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Faba Bean (Vicia faba L.) Variety Adaptation Trial in Alicho Wuriro and Anlemo Districts of Southern Ethiopia

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Abstract
Faba bean (Vicia faba L.) is a major food and feed legume. The trial consisting of 10 varieties and a local check were evaluated for adaptation in Alicho Wuriro and Anlemo districts of Southern, Ethiopia using a randomized complete block design with three replications during 2013. Data on some agronomical traits were recorded. Highly significant difference at (P<0.01) Table 4 were between days to flowering x varieties, plat height x locations, days to maturity x locations, hundred seed weight x varieties, yield x locations. And significantly different at (p<0.05) were between days to flowering x locations, plant height x locations x varieties, pods per plant x locations, number of pods per plants x locations x varieties, number of seeds per plants x locations x varieties, days to maturity x varieties, 100 seed weight x locations x varieties. The top mean grain yield (Table 2 and Graph 1), (4.62 ton ha-1) over locations was achieved by variety Dosha followed by Shallo (4.58 ton ha^{-1}), Obse (4.48 ton ha^{-1}), Gabelcho (4.44 ton ha^{-1}) and Moti (4.37 ton ha^{-1}). Among the tested locations maximum mean yield was at Anlemo (4.46 ton ha^{-1}) followed by Alicho Wuriro (3.92 ton ha^{-1}). Yield over locations were highly significant differences at (P<0.01). From Anlemo district Shallo variety with mean yield (5.42 ton ha^{-1}); followed by varieties Dosha (5.07ton ha^{-1}), Moti (4.86 ton ha^{-1}), Gabelcho (4.79 ton ha^{-1}), Degaga (4.79 ton ha^{-1}) and Obse (4.58 ton ha^{-1}) which were higher than location mean but not significantly different (Table 2 and Graph 1). From Alicho Wuriro district there was no varieties significantly difference on yield, but Tumsa (4.58 ton ha^{-1}), Obse (4.38 ton ha^{-1}), Dosha (4.17 ton ha^{-1}) and Gabelcho (4.10 ton ha^{-1}) to be used as variety option (Table 2 and Graph 1). Dosha variety was the highest and stable in grain yield across locations. But Tumssa variety was not stable; the highest grain yield in Alicho Wuriro district but the lowest garin yield in Anlemo district. Variable diseases chocolate spot and rust severity scores (1-9) scale were recorded for all tested varieties. Almost all the varieties tested across locations in 2013 cropping season were exhibited immune to moderately susceptible (2-5) reactions to important diseases indicating that they could be used as a source of gene for resistance in breeding programs Table 3. Different severity scores were recorded for both diseases reactions on the same varieties in different environments but both did not show significant differences Table 4. But rust positively highly correlated to grain yield.
Keywords: Faba bean, disease reaction, fungal pathogens.

1. Introduction

Faba bean (*Vicia faba* L.) is a major food and feed legume because of the high nutritional value of its seeds. In Ethiopia, it was with other food legumes covers about covered 15.17 % (1,863,445.42 hectares) of the grain crop area and 11.89% (about 27,510,311.88 quintals) of the grain production was drawn from the same crops. It accounts 4.67 % (about 574,060.45 hectares). The production obtained from faba bean was 4.08% (about 9,439,641.70 quintals) of the grain production. In Southern Ethiopia also it accounts 1st from grain legumes in area coverage 72,520.46 hectares and productions of 1,137,129.34 quintals in total grain yield that covers 15.68%. Regardless of its significance, national as well as regional average yield is low; 16.44 qt/ha and 15.68 qt/ha, respectively (CSA, 213). Ethiopia is probably one of the primary centres of diversity for faba bean. Although the small seeded type of the Ethiopian faba bean is not well studied, there are some reports of tremendous diversity in protein content, chocolate spot and leaf rust resistance IBC (2008). In addition, it is grown in pockets in the rest of the country's high land and semi-high land regions with altitudes ranging from 1800-3000 meters above sea level. It is widely used for food and has high protein content (MOA, 2012). Pulses complement cereals as a source of protein and minerals as they provide 15-40% of protein (Monti and Grillo, 1983). Pulses have slowly digestible carbohydrates, high fiber and protein contents, and moderate energy. The amount of protein in pulses is about 17–35% on a dry weight basis (Mc Crory et al., 2010). Pulses can play a significant role in improving smallholders' food security as an affordable source of protein in fact; pulses make up around 15% of the average Ethiopian diet (IFPRI, 2010). This crop is very much important in the highlands of South Nation and Nationalities of Ethiopia since it fetches cash for the farming community and also serves as rotational crop which play great role in controlling disease epidemics in areas were cereal mono cropping is abundant. It plays a significant role in soil fertility restoration as a suitable rotation crop that fixes atmospheric Nitrogen. Nationally important cereal crops like wheat, tef and barley were used in crop rotation with (MOA, 2012). Generally, it was a crop of manifold merits in the economic lives of the farming communities of highlands of Ethiopia. Accordingly, this paper evaluate the reaction of faba bean varieties with a local check to adaptability as well as their disease reactions to the two locations of Southern Ethiopia.

