPP:** *number of seed per pod.*

Mean Performance of the varieties

The mean grain yield of evaluated field pea varieties across the five environment/locations ranged from 3.0 for Bursa to 2.3 t/ha for Burqitu (Table 4). Moreover, the performance of the varieties was not consistent across the five environments. This maybe due to environmental variations and the genotype by environment interaction (GEI) that causes variation in yield and phenotypic traits of specific genotype (Niedbała, 2019; Niazian and Niedbała, 2020). For combined data analysis, variety Adi revealed the highest mean harvest index over locations followed by Weyib, T/shaman, while Hortu manifested the lowest harvest index. For above-ground biomass characters, Bursa manifested the maximum value (87 q/ha), while Adi revealed the minimum value (69.45 q/ha) for above-ground biomass followed by Burkitu (Table 4). The maximum hundred seed weight (20.77 gm) was observed in Local variety for the combined data analysis, while the minimum hundred seed weight of 19.03 gm was shown by Adi. The maximum number of seeds per pod 5.7 was registered for Weyib, while the minimum number of seeds per pod 4.85 was manifested by Burqitu over locations (Table 4).

Table 4: *Combined mean value of yield and yield related traits of nine field pea variety over 5 locations.*

Variety	GY (t/ha)	HI	AGB	HSW	SPP
Adi	2.84ab	45.21a	69.45c	19.03bc	5.38ab
Burkitu	2.3c	36.77c	71.0c	20.5a	4.85b
Bursa	3.0a	36.35c	87a	19.21bc	4.85b
Herena	2.35c	33.88cd	76.45bc	18.76c	5.24ab
Hortu	2.4c	31.87d	77.16abc	19.56abc	5.41ab
Letu	2.74ab	35.97c	81.7ab	20.31ab	5.36ab
T/shaman	2.6bc	42.13b	71.3c	19.64abc	4.89b
Weyib	2.83ab	43.25ab	75.33bc	20.32ab	5.72a
Local	2.6bc	34.56cd	85.05ab	20.77a	5.1b
Grand mean	2.63	37.78	77.16	19.79	5.2
LSD(5 %)	3.15	2.89	9.95	1.28	0.58
SD	3.5	3.2	11.04	1.42	0.64
CV	13.31	8.50	14.31	7.19	12.29

GY: *grain yield,* **HI:** *harvest index,* **AGB:** *above ground biomass,* **HSW:** *hundred seed weight,* **SPP:** *number of seed per pod. Mean in the same column followed by the same letters are non-significantly different at 5 % significance level.*

The combined data analysis for the number of seeds per pod revealed significant differences among the tested varieties. The highest number of seeds per pod (5.72) was manifested by Weyib, whereas the lowest seed per pod (4.85) was revealed by Burkitu and Bursa varieties (Table 4).

Grain Yield

Grain yield may be the result of many plant characteristics which are interacting with numerous external factors during the life of the plants. The ranking of varieties based on grain yield may be considered a reliable measure for genotypic performance (Niazian and Niedbała, 2020). At all locations, the yield obtained showed a statistically significant difference among the tested varieties for grain yield except

Table 5: *Mean value of grain yield and yield-related traits of nine tested field pea variety at Babich, chaliyarefisoalenga and Ejersalafo.*

