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Variation and association for kernel yield and yield related traits of released groundnut (*Arachis hypogaea* L.) varieties in abergelle district, northern Ethiopia

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Abstract
Groundnut (*Arachis hypogaea* L.), also known as monkey-nut, peanut, earthnut and goobers, is a major cash crop and widely grown in all the tropical and subtropical regions of the world for direct use as food, oil and high protein meal, and is the second most important lowland oilseed crop after sesame in Ethiopia. However, its production and productivity is considerably low in Abergelle areas, Northern Ethiopia due to insufficient improved and disease resistant/ tolerant varieties. Thus, a field experiment was conducted during the 2016 and 2017 main cropping seasons using a randomized complete block design with three replications at Abergelle agricultural research center on station to evaluate the performance and select the best genotypes for kernel yield and yield related traits and to assess the association among traits of some released groundnut varieties under rain-fed conditions. There was significant genotypic variability for all the traits evaluated under study. Highly significant ($P\leq 0.01$) and positive association of kernel yield with dry pod yield (rg = 0.85, rp= 0.83), harvest index (rg = 0.82, rp= 0.86), shelling percentage (rg = 0.80, rp= 0.83) and biomass yield (rg = 0.43, rp= 0.31) was observed. However, the association between kernel yield and days to flowering and days to maturity was strongly negative and highly significant ($P\leq 0.01$). This indicates that selection for those traits showing positive and significant correlation coefficient with kernel yield would supports the possibility to increase kernel yield and the vice versa. Overall, Fetene and Roba had better performance than the other varieties for yield with 1716 and 1621 kg ha^{-1}, respectively. Therefore, Fetene and Roba are recommended as promising varieties to the farmers of Abergelle areas.

Keywords: *Arachis hypogaea* L., correlation, genotypic variability, kernel yield

Introduction

Groundnut (*Arachis hypogaea* L.), which is also known as peanut, earthnut, monkey nut and goobers, is an oil seed and grain legume crop. It is one of the world's most popular crops cultivated throughout the tropical, sub-tropical and warm temperate areas where annual precipitation is between 1000-1200 mm for optimum growth of the crop. Groundnut has high economic and nutritional value and is an important cash crop for peasants in poor tropical countries. It is widely grown in more than 100 countries of tropical, subtropical, and warm temperate regions of the globe (FAOSTAT, 2016) [9]. It contains 48-50% oil and 26-28% protein, and a rich source of dietary fiber, minerals, and vitamins (Janila *et al*., 2013) [13]. A recent study (Mahesh *et al*, 2018) [15] also reported that groundnut has high quality edible oil (44-56%), protein (22-30%) on a dry seed basis, carbohydrates (10-25%), vitamins (E, K, and B complex), minerals (Ca, P, Mg, Zn and Fe) and fibber; shell used as fuel and animal feed, cattle litter, filler in feed and fertilizer industry; Haulm used as animal fodder or in manuring; roots being legume add the nitrogen (100-152 kg ha-1N) and organic matter to soil. Groundnut is an important crop from the perspective of food and nutrition security of poor smallholder farmers in developing countries, where it is grown widely. It is grown extensively in the developing countries of Asia, Africa and Latin America. About 62% of the production comes from South, East and Central Asia. Africa and Asia produced 91% of the world's total groundnut production (Nedumaran *et al*., 2015) [17].

The lowland areas of Ethiopia have considerable potential for increased oil crop production amongst groundnut is the second most important lowland oilseed crop after sesame in the country.

The estimated annual groundnut production in Ethiopia was about 103,062.38 tons from 64,649.34 hectares of production area. The average national yield was about 1.6 tons per hectare (CSA, 2015) [7]. It is mainly produced by smallholder farmers in the lowland area of Ethiopia. Currently, the production is concentrated in some areas of Oromia, Benishangul-Gumuz, Amhara, SNNP, Harari and Gambela regions. Eastern Hararghe zone of Oromia region hold primary position in producing and supplying groundnut both to domestic and export markets as compared to other parts of the country (Wijnands *et al*., 2009) [29]. Currently the crop is becoming one of the high value crops that are growing in the dry lowland areas of the central zone of Tigray region, northern Ethiopia specifically in Abergelle and Rama areas.