2. Materials and Methods

2.1. Description of the Area

This study was conducted on Worabe Aricultural Research Centre at Alicho Wuriro and Anlemo districts of Southern, Ethiopia during 2013 cropping season. Alicho Wuriro district is one of the 9 districts including administration town from Siltie zone. Concerning the climate of the zone it has two different agro-climatic conditions, *Dega* and *Woina-dega* and consisting 37% and 63% respectively. The average temperature ranges from 12-26˚C and the average annual rainfall ranges from 780-1818 mm. About 95.5% of the population engaged in agriculture Ligbato Ahmed and Yewbdar Ahmed, (2011). The trial was conducted at Alicho Wuriro district about 18 km from Worabe town, capital of Siltie zone. It was done at elevation of 2787 meters above sea level (masl), and geographically located at 038°09' 048'' East and 07°56' 416'' North. While Anlemo district is one of 10 districts and an administrative town in Hadya zone. The size of this zone is 346958.5 hectares. From this 12.9% is low altitude, 68.1% is mid altitude and 19% is high altitude areas. The people engaged by growing crops and rearing of animals and hence the most important livelihood is agriculture. The amount of rainfall received ranges from 801 mm to 1400 mm. The rainy season lasts from June to August. The annual mean maximum temperature is 22.54 °c (Statistical Abstract, 2011-12). The trial has been done at elevation of 2506 meters above sea level (masl), and geographically located at 037°57' 145'' East and 07°37' 368'' North at Anlemo district.

2.2. Materials

There were ten varieties with a local check. The varieties were listed here; Hachalu, Dosha, Tumsa, Wolki, Obse, Moti, Gabelcho, Degaga, Shallo, CS-20DK and local cultivar as a check.

2.3. Experimental Layout

The trial has been laid out with randomized complete block design (RCBD) with three replications, ten faba bean varieties and a local check. Each plot size were 2.4 meters X 3 meters which equals to 7.2 meter squares and the actual area that the data have been collected were 1.6 meters X 3 meters equals to 4.8 meter square with spacing 40 cm by 10 cm between rows and plants respectively. Land preparation was done mid-May to June at both locations planting of faba bean was conducted at end of June. Fertilizer rates of 100 kg DAP per hectare was applied at the time of planting, in both locations. The recommended hand weeding was used to control weeds and cultivation once before flowering.

2.4. Data Collection

Agronomic data such as days to flowering collected the data at 50% days of flowering, number of pods per plant have been taken from five plants randomly selected from center rows, then number of seeds per plants have been counting from that five plants used previously for number pods per plants, days to 95% maturity date of data was collected from planting to physiologically matured date, plant height was measured by centimeter for the five plants, Disease data of chocolate spot and rust were collected based on 1-9 scale following Little and Hills (1978); where 1 stands for immune, 2 for highly resistant, 3 for resistant, 4 for moderately resistant, 5 and 6 for moderately susceptible, 7 for susceptible, and 8 and 9 highly susceptible, hundred seed weight was measured by using sensitive balance after drying the seeds and grain yield per hectare were converted that grain yield obtained from the total harvestable areas of center rows that means from 4.8 meter square actual area of each plots from both locations.

2.5. Statistical Analysis

The experiment has been used randomized complete block design (RCBD) with three replications, ten faba bean varieties and a local check. The agronomic data were subjected to the analysis of variance (Gomez and Gomez, 1984). Combined analysis of variance was performed across test locations of Alicho Wuriro and Anlemo districts in Southern Ethiopia. Analysis of variance for each location was done for grain yield and other traits, using the (SAS System for Windows Release 9.00).

