Current Research in Agricultural Sciences
2014 Vol. 1, No. 3, pp. 65-76
ISSN(e): 2312-6418
ISSN(p): 2313-3716

EVALUATION OF FIELD PEA (PISUM SATIVUM L) GENOTYPES PERFORMANCE FOR YIELD AND YIELD COMPONENTS AT FIVE GROWING ENVIRONMENTS OF SOUTHERN ETHIOPIA

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ABSTRACT

Field experiments consisting of 24 field pea genotypes were evaluated for performance and correlation of yield and its components in five locations of Southern region, Ethiopia using a randomized complete block design with three replications during 2006/07. Data on some agronomical traits such as number of pods per plant, number of seeds per plant, number of seeds per pod, Harvest index, 100 seed weight, plant height, biological yield, and seed yield were recorded. Significant difference was observed in all locations among the field pea genotypes for grain yield. The top mean grain yield (2659 kg ha^{-1}) over the locations was achieved by the genotype Gume followed by Milky (2625 kg ha^{-1}), FpEx-Dz (2511 kg ha^{-1}) and Weyyetu (2460 kg ha^{-1}). Among the test locations maximum mean grain yield was produced at Angacha (3801.98 kg ha^{-1}) followed by Hossana (2087.93 kg ha^{-1}), Freeze (1734.96 t ha^{-1}) and Waka (1428.8 kg ha^{-1}). The mean seed yield and positive environmental indices value of the present study corroborated that Angacha was found to be a favourable environment for the majority of field pea genotypes. Combined analysis of variance (ANOVA) Genotype environment interaction (GEI) was highly significant for all traits of the study though; Markos, IG-51890 and IG-51700 identified to be stable for more than one trait and officially released variety should be demonstrated on farm for acceptability and two 'pipe line 'genotypes namely IG-51890 and IG-51700 for further evaluation in diverse environments of south Ethiopia. Strong positive correlation of number of seeds per plant, number of pods per plant, harvest index, biological yield and plant height with seed yield indicates that these traits should be used as selection criteria to improve grain yield.

Keywords: Field pea, Performance, Simple correlation, Wider adaptability, Yield components.

Contribution/ Originality

The study with the objective of releasing new varieties from promising field pea genotypes and demonstrating the commercial cultivars for growing areas of southern region, Ethiopia.

1. INTRODUCTION

Field pea (Pisum sativum L.) is an annual herbaceous legume adapted to cool moist climate with moderate temperatures [1]. It is the second most important staple cool-season food legume among the highland pulses in rural Ethiopia [2]. In Ethiopia field pea is produced in various regions and is widely grown in north, south, west and central parts of the country including, pocket areas in highland and mid highlands with altitude ranging from 1800-3000 m.a.s.l. It is one of the major cool season food legumes, which occupies about 255,968.83 and 52,124.96 hectares of land annually with estimated production of 3,273,775.14 qt and 651,049.80 qt in the

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country and southern region, respectively [3]. Besides, it plays a significant role in commodity group of export, earning a substantial amount of foreign exchange for the country and cash for poor farmers. In 2001/2002, from a total 1,229,336 quintals (qt) of pulses production of the southern region, about 2.3 % of foreign currency was contributed from field pea [4].

Regardless of its significance, national as well as regional average yield is low; 12.79 qt/ha and 12.49 qt/ha, respectively [3]. Of the major problems that contribute for low yield and productivity, are few numbers of improved field pea varieties with high yield potential, wider adaptability, resistant to biotic and a biotic stresses for southern part of Ethiopia in field pea production. Thus to improve the productivity of field pea in Ethiopia, selections of some high yielding varieties has been achieved but unstable for grain yields under a wide range of geographical zones of Ethiopia [2].

Several Researchers have recently reviewed the Genotype x environment interactions (GEI) and its implication for efficient breeding strategies in crop plants for adaptation and yield stability [5]. Stability analysis based on regression technique of popularized by Eberhart and Russell [6] and explained using genetic models based on approach by Perkins and Jinks [7], [8] has made it possible to handle rationally these Genotype x environment interactions.

Successful yield improvement strategy also requires the knowledge on the nature of correlation among different traits interact to influence the final yield, especially for crops that are tested in diverse environment. The reviews of literature reveal differences between results reported by various scientists on performance and correlation analysis in different crops. This indicates that the traits association changes with change in genotype.