Groundnut production and productivity is, however hampered by several biotic and abiotic factors including, among others, critical moisture stress especially during and after flowering, lack of farmer preferred varieties, lack of appropriate production and post-harvest practices, and diseases (Alemayehu *et al*., 2014) [1]. The aim of groundnut breeding programs across the world is to develop new varieties that meet the requirements of growers, processors, and consumers. Thus, the targeted traits for improvement in groundnut depends on the level of productivity desired, consumers' and industry requirements in a country.

Owing to this, the objectives of this experiment were to evaluate the performance, select the best genotypes for kernel yield and yield related traits and to assess the association among traits of some released groundnut varieties under rain-fed conditions in the dry lowland areas of Abergelle district, Northern Ethiopia.

Materials and Methods

Description of the Study Area

The field experiment was carried out under rain-fed conditions at Abergelle Agricultural Research Center on station during the 2016 and 2017 main cropping seasons, respectively. Abergelle is located in the central zone of Tigray region, Northern Ethiopia (Fig. 1) situated at 13°14'06"N latitude and 38°58'50"E longitude. The area is agro-ecologically characterized as hot warm sub moist lowland (SMl-4b) located at an altitude below 1500 m.a.s.l. The percentage proportion of sand, silt and clay of the testing site was 94, 1 and 5%, respectively, indicating that the textural class of the experimental site is sandy. The site had neutral nature with soil pH 7.04, indicating the site is ideal for groundnut production (Redae *et al.*, 2017) [11].

The average annual rainfall and temperature status of the study area ranges from 350-650 mm and 21-41 ^{0}c, respectively. The rainfall status of the mandate area is unpredictable and erratic from season to season, which results in strong variation in crop yields (Fantaye *et al*., 2018) [8]. The rain may start late and/or ends early. The rainfall distribution from the agricultural point of view is mono-modal, concentrated during the summer (July to August). It is obvious that this kind of rainfall has a negative impact on the agricultural activities of the community causing uncertainty.

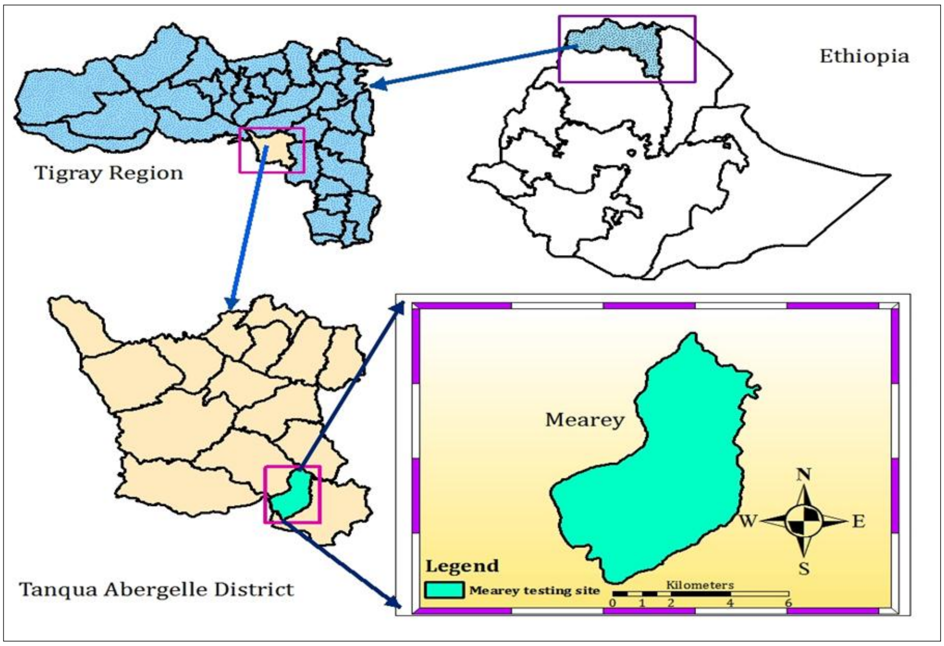

Fig 1: Map of the study area

Experimental Design and Crop Management

Seven improved groundnut varieties, sourced from Haramaya University and Werer Agricultural Research Center (MARC) were evaluated in this study (Table 1).