3. Result and Discussion

3.1. Agronomic Performances

The analysis of variance for some agronomic characters of faba bean (*Vicia faba*) varieties were represented in Table 4 and there was highly significant at ($P<0.01$) variation between days to flowering x varieties, plant height x locations, days to maturity x locations, hundred seed weight x varieties and there was significantly different at ($p<0.05$) between days to flowering x locations, plant height x locations x varieties, pods per plant x locations, pods per plants x locations x varieties, number of seeds per plants x locations x varieties, days to maturity x varieties, hundred seed weight x locations x varieties across locations with a cropping year, indicating that the environmental factors were highly attributed for the variations. When looking the yield of varieties per hectare in

(ton ha-^{1}) for both locations in combined analysis result did not show significance differences. From tested varieties in (Table 2 and Graph 1) Dosha (4.62 ton ha-^{1}), Shallo (4.58 ton ha-^{1}), Obse (4.48 ton ha-^{1}), Gabelcho (4.44 ton ha-^{1}) and Moti (4.37 ton ha-^{1}) were the most preferred from others, to use for production or multiplications in there order to tested locations due to yield advantages. Especially local variety was the second least next to Hachalu variety in the overall mean yield. As analysis of variance in yield mean by locations was highly significant differences at ($P<0.01$) as above discussed. That means Anlemo district with grand mean of yield *(*4.46 ton ha-^{1}) was indicated statistical analysis result shows highly significantly different. From Anlemo district Shallo variety with mean yield (5.42 ton ha-^{1}) as mean comparison exhibits significantly different from Tumssa variety but not significantly different from other tested varieties. Following the varieties that resulted higher location yield mean were: Dosha (5.07ton ha-^{1}), Moti (4.86 ton ha-^{1}), Gabelcho (4.79 ton ha-^{1}), Degaga (4.79 ton ha-^{1}) and Obse (4.58 ton ha-^{1}) and used as variety option due to yield advantages from the rest (Table 2 and Graph 1). This location was more potential for production of faba bean than Alicho Wuriro district which have resulted a mean yield of (3.92 ton ha-^{1}) from tested faba bean varieties. From Alicho Wuriro district there was no varieties significant difference as mean comparison done on yield. Hence the varieties with mean yield Tumsa (4.58 ton ha-^{1}), Obse (4.38 ton ha-^{1}), Dosha (4.17 ton ha-^{1}) and Gabelcho (4.10 ton ha-^{1}) to be used or preferred as variety option by their yield (Table 2 and Graph 1). For both locations the local check were resulted yield lower than mean yields of each location.

3.2. Disease Reaction

The three fungal diseases, chocolate spot (*Botrytis fabae*), ascochyta blight (*Ascochyta fabae*) and rust (*Uromyces viciae-fabae*) can lead to very significant loss in yield and seed quality if susceptible varieties are cultivated and disease is not managed effectively with regular application of fungicides Hanounik, S.B. and Robertson, L.D. (1989). Rusts (*Uromyces viciae-fabae*) on beans, appears at a much earlier stage of crop development and can cause significant (>50%) yield loss. Chocolate spot (*Botrytis fabae*) this is also serious disease of field beans in wet seasons and can cause serious yield loss. The leaf symptoms are small, brown spots that coalesce and produce large, black blotches if high humidity prevails, Lane A. and Gladders P. (2000). Variable diseases chocolate spot and rust severity scores (1-9) scale were recorded as Little and Hills (1978), for all tested varieties of faba bean in two environments. Almost all of the varieties tested across two locations at 2013 cropping season were exhibited immune to moderately susceptible (2-5) reactions to important diseases indicating that they could be used as a source of gene for resistance in breeding programs Table 3. Some of the tested varieties were resistant to rust than chocolate spot. However, the varieties showed resistance reaction to rust and moderately resistance reaction to chocolate spot; indicating that yield loss could be inflicted during heavy infestation. Therefore, source of resistance for these diseases should be sought and utilized in breeding programs. Different severity scores were recorded for both diseases on the same genotype in different environments but both of the fungal pathogens did not show significant difference across locations and varieties Table 4. This indicates that disease severity on a particular variety depends on environmental factors that favour or disfavour disease build up, and the inherent (genetic) potential of the variety to resist the disease.