Seboka and Fikresilassie [9] conducted experiments on 16 field pea genotypes and reported that seed yield had positive and significant correlation with grain filling periods, number of seeds per pod, seed per plant, pod length and plant height. Positive and significant association was existed between seed yield and plant height and number of days to physiological maturity.

Tesfaye [10]; Tezera [11]also reported that positive and highly significant association exhibited between seed yield and thousand seed weight which is consistent with this study but against with the study reported by Seboka and Fikresilassie [9] in Ethiopia. The positive significant correlation observed between seed yield with plant height are in agreement with results reported by Fikreselassie, et al. [12] but contradicts with earlier studies from Ethiopia [10, 11].

Bakhsh, et al. [13] showed that correlation of plant height, number of primary branches and harvest index with grain yield were different. Several past studies show that the association between characters changes with change in environment and genotype. For example Singh and Singh [14] showed 100 seed weight to be negatively associated with grain yield, whereas, the same trait appeared to be positively associated with grain yield in another study reported by Arshad, et al. [15]. Similarly, the harvest index was positively associated with grain yield in one of these studies whereas; this correlation was negative in the other. It has been suggested that these differences could be due to variations in genotypes studied in different environments [13].

In this Research with determining field pea genotype having high yield and wider adaptability, correlation between yield and yield components were examined in the southern region of Ethiopia

2. MATERIALS AND METHODS

2.1. History of the Study Area

The genotypes were evaluated at five locations: Angacha (2381masl,1759.1mm, Luvicphaeozems, 18.27°c, E38°29', N07°3');Hossana (2290masl,1592.1mm, Profondic Luvisols, 17.02°c, E37°5', N07°5'); Freeze (2884masl,1860.7mm, ,Dystric Luvisols,18°c, E38°00', N07°52');Waka(2440masl,817.7mm,Haplicalisol,16.54°c,E37°11'36",N07°03'0.83")andAreka(1830 masl,1659.1mm,Haplic alisol,20.3°c, E37°41'30", N07°4'24") [16, 17] representing the field pea growing areas of SNNPRs in the Meher season of 2006/07.

2.2. Design and Methodology

The experiment was laid out in complete Randomized block design with three replications of plots having 6 rows of 4m length with 20 cm and 5 cm distance between rows and plants with the plots and blocks path of 1.5m and 2m, respectively. The plant materials used in this Research were twelve promising materials from regional variety trial, eleven released materials obtained from Kulumsa Agricultural Research center and local checks of the respective locations ; a total of 24 field pea genotypes were used in this study during 2006/07 Meher growing season (Table 1).

Land preparation was done mid-May to June at all locations and planting of field pea was conducted starting from end of June to Early July. Fertilizer rates of 100 kg DAP per hectare was applied at the time of planting, in all locations. The recommended hand weeding was used to control weeds. Morphological data on plant height, hundred seed weight, pod per plant, Harvest index, seed per plant, biological yield were recorded. Grain yield per plot were recorded and converted into Kg/ha.

Analysis of variance for each environment was done for grain yield and other traits, using the SAS System for Windows Release 8.02 [18] system computer program. Bartlett's test was used to examine the homogeneity of variances between environments for validity of the combined analysis of variance on the data.

A combined analysis of variance was done from the mean data (Table 3) from each location, to create the means data for the different statistical analysis methods.

Table-1. Origin and name of field pea genotypes used for the study

No	Genotype name	Origin	Status	No.	Genotype	Status	Origin
1	Fp. Coll.37/99	Ethiopia	P	13	Dadimos	R	Brundi
2	Fp. Coll.40/99	Ethiopia	P	14	Tulu dimtu	R	Ethiopia
3	Fp. Coll.51/99	Ethiopia	P	15	Hassabe	R	UK
4	Fp. Coll.199/99	Ethiopia	P	16	Woyyetu	R	USA x Ethiopia
5	IG. -49563	ICARDA/ Australia	P	17	IG- 51890	P	ICARDA/ Australia
6	IG -50936	ICARDA/ Australia	P	18	Milky	R	NEP 634 x180 (USA)
7	IG- 50547	ICARDA/ Australia	P	19	FPEX-DZ	P	Ethiopia
8	IG- 51664	ICARDA/ Australia	P	20	SAR-Fp-61	P	ICARDA/ Australia
9	IG-51700	ICARDA/ Australia	P	21	SAR-Fp-13	P	ICARDA/ Australia
10	Gume	Brundi X ICARDA	R	22	Markos(R)	R	ICARDA
11	Megeri	Australia	R	23	Tegegnech(R)	R	Brundi
12	Holletta-90	Ethiopia	R	24	Local check		Ethiopia