Table 1: Description of the experimental materials

Genotype	Year-of release	Seed color	Status	Source
Baha gudo	2012	Red	Released variety	Haramaya University
Baha jidu	2012	Red	Released variety	Haramaya University
Bulki	2002	Light red	Released variety	Werer ARC
Fetene	2009	Red	Released variety	Werer ARC
Manipinter		variegated	Released variety	Werer ARC
Roba	1989	Red	Released variety	Werer ARC
Sedi	1993	Red	Released variety	Werer ARC

Note: ARC= Agricultural Research Center

These varieties were planted under field conditions in a randomized complete block design (RCBD) replicated thrice. The plot size was 21 m^2 (4.2 m plot width x 5 m row length) having 7 rows with harvestable plot area of 3 m x 5 m (15 m^2) with five rows and spacing 60 cm between rows and 20 cm between plants. According to Jeetarwal *et al*. (2015) spacing of 40-60 cm between plants and 15-30 cm within rows is appropriate for groundnut. The spacing between plots and blocks were 0.50 and 1m, respectively. Di-ammonium phosphate (DAP) fertilizer was applied at a rate of 100 kg ha^{-1} at planting. Further agronomic (management) practices like earthing up at 50% flowering, weeding, hoeing, pest or disease-control was applied uniformly to all treatments as required.

Data Collection and Sampling Techniques

Data were collected on plot basis and plant basis from the central five rows for all traits. For data recorded on single plant basis (pods per plant and seeds per pod), five plants were randomly taken and tagged from the net harvestable plots and the mean values of these five plants were calculated using Microsoft Excel. The data recording for each trait (11) was carried out as follows.

1. Days to 50% flowering: It was recorded as the number of days from sowing to 50% of the plants in the plot started flowering
2. Days to maturity: It was recorded as number of days from sowing to the stage when 90% of the plants in a plot have changed the color of their pods to yellow.
3. Seed filling period: It was recorded as days from flowering to maturity, *i.e.* the number of days to maturity minus the number of days to flowering
4. Number of pods per plant: This was determined as the mean value of five randomly sampled plants obtained by counting total number of pods per plant.
5. Number of seeds per pod: The mean number of seeds per pod was obtained by counting the number of seeds collected from five mature pods from each five sampled plants.
6. Dry pod yield (kg ha^{-1}): This was measured after harvesting the whole pods from the net plot and converted to kilograms per hectare after sun drying.
7. Kernel yield (kg ha^{-1}): It was determined as shelling percentage multiplied by dry pod yield and adjusted to standard moisture level (10%) per plot in grams and converted into kilograms per hectare.
8. Biomass yield: The weight in grams of sun dried above ground parts of the plants was recorded from the central four rows.
9. Harvest index: It was calculated as the ratio of kernel yield to total above ground biomass yield (biological yield).
10. Shelling percentage (%): This was calculated from 15 tagged plants by dividing the weight of seeds to the weight of pods and multiplying it by 100.
11. 100-kernel weight: It was recorded by counting 100-seeds from a bulk of shelled seeds and weighed using a sensitive balance.

Phenotypic and Genotypic correlation coefficients

Both phenotypic and genotypic correlation coefficients, which is the inherent association between two variables were estimated using the standard procedure suggested by Weber and Moorthy (1952) [22] using the corresponding variance and covariance components as shown in Equations below.

$$rp(xy) = \frac{Pcov(x,y)}{\sqrt{\sigma^2 px.\sigma^2 py}}$$

Where: rp= phenotype correlation coefficient, $\boldsymbol{P}c\boldsymbol{ov}$xy= phenotype covariance between traits x and y, σ^2px = phenotype variance for variable x, σ^2py = phenotypic variance for traits y.

$$rg(xy) = \frac{Gcov(x,y)}{\sqrt{\sigma^2 gx.\sigma^2 gy}}$$

Where: rg= genotype correlation coefficient, $\boldsymbol{G}c\boldsymbol{ovxy}$= genotype covariance between traits x and y, σ^2gx = genotypic variance for trait x, σ^2gy = genotypic variance for trait y.