3.3. Correlation of Yield and Yield Related Characters

The correlation coefficients among traits computed as Spearman's coefficient of correlation among all the stability parameters in Table 5. The coefficients of variations at phenotypic and genotypic levels were estimated using the formula adopted by Johnson et al. (1995). Significance of variability for each trait was tested against tabulated F-values at 5% and 1% probability level. Association reveals that grain yield had negative and significant phenotypic correlations with the number of pods per plant and number of seeds per plant. Whereas, genotypic association showed the grain yield had positive and highly significant with varieties/ genotypes, reaction to rust disease, and days to maturity. Positive and significant genotypic association was existed between grain yield and days to flowering and plant height.

Table 1 . List of varieties/materials along with their source.

No	Material	Source
1	Hachalu	Kulumssa Agricultural Research Center
2	Dosha	Kulumssa Agricultural Research Center
3	Tumsa	Kulumssa Agricultural Research Center
4	Wolki	Kulumssa Agricultural Research Center
5	Obse	Holeta Agricultural Research Center
6	Moti	Kulumssa Agricultural Research Center
7	Gabelcho	Kulumssa Agricultural Research Center
8	Degaga	Kulumssa Agricultural Research Center
9	Shallo	Sinana Agricultural Research Center
10	CS-20 DK	Kulumssa Agricultural Research Center
11	Local cultivar	Farmer

Table 2. Overall means for agronomic characters and grain mean yield in ton ha-[1] of faba bean varieties grown at Anlemo and Alicho Wuriro districts of Southern, Ethiopia during 2013.

	Agronomic characters						Mean yield in ton ha-[1] across locations		Over all mean of yield in ton ha-[1]
Varieties	DTF	PLH	PPL	SPPL	DTM	HSW	Alicho Wuriro	Anlemo	
CS-20 DK	60.2^{c}	137.5^{a}	24.0^{ab}	63.0^{ab}	153.3^{ab}	66.12^{bc}	3.82^{a}	4.24^{ab}	4.03^{a}
Degaga	65.2^{a}	126.3^{b}	21.8^{ab}	57.2^{ab}	153.2^{ab}	65.13^{c}	3.40^{a}	4.79^{ab}	4.10^{a}
Dosha	61.7^{bc}	133.0^{ab}	24.2^{ab}	63.7^{ab}	152.8^{ab}	69.65^{bc}	4.17^{a}	5.07^{ab}	4.62^{a}
Gabelcho	66.8^{a}	134.3^{ab}	20.2^{b}	48.5^{b}	155.5^{a}	85.17^{a}	4.10^{a}	4.79^{ab}	4.44^{a}
Hachalu	64.8^{ab}	131.3^{ab}	24.5^{ab}	62.3^{ab}	152.8^{ab}	70.52^{bc}	3.75^{a}	3.68^{ab}	3.72^{a}
Local	59.0^{c}	130.3^{ab}	26.7^{a}	70.8^{a}	153.3^{ab}	64.17^{c}	3.89^{a}	3.82^{ab}	3.85^{a}
Moti	60.0^{c}	137.7^{a}	21.3^{ab}	55.0^{ab}	152.5^{ab}	79.68^{ab}	3.89^{a}	4.86^{ab}	4.37^{a}
Obse	60.3^{c}	134.0^{ab}	21.7^{ab}	59.8^{ab}	152.0^{b}	73.15^{ab}	4.38^{a}	4.58^{ab}	4.48^{a}
Shallo	59.0^{c}	133.8^{ab}	22.8^{ab}	56.8^{ab}	152.2^{b}	66.82^{bc}	3.75^{a}	5.42^{a}	4.58^{a}
Tumsa	65.0^{ab}	141.0^{a}	25.3^{ab}	60.5^{ab}	155.5^{a}	70.38^{bc}	4.58^{a}	3.33^{b}	3.96^{a}
Wolki	62.0^{b}	130.8^{ab}	24.0^{ab}	63.2^{ab}	151.0^{b}	64.17^{c}	3.40^{a}	4.44^{ab}	3.92^{a}
Grand Mean	62.18	133.65	23.32	60.07	153.11	70.45	3.92^{b}	4.46^{a}	4.19
LSD	4.22	11.05	6.50	17.63	3.45	14.07	18.95	18.98	12.74
CV (%)	4.35	5.29	17.85	18.79	1.44	12.79	20.80	18.32	19.48
R-Square	0.67	0.95	0.54	0.54	0.74	0.59	0.28	0.49	0.46

DTF= days to flowering, PLH= plant height (cm), PPL= number of pods per plant, SPPL= number of seeds per plant, DTM= days to maturity, HSW= hundred seed weight in gram, LSD = Least significant differences and CV = coefficient of variations.