Note: - P =Promising material at Areka Agricultural Research Center (ARC), R- Released varieties by various research centers of Ethiopia **Note:** 1-24 name of genotypes: 1 = Fp. Coll.37/99, 2= Fp. Coll.40/99, 3= Fp. Coll.51/99, 4= Fp. Coll.199/99, 5= IG. -49563, 6= IG -50936,G7= IG- 50547,8= IG- 51664,G9= IG-51700,10= Gume,G11= Megeri,G12= Holletta-90 ,G13= Dadimos ,G14= Tulu dimtu,G15= Hassabe ,G16= Woyyetu,17= IG- 51890,18= Milky,19= FPEX-DZ,20= SAR-Fp-61, 21= SAR-Fp-13,22= Markos,23= Tegegnech,24= Local check

2.3. Stability Analysis

Stability parameters were estimated following the Eberhart and Russell [6]. A genotype with high mean seed yield, regression coefficient (b) close to unity and deviation from regression (S2d) near to zero was defined as a stable cultivar [6]. It was calculated by regression mean grain yield of individual genotypes/environments on environmental/genotypic index.

3. RESULTS AND DISCUSSION

The analysis of variance of field pea genotypes at individual locations (Table 2) was highly significant for mean grain yield at Angacha, Areka,waka and Freeze, whereas significant at Hosanna. Combined analysis of variance were performed for grain yield and other yield related traits to see the nature of main effect and GEI so that it may help to recognize the influence of GEI variety selection for general and or/ specific adaptations.

The pooled analysis of variance over locations for plant height, harvest index, pods per plant, seeds per plant, biological yield and grain yield (Table 3) showed highly significant to significant differences between genotypes, locations and genotype x locations interaction, thus indicating substantial variability among these for seed yield and yield components except seed per plant and pod per plant. Significant genotype x environment interaction(GEI) was also reported by Karasu, et al. [21] in soybean, by Bakhsh, et al. [20] in chickpea and by Girma, et al. [19] and Tezera [11] in field pea.

The average grain yield range for genotypes over test location was 1540.6 for Fp coll. 199/99 to 2658.8 kg/ha for Gume. Varieties Gume, Milky and Woyyetu were found to be superior yielder with their average yield of 2658.8, 2624.9 and 2460.3 kg/ha, respectively (Table 6). Similarly genotypes were also significantly different for Biological yield, hundred seed weight, and harvest index and plant height across test locations. Average plant height ranged from 117.3 for IG-51890 to 139.4 for Holleta-90. Environmental effects were highly significant for all traits.

Genotypic (varietal) effects were highly significant for all traits except seed per plant and pod per plant (Table 3). GEI effects were significant for all traits indicating the importance of GEI.

Table-2. Analysis of variance of 24 field pea genotypes at individual locations during 2006/07

Source of variation	DF	Mean Square of grain yield (kg/ha) at each locations				
		Angacha	**Hosanna**	**Areka**	**Freeze**	**Waka**
REP	2	3604.22 ns	1197730.4 *	424125.8 ns	426862.4 ns	15571.7 ns
VAR	23	1313137.9**	591978.7 *	453387.99**	309029.4 **	1004844.3 **
Error	46	186645.8	172432.6	89697.44	140035.9	93047.04
CV		11.36	19.88798	19.89026	21.56903	21.34903
LSD 5%)		710.04	682.47	463.65	615.03	501.33

Note:-ns, *, ** are non-significant, significant (P<0.05) and highly significant (P<0.01), respectively.

Combined analysis of variance for average harvest index across test environments also showed that genotypes were significantly (P<0.01) different for average harvest index values. Megeri, Gume and Tegegnech were the best genotypes with their over location average harvest index value of 0.32, 0.31 and 0.29, respectively. Although there were observable variations among genotypes for over location means for number of pods per plant and number of seeds per plant, but difference among genotypes were not significant.