	Test environments														
Variety	Babich					Cheliyarefisoalenga					EjersaLafo				
Parameters	GY (t/ha)	HI	AGB	HSW	SPP	GY (t/ha)	HI	AGB	HSW (gm)	SPP	GY (t/ha)	HI	AGB	HSW	SPP
Bursa	2.8a	24.55a	114.00b	19.44cd	5.10ab	2.08c	43.0ab	43ab	20.26ab	4.63bc	4.18a	38.8a	108.25a	23.75ab	5.25ab
Local	2.7a	22.15a	121.00a	21.76ab	5.10ab	1.93d	31.5d	31.5d	21.14a	5.1abc	3.93a	36.2a	110.0a	23.96ab	5.25ab
Adi	2.5.4ab	22.55a	113.00c	17.58d	5.10ab	2.07c	35.5c	35.5c	21.55a	5.3abc	2.89a	38.95a	75.75a	24.21a	6.5a
Weyib	2.43ab	21.30ab	114.00b	20.85abc	5.70a	2.92a	41.65b	41.65b	22.25a	5.1a	3.09a	43a	77a	22.55b	6 ab
Letu	2.42ab	23.55a	103.00c	19.96cb	5.30ab	1.91d	34.5c	34.5c	22.71a	5.75abc	4.26a	37a	114.75a	24.35a	6 ab
T/shaman	2.17b	20.85ab	104.00c	17.65d	5.50ab	2.75b	45.5a	45.5a	21.72a	4.45c	3.45a	36.9a	94.75a	23.56ab	5b
Burqitu	1.68c	17.50bc	96.00d	22.21a	4.40b	0.91g	20f	20f	22.43a	5 abc	3.41a	36.75a	94.5a	23.04ab	5.25ab
Hortu	1.36c	14.95cd	91.00e	18.01d	4.70ab	1.75e	43.3ab	43.3ab	23.12a	6.12a	3.93a	34.6a	113.5a	22.9ab	5b
Herena	1.29c	12.40d	104.00c	15.42e	5.20ab	1.23f	28.25e	28.25e	21.35a	5.03abc	4.37a	37.75a	115.5a	24.4a	6 ab
EMS	3.33	3.04	2.22	0.70	0.26	0.25	1.39	1.39	2.36	0.25	41.01	32.86	518.78	0.47	0.34
LSD (5%)	4.21	4.02	1.09	1.93	1.19	1.16	2.71	2.71	3.54	1.15	14.77	13.82	52.52	1.58	1.35

GY: *grain yield,* **HI:** *harvest index,* **AGB:** *above-ground biomass,* **HSW:** *hundred seed, SPP number of seed per pod. Mean in the same column followed by the same letters are non-significant different at 5 % significance level.*

at Ejersalafo site (Table 5). At the Babich site, the highest mean grain yield of 2.8 t ha^{-1}was obtained from the Bursa variety, while the lowest yield 1.29 t ha^{-1}was obtained from Harena (Table 5). At CheliaRefisoAlenga location, the maximum grain yield 2.92 t/ha^{-1} was manifested by Weyib variety, while the minimum grain yield 0.91 t/ha^{-1} was revealed by Burkitu (Table 5). On another hand, all the tested varieties revealed non-significant differences for grain yield at the Ejersolafo site (Table 5). The maximum grain yield mean value of 5.06 t ha^{-1}was manifested for Adi variety followed by Weyib 4.72 t ha^{-1}, while the minimum grain yield mean value 3.33 t ha^{-1}was revealed by Local at Goda hora location (Table 6). At the Goremti location, the highest grain yield mean value of 1.75 t ha^{-1} was manifested by Letu variety followed by Adi 1.62 t ha^{-1}, while the lowest grain yield 0.96 t ha^{-1}was manifested by Herena (Table 6). The mean grain yield of the tested varieties across the environment was varied, this indicated the existence of significant genotypes into environmental interaction. Larger yield variation between environments indicated that the environments were variable whereas some of the environments were more favorable for field pea varieties to produce high yield while other locations were less favorable. It also indicated that the varieties responded differently at different locations due to the effects of genotype x environment interaction. The performance of a given variety depends upon its genetic potential and the environment where it is grown (Mangistu et al., 2011). Among locations, the Goremti site was not conducive for field pea production since all the tested varieties manifested low grain yield. Likewise, Fikere et al. (2010) and Kindie et al. (2019) had reported significant differences among the tested field pea genotypes across the tested environments for grain yield and other yield-related traits.