Table 3. Average severity (1-9) scale of Chocolate spot (Chst) and Rust (Rst), Faba bean varieties evaluated at 2 locations (2013) in Southern, Ethiopia.

Varieties	Disease reactions of the locations				Over all mean of disease reactions	
	Alicho Wuriro		Analimo		Rst	ChSt
	Rst	ChSt	Rst	ChSt		
CS-20 DK	3	4	4	4	4	4
Degaga	3	4	3	4	3	4
Dosha	3	5	3	4	3	5
Gabelcho	3	4	2	3	3	4
Hachalu	3	4	3	4	3	4
Local	3	4	3	5	3	5
Moti	3	4	4	4	4	4
Obse	3	4	3	5	3	5
Shalio	3	4	3	4	3	4
Tumsa	3	4	3	4	3	4
Wolki	3	4	3	4	3	4
Average severity	3	4	3	4	3 ns	4 ns
LSD	0.70	1.98	1.79	1.74	0.92	1.25
CV (%)	9.75	20.54	25.24	18.44	19.07	19.54
R-Square	0.33	0.20	0.33	0.53	0.33	0.39

ChSt = Chocolate Spot (1-9 scale), Rst = Rust (1-9 scale), LSD= Least significance difference, CV = coefficient of variations and ns= Non significance.

Table 4. Combined analysis of variance for some of agronomic traits of Faba bean (*Vicia faba*) varieties tested on one cropping season (2013) and two locations at Alicho Wuriro and Anlemo districts in Southern Ethiopia.

		Mean squares								
Source of variation	DF	DTF	PTH	ChSt	Rst	PPL	SPPL	DTM	HSW	YPH
L	1	44.18*	36636.74**	0.14 ^{ns}	0.02^{ns}	114.68*	507.41^{ns}	422.56**	0.60 ^{ns}	474.95*
R(L)	4	6.45 ^{ns}	105.02 ^{ns}	1.39 ^{ns}	0.06 ^{ns}	25.95 ^{ns}	133.39^{ns}	2.56 ^{ns}	42.97^{ns}	49.98^{ns}
G	10	46.98**	98.31 ^{ns}	0.41^{ns}	0.38 ^{ns}	22.42^{ns}	198.48^{ns}	11.18*	269.39**	61.08^{ns}
L*G	10	5.58 ^{ns}	122.64*	0.67^{ns}	0.28 ^{ns}	36.88*	293.91*	1.59 ^{ns}	184.60*	99.85^{ns}
Error	40	7.30	50.06	0.64	0.34	17.32	127.49	4.89	81.25	66.61
CV (%)		4.35	5.29	19.54	19.07	17.85	18.79	1.44	12.79	19.48

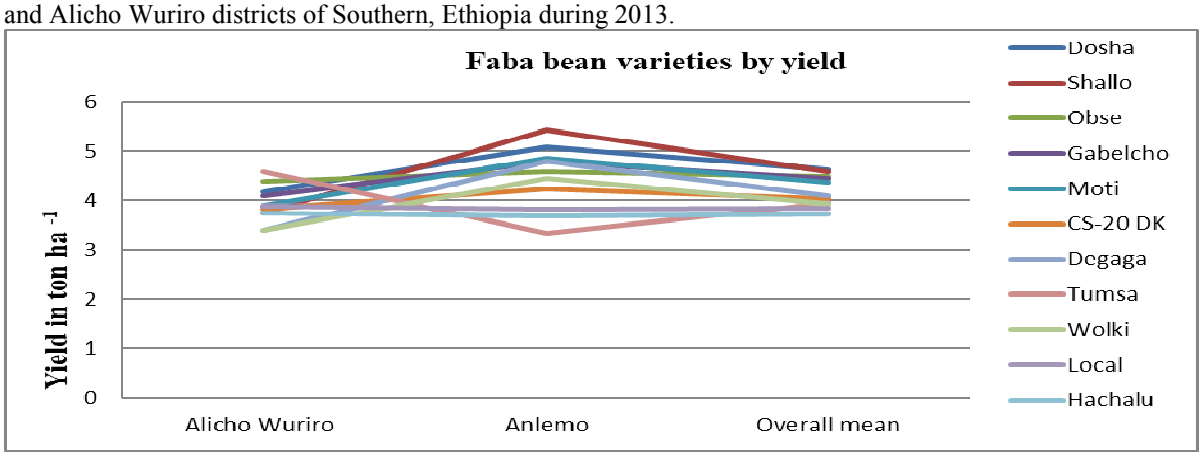
*, **, ns =significant, highly significant and non-significant at the level of P<0.01 and 0.05 respectively. L, G and R = location, genotype/variety and replication respectively. CV% = Coefficient of variation in percentage. DF= degree of freedom, DTF = days to 50% flowering, DTM = Days to 95% maturity, ChSt = Chocolate Spot (1-9 scale), Rst = Rust (1-9 scale), PTH = plant height in centimeter, PPL = number of pods per plant, SPPL = number of seeds per plant, HSW = hundred seeds weight in gram, YPH = yield in ton ha^{-1}.