Mean number of pod and seed of genotypes for test environments ranged from 9.1 to 13; 45 to 73, respectively. Analysis of variance of biological yield showed that highly significant (P<0.0.01) differences were also observed among genotypes. It ranged from 6678 for IG-50547 to 10116 kg/ha for Milky. The highest hundred seed weights were recorded (23.9gm) Gume and Markos (23.6gm) while the lowest was (15.2gm) Fp coll. 199/99. The knowledge of environmental effects on plant traits is essential for choosing appropriate environments for good performance of genotypes [22]. For all plant traits environments were significantly different. The significant effect of environment indicated that the testing environment were statistically different in yield potential i.e the mean yield of genotype differed from environment to environment. The superior mean grain yield (2659kg ha-1) over the locations was recorded by the genotype Gume followed by Milky (2625 kg ha-1), FpEx-Dz (2511 kg ha-1) and Weyyetu (2460 kg ha-1) (Table 6). Among the locations maximum mean seed yield was produced at Angacha (3801.93 kg ha-1) followed by Hossana (2087.95kg ha-1), Freeze (1734.96 t ha-1) and Waka (1428.8 kg ha-1) (Table 4).

The environmental indices were found to be positive for days to HI and 100 seed weight under Waka agro climatic condition. At Hosanna, most of the yield contributing traits i.e. pod/plant; seed/pod/, seed/plant, biological yield, harvest index and 100 seed weight were found positive. Under Angacha conditions almost all the yield attributing traits viz., number of pods per plant, number of seeds per plant, seed/pod, biological yield, harvest index and grain yield possessed positive value for environmental index for each location which suggested that Angacha was the most favorable location for the expression of almost all the characters under study (Table 4). Therefore, results of the present study corroborate d that Angacha was found to be a favourable environment for the majority of field pea genotypes of this study. The yields of a given genotype changed with the changes of environment indicate the evaluation of genotypes over locations is crucial. This study revealed that the yield potential of each genotype changed with the varying environments. The combined analysis of variance indicated that big influence of environment on yield performance of field pea genotypes in southern Ethiopia. The relatively large portion of GEI variance, when compared to genotypes is of very important consequence. GEI effect was highly significant to significant for all traits and it accounted 14.4 % of total variation for grain yield, 10.67 % for biological yield, 0.46 % for harvest index, 12.63 % hundred seed weight, 9.9% for plant height, 22.05 % for seed per plant and 22.8 % for pod per plant (Table 3).

The presence of significant GEI showed that inconsistency in performance of field pea genotypes across environments. Similar result was recorded [11, 19, 23, 24] a change in environment caused GEI on field pea, lentil and grass pea, respectively. These differential responses of genotypes caused difference in ranking of genotypes at each environment. Hence as the extent of GEI increase, there will be difficulties to select varieties, which perform well in diverse environmental conditions. Some genotypes that perform well in one environment are found to be dispirited in other environments. For example Milky was the top yielding genotypes in its grain yield (3015kg/ha) at Freeze while it is the 4th from the last at Areka. The grain yields of Gume were 2405,4828,2546,1428 and 2087 kg/ha at Areka, Angacha, Hosanna, Freeze and Waka, respectively. Also significant differences were observed among locations indicating the dissimilarity of the environments and significant G x E interaction meant that the genotype inconsistently over the different environments (ranks of genotypes changed in different environments). This suggests that, genotypes need thorough and repeated testing before they can be recommended for particular environments or set of environments.

Table-3. Combined analysis of variance over locations for grain yields and six yield components of field pea

Source	DF	Grain yield	Bioh	Spp2	Ppp	HI	HSW	Ph
		Mean Square	Mean Square	Mean Square	Mean Square	Mean Square	Mean Square	Mean Square
REP(ENV)	10	453578.84**	6233780.12**	513.41**	11.03**	0.006**	9.57 **	529.236**
ENV	4	71010364.4**	722504177.46**	227634**	544.64**	0.093**	244.18**	37244.25**
VAR	23	1523927.7**	12557808.96**	718.80ns	15.43ns	0.012**	85.65**	441.16*
ENV*VAR	92	645808.28**	4696614.31**	487.23**	11.69**	0.004**	6.18 **	255.30*
Error	230	134348.87	1656151.57	198.56	4.31	0.0013	3.873913	212.90
CV		17.50	15.87	25.1	19.59	14.08	10.39	11.297
% GEI		14.4	10.66	22.05	22.8	0.46	12.8	9.9

Note:-ns, **, * are non-significant, significant (P<0.05) and highly significant (P<0.01), respectively.