Data Analysis

Homogeneity of error variance was tested prior to combined analysis using Bartlett's test (Steel and Torrie, 1980) [19] and statistical analyses were performed using the SAS (Statistical Analysis System) software version 9.1 program (SAS Institute, 2004) [18] and Spearman's correlation coefficient among traits were analyzed using Genstat statistical package version 16th ed. Means were separated using Fisher's Least Significant Difference (LSD) test at 5% level of probability as stated in Gomez and Gomez (1984) [12].

Results and Discussion

Variation in kernel yield and other agronomic traits

A significant difference was observed between varieties for days to flowering, seed filling period and physiological maturity as presented in Table 2. The shortest number of days to 50% flowering (47) was observed in the varieties Fetene and Sedi (check). Fetene matured in 99 days earlier than the other varieties and seed filling occurred in a shortest period of time (52 days), thus, making it more adaptable in the drought prone areas of Abergelle and other districts having the same agro ecologies in the region, northern Ethiopia. The longest number of days to 50% flowering (53 days) and physiological maturity (106 days) were observed for the varieties BaHa gudo and BaHa jido, respectively. The observed difference in earliness traits (days to flowering, seed filling period and days to physiological maturity) were due to differences in genotypic makeup, as groundnut show variability in growth habit, seed characteristics, maturity and adaptation. This study agrees with other authors (Amare and Tamado, 2014; Aliyi, 2017; Berhane *et al.*, 2017; Mastewal *et al.*, 2017; Redae *et al.*, 2017) [3, 2, 6, 16, 11] who have reported variability among groundnut varieties across seasons for phenolgical traits.

The varieties showed significant variation for number of seeds per pod, number of pods per plant and 100- seed weight. Relatively more number of pods per plant was recorded from standard check (Sedi) variety with 23.48 followed by Fetene with 23.10 pods per plant, respectively. On the contrary, BaHa gudo had scored lower (15.35) number of pods per plant. The groundnut varieties exhibited variation for number of seeds per pod. The check variety (Sedi) had more number of seeds per pod (2.8) compared to the other varieties, while Roba had the lowest (1.9) number of seeds per pod. There were significant differences among the varieties in terms of individual seed weight and 100 seeds weight. BaHa gudo had the highest 100 seed weight (67 g) while Sedi had the lowest (44 g). Moreover, this result confirmed that large seeded groundnut type showed highest 100- seed weight, whereas, small seeded groundnut type detected lowest 100- seed weight.

Table 2: Mean values of some Phenological and Agronomic traits of Groundnut varieties grown at Abergelle on station

Variety	Traits														
	DF			DM			PPP			SPP			100KW		
	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean
Bahagudo	64^{a}	42^{a}	53^{a}	108^{a}	93^{a}	100^{c}	18.13^{b}	12.57^{b}	15.35^{c}	2.07^{b}	2.07^{b}	2.07^{bc}	68.07^{a}	65.17^{a}	66.62^{a}
Bahajidu	64^{a}	40^{b}	52^{a}	120^{a}	93^{a}	106^{a}	18.67^{b}	17.57^{ab}	18.12^{abc}	1.93^{b}	2.35^{a}	2.13^{b}	46.83^{bcd}	53.53^{b}	50.18cd
Bulki	63^{a}	40^{b}	52^{ab}	120^{a}	89^{b}	105^{b}	17.47^{b}	17.77^{ab}	17.62^{bc}	2.2^{b}	1.93^{c}	2.07^{bc}	43.67^{cd}	51.03^{c}	47.35^{de}
Fetene	57^{b}	37^{c}	47^{c}	108^{a}	90^{ab}	99^{c}	23.87^{ab}	22.33^{a}	23.10^{ab}	1.87^{b}	2.00^{bc}	1.93^{c}	55.80^{b}	55.83^{b}	55.82^{b}
Manipinter	59^{b}	41^{ab}	50^{b}	117^{a}	90^{ab}	104^{b}	26.40^{ab}	13.67^{b}	20.03^{abc}	1.93^{b}	2.00^{bc}	1.97^{c}	56.67^{b}	54.30^{b}	55.48^{b}
Roba	63^{a}	40^{b}	52^{a}	108^{a}	92^{ab}	100^{c}	22.33^{ab}	23.33^{a}	22.83^{ab}	1.93^{ab}	1.87^{c}	1.90^{c}	51.83^{bc}	55.10^{b}	53.42^{bc}
Sedi	57^{b}	37^{c}	47^{c}	117^{a}	89^{b}	103^{b}	32.53^{a}	14.43^{b}	23.48^{a}	3.27^{a}	2.27^{a}	2.77^{a}	39.83^{d}	47.80^{d}	43.82^{e}
LSD (5%)	2.42	1.872	2.14	Ns	3.15	2.5	10.39	6.03	8.29	0.374	0.17	0.3	9.84	2.374	6.77
CV (%)	2.26	2.95	2.5	Ns	1.98	1.3	26.06	19.81	24.6	9.85	4.72	7.7	10.84	2.48	7.6