Harvest index

Harvest index is a critical factor of yield-related traits which can influence grain yield. At all locations, the yield obtained showed statistically significant differences among the tested varieties for harvest index except at Ejersalafo site (Table 5). At the Babich site, the maximum harvest index value of 24.55 was manifested for the Bursa variety, while a minimum mean value (12.4) was revealed for Herena (Table 5). At CheliaRefisoAlenga location, the maximum harvest index (45.5) was manifested by the T/shaman variety, while the minimum value (20) was revealed by Burkitu (Table 5). On the other hand, all the tested varieties revealed non-significant differences for harvest index at the Ejersolafo site (Table 5). The highest harvest mean value 77.3 was manifested for Adi variety followed by the T/shaman variety with mean value of 75.65, while the lowest mean value of 43.75was revealed by Hortu at Goda hora location (Table 6). At the Goremti location, the highest harvest index (28.8) was manifested by the Adi variety, while the lowest value of 12.8was manifested by Herena (Table 6).

Table 6: *Mean value of grain yield and yield-related traits of nine tested field pea variety at Goda hora and Goremti.*

Variety	Test environment									
	Goda hora					Goremti				
Parameters	GY (t/ha)	HI	AGB	HSW	SPP	GY (t/ha)	HI	AGB	HSW	SPP
Bursa	4.64b	54.1d	85.75b	10.31a	3.5c	1.31ab	15.9c	84.0a	22.3ab	5.8a
Local	3.33e	37.95f	87.75a	12.82a	5ab	1.12ab	15.2c	75ab	24.15a	5a
Adi	5.06a	77.3a	65.5e	13.42a	4 bc	1.62ab	28.80a	57.50ab	18.4c	6 a
Weyib	4.72ab	68.9b	68.5d	12.82a	5.5a	0.97b	12.8c	75.5ab	23.1ab	6.3a
Letu	3.33e	40.7ef	81.75c	13.22a	4 bc	1.75a	23.30b	74.50ab	21.3abc	5.75a
T/shaman	3.61de	75.65a	47.75h	11.38a	4bc	1.08ab	16.8c	64.50ab	23.9a	5.5a
Burqitu	4.17c	68.95b	60.5g	11.67a	3.5c	1.29ab	15.4c	84.0a	23.15ab	6.1a
Hortu	3.61de	43.75e	82.5c	14.26a	5.5a	1.35ab	25.6ab	55.50b	19.5bc	5.75a
Herena	3.89dc	62.2c	62.5f	10.51a	4.5abc	0.96b	13.35c	72ab	22.1abc	5.5a
EMS	2.35	3.75	0.74	4.15	0.25	11.47	3.81	149.5	2.76	0.40
LSD (5%)	3.53	4.47	1.99	4.69	1.15	7.81	4.49	28.19	3.83	1.46

GY: *grain yield,* **HI:** *harvest index,* **AGB:** *above ground biomass,* **HSW:** *hundred seed, SPP number of seed per pod. Mean in the same column followed by the same letters are non-significant different at 5 % significance level.*

Above-ground biomass

At all locations, the yield obtained showed statistically significant differences among the tested varieties for above-ground biomass traits except at the Ejersalafo site (Table 6). At the Babich site, the maximum above-ground biomass (121q/ha) was manifested for the local variety, while a minimum value (91q/ha) was revealed for Hortu (Table 5). At Chelia Refiso Alenga location, the maximum above-ground biomass (45.5q/ha) was manifested by T/shaman variety, while the minimum (20q/ha) was revealed by Burkitu (Table 5). On the other hand, all the tested varieties revealed statistically non-significant differences for above-ground biomass at the Ejersolafo site (Table 5). The highest above ground biomass value (87.75 q/ha) was manifested for Local variety followed by T/shaman variety with mean value of 75.65 q/ha, while the lowest value of 62.5 q/ha was revealed by Herena at Goda hora location (Table 6). At the Goremti location, the highest above ground biomass mean value (84 q/ha) was manifested by Bursa and Burkitu varieties, while the lowest value 55.5was manifested by Hortu (Table 6).