N.B Bio=biological yield, Spp2 =seed per plant, ppp= pod per plant, HSW=hundred seed weight, ph= plant height &HI=Harvest index

Table-4. Environmental indices, mean yield and CV of individual location in 2006/07 Cropping season

Serial No.	Characters	Waka	Areka	Hosanna	Freeze	Angacha
1	Pod/plant	-2	-2.78	1.26	-0.43	4.06
2	HI	0.03	-0.042	-0.009	0.041	0.037
3	100 seed weight	1.65	-2.85	1.01	1.01	-0.82
4	Seed/pod	-0.45	-0.178	0.04	0.13	0.46
5	Seed/plant	-15.29	-16.16	6.08	-1.82	27.14
6	Biological yield (kg/ha)	-1724.8	-2109.5	605.6	-2069.23	5297.8
7	Grain yield (kg/ha)	-665.59	-676.08	-6.44	-359.43	1707.54
8	Grain yield Location mean	1428.8	1418.31	2087.95	1734.96	3801.93
9	CV	21.34	19.89	19.88	21.56	11.36

Source: Individual location agronomic & yield data

3.1. Correlation of Yield and Yield Related Characters

The correlation coefficients among traits such as biological yield, harvest index, number of pod per plant, 100 seed weight, seed /plant and plant height in field pea genotypes for mean data over five test environments are presented in Table 5. The association study of yield with other components indicated that there was high magnitude of positive and significant correlation of grain yield with biological yield (r = 0.89**), seed/plant (r=0.63**),), pod/plant (r=0.59**), harvest index (r = 0.58**), seed/pod (0.36**), plant height (r = 0.48**) and hundred seed weight(r=0.12**). Traits like harvest index, pod per plant, seed/pod, seed /plant, biological yield and plant height each of which had positive and significant correlation one among other traits. But the association of 100 seed weight with pod per plant, seed /pod and biological yield had positive and non significant; seed /plant and plant height had negative and none significantly, whereas the same trait had positive and significant association with harvest index.

The result of this study showed the existence of significantly positive association between grain yield and number of yield components, namely biological yield, harvest index, number of pods per plant, 100 seed weight ,seed /plant ,seed per pod and plant height indicating that selection for any one of them permits improvement in grain yield. This finding is in line with [10, 11] reported that the existence of positive association between grain yield and number of other components, namely biological yield per plant, harvest index per plant, number of pod per plant and 1000 seed weight. The positive and significant correlation of seed yield with number of seeds per pod, seed per plant ,pod per plant and plant height in this study corroborate with the Seboka and Fikresilassie [9]. Similarly the positive significant correlation observed between seed yield with plant height in the study are in agreement with results reported by Seboka and Fikresilassie [9], Fikreselassie, et al. [12] but against with previous studies from Ethiopia [10, 11]. The improvement of any one of these characters can improve not only grain yield but also other characters that had close association with grain yield. Hence, for efficient selection for grain yield improvement should consider all these traits at the same time rather than considering single strongly correlated characters.

Table-5. Simple correlation for mean yield and yield related traits of 24 field pea genotypes

	GY	PH	HI	PP/PT	SS/P	SS/PT	BIO	HSW
GY	*							
PH	0.48**	*						
HI	0.58**	0.14**	*					
PP/PT	0.59**	0.54**	0.32**	*				
SS/P	0.36**	0.24**	0.33**	0.29**	*			
SS/PT	0.63**	0.52**	0.39**	0.92**	0.62**	*		
BIO	0.89**	0.55**	0.28**	0.60**	0.29**	0.60**	*	
HSW	0.12**	-0.08ns	0.26**	0.008ns	0.08ns	-0.009ns	0.05ns	*

Note: ns, **= non significant and highly significant at 1% PH=plant height, HI= harvest index,

PP/PT= pod /plant, HI= Harvest index, SS/P=seed/pod, SS/PT=seed/plant &HSW= hundred seed weight

The stability parameters as expressed in terms of mean (x') regression coefficient (bi) and standard deviation from regression (s2di) according to Eberhart and Russell [6] for all the 24 genotype of field pea are given in (Table 7,a,b). The simultaneous consideration of two parameters of stability and yield (Table 7a) for the individual genotype revealed that the genotypes Gume, Milky, Megeri, Dadimos, Woyyetu, FPEX-DZ, SAR-Fp-61 and Tegegnech were high Yielders (between 2100-2700Kg/ha) and had high values of S2di showing the performance of the varieties were unstable while SAR-Fp-13 had average yield and unstable.