Note: Means with the same letters within the columns are not significantly different at $P \leq 0.05$. DF=Days to 50% flowering, SFP=seed filling period, DM= days to 90% maturity, SPP= number of seeds per pod, PPP= number of pods per plant, 100SW= 100- kernel weight; LSD=least significance difference at 5%, CV (%) = coefficient of variation in percent and Ns= non-significant.

The combined analysis of variance revealed significant ($P \leq 0.05$) differences among the varieties for all yield and yield related traits (Table 3). The highest kernel yield (1716 kg ha^{-1}) was recorded by the variety Fetene followed by Roba (1621 kg ha^{-1}), while the lowest yield (1161 kg ha^{-1}) was recorded in case of Bulki. In accordance with the finding, Fikre *et al*. (2012) [10] reported that Fetene variety gave highest kernel yield of 2740 kg ha^{-1} in Central Rift valley of Ethiopia. Besides, Fetene followed by Roba had significantly ($P \leq 0.01$) highest biomass yield (6670 kg ha^{-1} and 6477 kg ha^{-1}) than the other groundnut varieties. Those two varieties also took less number of days to fill their seeds, thus, making them more adaptable in the drought prone areas of Abergelle district.

Significant varietal difference was observed for harvest index and dry pod yield (Table 3). BaHa gudo had the highest harvest index (0.80) and dry pod yield (2480 kg ha^{-1}) while Bulki had the lowest harvest index (0.22) and dry pod yield (1601 kg ha^{-1}). There was sufficient variability among the varieties for majority of the traits studied; suggesting considerable potential for the improvement of groundnut. Highly significant ($P \leq 0.01$) (Table 4) differences were noted among the varieties for shelling percentage which ranged from 53.39% to 78.4%. Thus, shelling percentage is the sign of pod filling effectiveness and high shelling percentage values showed effective pod filling.

The variations in yield and yield related traits among varieties in this study agree with the previous works of Tulole *et al*. (2008) [20], Fikre *et al*. (2012) [10], Amare and Tamado (2014) [3], Jeyaramraja and Fantahun (2014) [14], Aliyi (2017) [2], Berhane *et al. (*2017) [6], Mastewal *et al*. (2017) [16], Redae *et al*. (2017) [11] and Wedajo and Wondewosen (2017) [23] who reported variability in groundnut yield and yield related traits.

Table 3: Mean values of Agronomic traits of Groundnut varieties grown at Abergelle on station