Hundred seed weight

Even though a hundred seed weight is one of the seed yield determining traits, in the present study the maximum hundred seed weight was not revealed for the maximum grain seed variety at the Babich site. This may be due to the effect of genotype and its interaction with the environment. But Habtamu and Million (2013) reported a negative association of hundred seed weight and seed yield. In the present study, a hundred seed weight showed statistically significant differences among the tested varieties at all studied locations. At the Babich site, the maximum hundred seed weight mean value of 22.21gm was manifested for Burkitu variety, while a minimum value of 15.42gm was revealed for Herena (Table 5). At CheliaRefisoAlenga location, the maximum hundred seed weight of 23.12 gm was manifested by the Hortu variety, while the minimum (20.26gm) was revealed by Bursa (Table 5). But all the tested varieties revealed statistically non-significant differences for hundred seed weight at the ChaliyaRefisoAlenga site (Table 5). The highest hundred seed weight value of 24.4gm was manifested for the Herena variety, while the lowest value (22.55gm) was revealed by Herena at the Ejersalafo location (Table 5). The highest hundred seed weight (14.26gm) was manifested for the Hortu variety, while the lowest value of 10.31gm was revealed by Bursa at Goda hora location (Table 5), but a statistically non-significant difference was observed between them. At the Goremti location, the highest hundred seed weight biomass (24.15gm) was manifested by Local variety, while the lowest value of 18.4was manifested by Adi (Table 6). The obtained value for hundred seed weights varied among locations within the same variety, this is due to the existence of genotypes into environmental interaction. But Ceyhan and Avci (2015) reported that the observed differences in grain weight among varieties might be due to inherent genetic differences among the varieties.

Number of seeds per pod

In the present study, the number of seeds per pod showed statistically significant differences among the tested varieties at all studied locations, except Goremti. At the Babich site, the maximum seed per pod (5.7) was manifested for the Weyib variety, while a minimum value of 4.4 was revealed for the Burkitu variety (Table 5). At CheliaRefisoAlenga location, the maximum seed per pod 6.12 was manifested by the Hortu variety, while the minimum value of 4.45 was revealed by T/shaman (Table 6). The highest seed per pod (6.5) was manifested for the Adi variety, while the lowest value (5) was revealed by Hortu at the Ejersalafo location (Table 5). The highest seed per pod (5.5) was manifested for Weyib and Hortu varieties while the lowest value of 3.5 was revealed by Bursa and Burkitu varieties at Goda hora location (Table 6). At the Goremti location, the highest seed per pod mean value of 6.3 was manifested by the Weyib variety, while the lowest value of 5 was manifested by Local variety (Table 6). The obtained value for seed per pod varied among locations within varieties, this was due to genotypes x environmental interaction. Number of seed per plant, biological yield, and harvest index were the most important factors in determining seed yield indicating that selection for any one of them may permit improvement in grain yield in field pea program (Gao and Ashamo, 2014).

Conclusions and Recommendations

Based on the present find Bursa variety is best performed at Babich, Weyibe variety is best performed at both CheliyaRefisoAlenga and Goda Hora sites, while Herena variety best performed at the Ejersalafo and Letubest performed at Goremti site. This suggested that testing of varieties over different locations is recommendable before large-scale production.Finally, to recommend the best varieties in the studied area yield stability analysis of the varieties is advisable and this work should be repeated in the future for more justification.

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Novelty Statement

The study was identified best varieties for the studied area and for an area of similar agro-ecology.

Author's Contribution

Gudeta Nepir Gurmu: Designed the work, data collection and manuscript editing.
Alemu Lenco Gemechu and Kegna Gadisa Imana: Collected the data.
Gemechu Nedi Terfa: Layout the experiment, data analysis and manuscript writing.

Conflict of interest

The authors have declared no conflict of interest.

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