The yield performance of the genotypes; 'Fp. Coll.199/99' (1541kg/ha), 'IG.-49563' (1694kg/ha), 'IG- 50547' (1557kg/ha), 'Hassabe' (1655kg/ha) were poor. All these varieties produced below average grain yield (2094kg/ha), had low deviation from regression indicating non-sensitivity to environmental changes. These varieties cannot be recommended due to their poor performance. The deviation from regression for majority of the genotypes was highly significant which revealed that response of these genotypes was unpredictable. The results indicated that the 24 genotype of field pea included in this study did not exhibit uniform stability and level responsiveness for all the characters. The genotype Markos was the high yielding and stable genotype with 12.19 and 30% higher yield from grand mean and local check, respectively and non-significant regression coefficient and deviations from regression.

Similarly, IG-51700 and IG-51890 gave 7.93 and 25.28%; 1.87and 18.25 % more yield than the grand mean and local check with regression close to unity and non-significant deviation from regression, thereby revealing stable performance across the environments, respectively. Taking into account the stability parameters together, genotypes SAR-Fp-13,FpEx-Dz,Milky,IG-51890,Tulu dimtu,Megeri,Gume,IG-50547,IG-49563,FP coll.199/99 and Fp coll.51/99 have value of bi < 1.00, hence these genotypes can be considered stable for this character (100 seed weight) in low yielding environments. Statistics also favoured IG-50936 and Dadimos for the stability of 100 seed weight in high yielding environments as b1 values of these genotypes are above 1.00 whereas Fpcoll 40/99, Tulu dimtu and Fp Ex-Dz (bi >1.00) indicated stability for seed per plant in high yielding and low yielding environments respectively (Table 7b). The inconsistency in the association of grain yield with seed per plant and 100 seed weight at different locations (Table-7b) revealed significant environmental effect on the performance of varieties. Based on the results obtained from for environments genotype Markos and IG-51700 (100 seed weight and grain yield), genotype IG-51890 (number of seed per plant and grain yield) were found to be mutually stable.

Table-6. Genotypes mean values for grain yield (kg/ha) and six yield components and order of 24 field pea ranking genotype grown at five environments

Trt.no.	Rank	Grain yield (kg/ha)	. Trt.no.	Rank	HI	. Trt.no.	Rank	Pod/plant	Trt.no.	Rank	Seeed/plant	Trt.no.	Rank	Plant ht (cm)	Trt.no.	Rank	Bio(kg/ha)	Trt.no.	Rank	100 swt
10	(1)	2659	11	(1)	0.32	18	(1)	13.0	18	(1)	73	12	1	139.4	18	(1)	10116	10	(1)	23.9
18	(2)	2625	10	(2)	0.31	10	(2)	12.2	10	(2)	71	18	2	137.3	19	(2)	9925	22	(2)	23.6
19	(3)	2511	23	(3)	0.29	9	(3)	12.1	11	(3)	65	6	3	134.9	16	(3)	9220	23	(3)	21.6
16	(4)	2460	21	(4)	0.28	19	(4)	11.9	19	(4)	65	20	4	134.2	9	(4)	9058	13	(4)	21.3
23	(5)	2456	13	(5)	0.28	11	(5)	11.2	3	(5)	60	10	5	133.9	6	(5)	8810	17	(5)	21.2
22	(6)	2349	22	(6)	0.28	12	(6)	11.1	14	(6)	60	3	6	133.6	22	(6)	8763	6	(6)	20.7
11	(7)	2285	18	(7)	0.27	2	(7)	11.1	20	(7)	59	1	7	133.3	23	(7)	8671	8	(7)	20.5
9	(8)	2260	9	(8)	0.27	14	(8)	11.1	16	(8)	59	9	8	133.1	10	(8)	8669	20	(8)	20.1
13	(9)	2155	17	(9)	0.27	3	(9)	11.0	24	(9)	59	2	9	131.6	24	(9)	8440	16	(9)	19.9
17	(10)	2133	16	(10)	0.27	16	(10)	10.9	12	(10)	56	14	10	130.9	12	(10)	8391	18	(10)	19.9
20	(11)	2132	20	(11)	0.26	17	(11)	10.8	9	(11)	56	19	11	129.6	20	(11)	8314	9	(11)	19.3
8	(12)	2086	3	(12)	0.26	20	(12)	10.5	2	(12)	55	15	12	129.6	8	(12)	7923	14	(12)	19.3
21	(13)	2072	1	(13)	0.26	24	(13)	10.5	23	(13)	54	16	13	129.4	17	(13)	7908	21	(13)	19.3
3	(14)	2047	2	(14)	0.26	5	(14)	10.2	8	(14)	53	22	14	128.5	15	(14)	7755	19	(14)	17.5
6	(15)	2037	14	(15)	0.25	22	(15)	10.0	4	(15)	53	13	15	128.4	13	(15)	7566	7	(15)	17.1
1	(16)	2025	19	(16)	0.25	23	(16)	10.0	22	(16)	53	5	16	127.8	5	(16)	7508	15	(16)	17.1
14	(17)	2004	8	(17)	0.25	4	(17)	9.9	21	(17)	52	23	17	126.7	21	(17)	7431	2	(17)	16.9
2	(18)	1871	6	(18)	0.25	13	(18)	9.8	5	(18)	52	24	18	125.7	14	(18)	7407	11	(18)	16.9
12	(19)	1849	12	(19)	0.23	21	(19)	9.8	6	(19)	52	4	19	124.7	3	(19)	7386	1	(19)	16.7
24	(20)	1804	24	(20)	0.23	7	(20)	9.7	17	(20)	51	8	20	124.1	1	(20)	7321	12	(20)	16.7
5	(21)	1694	7	(21)	0.22	8	(21)	9.7	1	(21)	51	21	21	123.4	4	(21)	7169	24	(21)	16.7
15	(22)	1655	4	(22)	0.22	15	(22)	9.3	7	(22)	48	7	22	121.6	2	(22)	7159	3	(22)	16.5
7	(23)	1557	15	(23)	0.21	6	(23)	9.1	13	(23)	48	11	23	120.9	11	(23)	7001	5	(23)	16.5
4	(24)	1541	5	(24)	0.18	1	(24)	9.0	15	(24)	45	17	24	117.3	7	(24)	6678	4	(24)	15.2
	Mean	2094			0.26			10.58			56			129.2			8108			18.9
CV		17.5		14.1				19.6		25.1				11.29			15.9			10.4