Variety	Traits														
	KY			DPY			BY			HI			Shelling%		
	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean
Bahagudo	1158^{ab}	1802^{bc}	1480^{bc}	2407^{a}	2554^{ab}	2480^{a}	472^{b}	6158^{bc}	5265^{d}	0.263^{a}	0.293^{c}	0.80^{a}	39.35^{b}	70.54^{b}	54.94^{c}
Bahajidu	1013^{bc}	1851^{bc}	1432^{c}	1333^{bc}	2387^{bc}	1860^{cd}	6750^{a}	6089^{bc}	6419^{bc}	0.15^{c}	0.304^{a}	0.23^{d}	60.75^{a}	77.55^{a}	69.15^{a}
Bulki	890^{c}	1432de	1161^{d}	1211^{c}	1991^{a}	1601^{d}	6352^{a}	4855^{c}	5604^{cd}	0.14^{c}	0.295^{bc}	0.22^{d}	57.17^{a}	71.86^{b}	64.51^{b}
Fetene	1299^{a}	2133^{a}	1716^{a}	1852^{ab}	2740^{a}	2296^{ab}	6334^{a}	7005^{a}	6670^{a}	0.21^{b}	0..305^{a}	0.255^{b}	57.0^{a}	77.74^{a}	67.37^{ab}
Manipinter	813^{c}	1354^{e}	1083^{d}	1500^{bc}	2090^{d}	1795^{cd}	4495^{b}	4797^{d}	4646^{e}	0.18^{bc}	0.282^{d}	0.23^{cd}	40.46^{b}	66.32^{c}	53.39^{c}
Roba	1308^{a}	1934^{ab}	1621^{ab}	1926^{ab}	2707^{a}	2316^{ab}	6380^{a}	6574^{ab}	6477^{ab}	0.21^{b}	0.294^{c}	0.25^{bc}	57.42^{a}	71.45^{b}	64.43^{b}
Sedi	1348^{a}	1640^{cd}	1494^{bc}	1926^{ab}	2159^{cd}	2042^{bc}	6630^{a}	5439^{cd}	6035^{bc}	0.20^{b}	0.301^{ab}	0.252^{b}	59.67^{a}	75.82^{a}	67.75^{ab}
LSD (5%)	254.37	256.01	240	636.54	245.24	467.8	672.75	753.8	700.6	0.042	0.01	0.029	6.055	3.55	4.87
CV (%)	12.99	8.43	10	20.93	5.9	13.6	6.51	7.364	7.1	12.44	1.31	7	6.51	2.78	4.6

Note: Means with the same letters within the columns are not significantly different at $P \leq 0.05$. KY= kernel yield (kg ha^{-1}), BY= biomass yield (kg ha^{-1}), DPY= dry pod yield (kg ha^{-1}), HI=harvest index, Shelling%= shelling percentage (%); LSD=least significance difference at 5%, CV (%) = coefficient of variation in percent.

Table 4: Mean sum of squares for Agronomic traits from analysis of variance of Groundnut varieties tested at Abergelle on station

Traits	Mean square			Mean	CV (%)
	Replication	Trt	Error		
	(DF=2)	(DF=6)	(DF=12)		
Days to flowering	0.17	6.78*	1.63	50	2.5
Seed filling period	1.17	59.21*	2.86	52	3.2
Days to maturity	1.17	38.02*	1.654	103	1.3
Number of seeds per pod	0.04	0.30*	0.03	2.12	7.7
Number of pods per plant	12.45	80.50*	24.38	20.1	24.6
Biomass yield	64471	1961341**	174275	5874	7.1
Harvest index	0.0025	0.0027**	0.0003	0.244	7
100- kernel weight	22.39	32.43	16.26	53.24	7.6
Kernel yield	31615	53540**	20437	1427	10
Dry pod yield	52240	171002*	77684	2056	13.6
Shelling%	3.13	62.294**	8.41	63.08	4.87

*, ** = significant at $P \leq 0.05$ and $P \leq 0.01$, respectively, DF= degree of freedom, Trt= treatments combination of variety by year, CV (%) = coefficient of variation in percent.

Correlation coefficient analysis

Table 5 shows relationships among the studied traits. Genotypic (rg) and phenotypic (rp) correlation coefficient analyses were estimated for 11 phenologic and agronomic traits of seven varieties. Highly significant ($P \leq 0.01$) associations were noted between most of the traits of groundnut under rain fed conditions. The highest positive and highly significant ($P \leq 0.01$) correlation was observed between days to flowering and maturity (rg=0.92, rp=0.83), kernel yield and dry pod yield (rg=0.85, rp=0.83), kernel yield and harvest index (rg=0.82, rp=0.86), dry pod yield and harvest index (rg=0.85, rp=0.78), shelling percentage and kernel yield (rg=0.80, rp=0.83) and shelling percentage and harvest index (rg=0.62, rp=0.80). The positive and significant association observed between yield and most of the important agronomic traits in this study is in agreement with the previous finding of Fikre *et al*. (2012) [10] in groundnut.