Table 5. Spearman's coefficient of correlation estimates at phenotypic and genotypic levels of 10 traits 10 faba bean varieties and a local cultivar evaluated at 2 environments in Southern Ethiopia.

Character	Attribute	DTF	PLH	Rst	ChSt	PPL	SPPL	DTM	HSW	YPH
Var	P	-0.191	0.249	-0.298	-0.065	0.150	0.046	-0.252	-0.055	-0.047
	G	0.574*	0.461	0.373	0.850**	0.661**	0.893**	0.454	0.874**	0.890**
DTF	P		-0.095	-0.369	-0.425	-0.257	-0.469	0.607*	0.365	-0.218
	G		0.782**	0.265	0.192	0.446	0.145	0.048	0.269	0.520*
PLH	P			0.482	-0.190	0.011	-0.195	0.406	0.399	0.166
	G			0.133	0.576*	0.974**	0.565*	0.215	0.225	0.627*
Rst	P				-0.289	-0.171	-0.092	-0.073	0.181	0.018
	G				0.389	0.616*	0.787**	0.832**	0.595*	0.957**
ChSt	P					0.293	0.524*	-0.188	-0.140	0.259
	G					0.383	0.098	0.579*	0.681**	0.441
PPL	P						0.898**	-0.025	-0.680**	-0.610*
	G						0.0002	0.942**	0.021	0.047
SPPL	P							-0.336	-0.761**	-0.517*
	G							0.312	0.007	0.104
DTM	P								0.445	-0.060
	G								0.170	0.861**
HSW	P									0.439
	G									0.177

*, ** =significant, highly significant at the level of P<0.01 and 0.05 respectively. L, G and R = location, genotype/variety and replication respectively. DTF = days to 50% flowering, DTM = Days to 95% maturity, ChSt = Chocolate Spot (1-9 scale), Rst = Rust (1-9 scale), PTH = plant height in centimeter, PPL = number of pods per plant, SPPL = number of seeds per plant, HSW = hundred seeds weight in gram, YPH = yield in ton ha^{-1}.

Graph 1. Grain mean yield and two locations mean yield in ton ha-^{1} of 11 faba bean varieties grown at Anlemo and Alicho Wuriro districts of Southern, Ethiopia during 2013.



4. Conclusion and Recommendations

This study was conducted on Worabe Aricultural Research Centre at Alicho Wuriro and Anlemo districts of Southern, Ethiopia during 2013 cropping season with the objective of evaluating faba bean varieties with a local check to adaptability. Data on some agronomical traits were recorded. Highly significant difference at ($P<0.01$) Table 4 were between days to flowering x varieties, plant height x locations, days to maturity x locations, hundred seed weight x varieties, yield x locations. And significantly different at ($p<0.05$) were between days to flowering x locations, plant height x locations x varieties, pods per plant x locations, pods per plants x locations x varieties, number of seeds per plants x locations x varieties, days to maturity x varieties, hundred seed weight x locations x varieties. The significant varieties x location (GXE) interactions and the changes in the rank of varieties across location suggest specifically adapted varieties and stability of varieties across locations. Dosha variety was the highest and stable in grain yield across locations. But Tumssa variety was not stable in yield, the highest grain yield in Alicho Wuriro district and the lowest garin yield in Anlemo district. Hachalu variety gives the lowest in grain yield across locations. When we compare the two locations, Anlemo district is the potential area than Alicho Wuriro district Table 2 and Graph 1 Almost all the varieties tested across locations in 2013 cropping season were exhibited immune to moderately susceptible (2-5) reactions to important diseases indicating that they could be used as a source of gene for resistance in breeding programs Table 3. Different severity scores were recorded for both diseases reactions on the same varieties in different environments but both did not show significant differences Table 4.

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