Note: 1-24 name of genotypes 1= Fp. Coll.37/99,2= Fp. Coll.40/99, 3= Fp. Coll.51/99, 4= Fp. oll.199/99, 5= IG. -49563, 6= IG -50936,7= IG- 50547,8= IG- 51664,9=,10= Gume,11= Megeri , 12= Holletta-90, 13= Dadimos, 14= Tulu dimtu, 15=Hassabe, 16=Woyyetu, 17= IG- 51890,18= Milky, 19= FPEX-DZ, 20= SAR-Fp-61, 21= SAR-Fp-13, 22= Markos, 23= Tegegnech, 24= Local check

Table-7a. Stability measures of grain yield for 24 field pea genotypes estimated by Eberhart and Russell [6]

No	Genotypes	Grain yield kg/ha)	% difference from mean	% difference from check	Regression coefficient (bi)	Deviation from regression (Sdi^2
1	Fp. Coll.37/99	2024.73	-3.30802	12.23	1.36*	0
2	Fp. Coll.40/99	1870.54	-10.6714	3.685	1.01	48950.02
3	Fp. Coll.51/99	2047.20	-2.23496	13.48	1.43*	1664.97
4	Fp. Coll.199/99	1540.60	-26.4279	-14.6	0.63	40586.78
5	IG. -49563	1693.66	-19.1184	-6.12	0.73	2359.79
6	IG -50936	2036.72	-2.73543	12.9	0.87	110069.89*
7	IG- 50547	1556.60	-25.6638	-13.7	0.73	26611.95
8	IG- 51664	2085.58	-0.4021	15.6	1.29	30762.43
9	IG-51700	2260.18	7.936008	25.28	0.91	5404.86
10	Gume	2658.80	26.9723	47.38	1.24	133549.3**
11	Megeri	2284.88	9.115568	26.65	0.99	474025.5**
12	Holletta-90	1849.26	-11.6877	2.505	0.62	364072.5**
13	Dadimos	2154.68	2.897803	19.44	1.34	104082.7**
14	Tulu dimtu	2004.21	-4.28797	11.09	0.99	198541.5**
15	Hassabe	1654.88	-20.9704	-8.27	0.69	15028.89
16	Woyyetu	2460.26	17.49093	36.37	0.95	328748.8**
17	IG- 51890	2133.28	1.875836	18.25	1.13	0
18	Milky	2624.90	25.35339	45.5	0.82	749682.0**
19	FPEX-DZ	2510.82	19.90544	39.18	0.77	261523.1**
20	SAR-Fp-61	2131.94	1.811843	18.17	1.27	172252.2*
21	SAR-Fp-13	2072.06	-1.04776	14.86	1.07	304882.9**
22	Markos	2349.46	12.19962	30.23	1.26	0
23	Tegegnech	2456.06	17.29035	36.14	1.07	221729.5*
24	Local check	1804.06	-13.8462		0.79	92862.33*
	Grand Mean	2094				