This study confirmed that genotypic correlation coefficients were found to be relatively higher in magnitude than their corresponding phenotypic correlation coefficients, except in a few cases, which clearly indicated the presence of inherent association among considered traits. In some cases, the phenotypic correlation values were higher than the genotypic correlation values suggesting the importance of environmental (seasonal) effects on the expression of the characters. These results were in conformity with Vasanthi *et al*. (2015) [21], Ashish *et al*. (2015) [4] and Aliyi (2017) [2], in other studies reported that genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficient among groundnut genotypes they considered.

The phenological traits such as, number of days to 50% flowering and days to maturity were significantly ($P \leq 0.01$) and negatively associated with *kernel yield* , dry pod yield, harvest index and shelling percentage (Table 5), similar results were obtained by Fikre *et al*. (2012) [10] and Aliyi (2017) [2]. This indicates that selection for increase in number of days to 50% flowering and number of days to maturity would lead to groundnut yield loss for late maturing groundnut varieties and yield gain for early maturing varieties. Likewise, 100 seed weight was significantly and negatively correlated with biomass yield, days to maturity, number of seeds per pod and number of pods per plant while the association of 100 seed weight with dry pod yield and harvest index was significant and positive.

However, the number of pods per plant, number of seeds per pod, seed filling period and 100 seed weight were not significantly and negatively associated with kernel yield of groundnut varieties. There was also negative and non-significant correlation between number of pods per plant with 100 seed weight, dry pod yield, harvest index and shelling percentage. Similarly, seed per pod was negatively and not significantly associated with dry pod yield, biomass yield and days to flowering. The obtained result agreed with studies by Jeyaramraja and Fantahun (2014) [14] in groundnut, who reported that the number of seeds per pod was negative and not significantly correlated with the number of days to maturity, individual seed weight, 100 seeds weight, oil content, shelling percent, shelled kernel yield and 100 pods weight. In dis agreement with the findings, positive association of pod yield with number of primary branches per plant, number of mature pods per plant and 100-seed weight was reported earlier by Vasanthi *et al*. (2015) [21]. Ashish *et al*. (2015) [4] also reported highly significant and positive correlation of kernel yield per hectare with days to 50% flowering, days to maturity, shelling percentage, 100 kernel weight and dry pod yield per hectare and negative phenotypic and genotypic correlation with early and late leaf spot.

Shelling percentage was positive but not significantly associated with biomass yield and seed filling period. The association between 100 seed weight with biomass yield; 100 seed weight with shelling percentage and harvest index with biomass yield were negative and non-significant where the association between harvest indexes with kernel yield was positive and highly significant. In line with the obtained result the association between harvest index and biomass yield was not significant while positive association between kernel yield and harvest index were reported in haricot bean (Berechu, 2015) [5]. These findings suggest that the characters showing positive correlation could effectively be utilized in crop improvement program and develop new groundnut genotypes. Overall result revealed that the positive and significant association of pairs of characters at genotypic and phenotypic (Table 5) levels justified the possibility of correlated response to selection. Furthermore, negative correlations prohibit the simultaneous improvement of those traits.

Table 5: Estimates of genotypic (upper diagonal) and phenotypic (lower diagonal) correlation coefficients among 11 Agronomic traits of seven Groundnut varieties tested at Abergelle on station