N.B: Negative values of deviation from regression=0, without *= non significant, **, * = Significant at the 1% and 5% levels, respectively

Table-7b. Stability measures of GY, SS /p and 100SW for the 24 field pea genotypes estimated by Eberhart and Russell [6] model

No	Genotypes	seed/plant	Hundred seed wt (gm)	Regression coefficient (bi)		Deviation from regression (Sdi^2)	
				Seed/plant (bi)	Hundred seed wt (bi)	Seed/plant	Hundred seed wt
1	Fp. Coll.37/99	50.6	16.7	0.78	1.16	878.12	8.89
2	Fp. Coll.40/99	54.8	16.9	1.6	1.42	1686.02	8.25
3	Fp. Coll.51/99	59.9	16.5	1.22	0.67	433.28	15.15
4	Fp. Coll.199/99	52.5	15.2	1.47	0.57	433.28	9.72
5	IG. -49563	51.8	16.5	0.92	0.54	1614.07	9.31
6	IG -50936	51.7	20.7	0.74	1.62	1188.62	50.20
7	IG- 50547	48.4	17.1	0. 67	0.64	492.39	24.78
8	IG- 51664	52.7	20.5	0.69	1.47	667.21	26.54
9	IG-51700	55.7	19.3	0.76	1.15	1449.82	14.39
10	Gume	70.6	23.9	0.92	0.72	1257.51	16.94
11	Megeri	65.4	16.9	1.05	0.72	1040	15.28
12	Holletta-90	55.9	16.7	1.43	1.21	1260.17	12.50
13	Dadimos	48.3	21.3	0.65	1.49	441.42	26.17
14	Tulu dimtu	59.9	19.3	1.58*	0.64	994.13*	26.92
15	Hassabe	45.4	17.1	0.69	1.06	554.46	23.24
16	Woyyetu	58.6	19.9	0.48	1.29	1447.70	22.54
17	IG- 51890	51.3	21.2	0.81	0.65	1071.61	11.10
18	Milky	73.3	19.9	1.20	0.64	1388.00	26.37
19	FPEX-DZ	64.6	17.5	1.55	0.89	1458.49	5.12
20	SAR-Fp-61	58.9	20.1	1.09	1.34	1704.02	10.07
21	SAR-Fp-13	51.9	19.3	1.25	0.44	645.94	13.83
22	Markos	52.5	23.6	0.24*	1.15	1603.14*	42.44
23	Tegegnech	53.8	21.6	0.84	0.99	271.34	12.51
24	Local check	58.5	16.7	1.21	1.48	1465.04	13.39
Grand mean		56.1	18.90				

N.B: Negative values of deviation from regression=0, with out *= non significant, **, * = Significant at the 1% and 5% levels, respectively

4. CONCLUSION AND RECOMMENDATIONS

Therefore, this study identified Markos, IG-51890 and IG-51700 to combine good yield with stability for 100 seed weight, seed per plant and grain yield. Among those genotypes Markos which is nationally released variety should be demonstrated and popularized on farmers' field for pre-scale up; whereas, the two promising genotypes IG-51890 and IG-51700 may be recommended for further testing in diverse environments of south region, Ethiopia. Therefore; top yielding field pea genotypes Gume, Milky, FpEx-Dz and Weyyetu were unstable indicating specific adaptability.

The positive value of environmental indices and maximum locations mean yield confirm that Angacha was found to be a favourable environment for the majority of field pea genotypes under this study. Similarly, in this study number of pods per plant, number of seeds per plant, plant height, biological yield and harvest index were the most important factors in determining seed yield indicating that selection for any one of them may permits improvement in grain yield in field pea program.

5. ACKNOWLEDGEMENTS

Sincere thanks to Dr Elias Urage and MulugetaTesdalu for safe and successful completion of this study. I am also grateful to SARI for financial support given to conduct my Research

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