	100KW	BY	DF	DM	DPY	HI	PPP	SFP	SPP	KY	Shelling%
100KW	1.00	-0.33^{*}	-0.13^{ns}	-0.31^{*}	0.46^{*}	0.37^{*}	-0.27^{ns}	-0.48^{*}	-0.50^{**}	0.19^{ns}	-0.18^{ns}
BY	-0.22^{ns}	1.00	-0.01^{ns}	0.22^{ns}	0.13^{ns}	-0.14^{ns}	0.28^{ns}	0.55^{**}	0.17^{ns}	0.43^{*}	0.46^{*}
DF	-0.14^{ns}	0.04^{ns}	1.00	0.92^{***}	-0.63^{**}	-0.86^{***}	0.28^{ns}	0.05^{ns}	0.05^{ns}	-0.79^{***}	-0.82^{***}
DM	-0.26	0.32^{*}	0.83^{***}	1.00	-0.66^{**}	-0.90^{***}	0.38^{*}	0.44^{*}	0.21^{ns}	-0.71^{***}	-0.66^{**}
DPY	0.56^{**}	0.08^{ns}	-0.55^{**}	-0.58^{***}	1.00	0.85^{***}	-0.06^{ns}	-0.25^{ns}	-0.04^{ns}	0.85^{***}	0.47^{*}
HI	0.34^{*}	-0.11^{ns}	-0.84^{***}	-0.82^{***}	0.78^{***}	1.00	-0.27^{ns}	-0.33^{*}	-0.06^{ns}	0.82^{***}	0.62^{**}
PPP	-0.11^{ns}	0.31^{*}	0.20^{ns}	0.35^{*}	-0.06^{ns}	-0.20^{ns}	1.00	0.31^{*}	0.39^{*}	-0.07^{ns}	-0.23^{ns}
SFP	-0.35^{*}	0.56^{**}	-0.04^{ns}	0.50^{**}	-0.23^{ns}	-0.22^{ns}	0.30^{ns}	1.00	0.40^{**}	-0.00^{ns}	0.20^{ns}
SPP	-0.34^{*}	-0.06^{ns}	-0.09^{ns}	0.04^{ns}	0.07^{ns}	0.18^{ns}	0.03^{ns}	0.26^{ns}	1.00	0.02^{ns}	0.05^{ns}
KY	0.28^{ns}	0.31^{*}	-0.76^{***}	-0.66^{**}	0.83^{***}	0.86^{***}	-0.09^{ns}	-0.03^{ns}	0.08^{ns}	1.00	0.80^{***}
Shelling%	-0.01^{ns}	0.28^{ns}	-0.83^{***}	-0.69^{**}	0.53^{**}	0.80^{***}	-0.27^{ns}	0.07^{ns}	0.15^{ns}	0.83^{***}	1.00

*, **, *** = significant at $P \leq 0.05$, $P \leq 0.01$ and $P \leq 0.001$, respectively, and ns= non-significant, DF= days to flowering, SFP= seed filling period, DM= days to physiological maturity, PPP= number of pods per plant, SPP= number of seeds per pod, KY= kernel yield, BY= biomass yield, HI= harvest index, DPY= dry pod yield, 100KW= 100- kernel weight and Shelling%= shelling percentage.

Conclusion and Recommendation

Abergelle ARC mandate area is characterized with less moisture and low soil fertility condition; hence varieties which tolerate these stress situations perform best. Promising varieties must have good yield and other essential agronomic traits. Thus, the current study entails the presence of significant genetic variation among yield and yield related traits of released groundnut varieties. The combined analysis of variance result revealed that the varieties performed significantly ($P \leq 0.05$) different for days to 50% flowering, seed filling period, 90% physiological maturity, number of pods per plant, number of seeds per pod, dry pod yield, *kernel yield* , biomass yield, harvest index, 100- seed weight and shelling percentage. Fetene had significantly highest yield (1716 kg ha^{-1}) followed by Roba (1621 kg ha^{-1}) than the other groundnut varieties. Moreover, those two varieties required less number of days to fill their seeds, thus, making them more adaptable in the drought prone areas of Abergelle district. The highest yield of those varieties is due to their inherent genetic potential. It is also due to better adaptation to the soil that is suitable for groundnut production in the study area. The correlation coefficient analysis also showed highly significant ($P \leq 0.01$) and highest positive correlation between the number of days to flowering and maturity (rg=0.92, rp=0.83), kernel yield and dry pod yield (rg=0.85, rp=0.83), kernel yield and harvest index (rg=0.82, rp=0.86), dry pod yield and harvest index (rg=0.85, rp=0.78), shelling percentage and kernel yield (rg=0.80, rp=0.83) and between shelling percentage and harvest index (rg=0.62, rp=0.80). This confirmed the fact that selection for those traits showed positive and significant correlation coefficient with kernel yield supports the possibility to increase kernel yield and the vice versa. Therefore, the current study revealed the presence of considerable variability for most of the traits studied and differences in the performance of the varieties as there were significant differences among varieties.

Generally, Fetene and Roba had better performance than the other varieties for yield and yield related traits, whereas, the variety Bulki generally performs poorly under rain fed growing conditions. As compared to the rest, these two varieties are, therefore recommended as promising varieties to the farmers of Abergelle area and other districts having the same agro-ecologies in the region, Northern Ethiopia.

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