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GROUPING AND SELECTION OF 32 SINGLE CROSS SUNFLOWER HYBRIDS USING PRINCIPAL COMPONENT ANALYSIS

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Abstract
Principal components analysis is one of the multivariate statistical methods and was used to access the genetic diversity of 32 sunflower hybrids developed at the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad during 2014-15. Eight males were crossed with 32 females to produce 32 F_1 hybrids using North Carolina Mating Design-I. Data were recorded on plant height, head diameter, percent filled achenes, 100-achene weight, achene yield per plant, harvest index, oil content, palmitic acid, stearic acid, oleic acid and linoleic acid. The first four principle components with Eigen value greater than one contributed 69.28 % of the total variability. The first principal component showed higher values for 100-achene weight (0.860), achene yield per plant (0.903), harvest index (0.777), second had higher values for oleic acid (-0.780) and linoleic acid (0.834), third had higher values for head diameter (-0.749) and percent filled achenes (0.782), whereas the fourth was associated with plant height (0.741). Four distinct groups can be differentiated on the basis of biplot diagram. H-1 and H-32 were the best hybrids having higher achene (94.63g, 91.45g) and oil yield (46.24%, 44.08%) respectively.

Keywords: Genetic diversity, hybrid, principal components analysis, sunflower, variability

INTRODUCTION

Sunflower (*Helianthus annuus* L.) ranks fourth, among the crops grown for edible oil, in the world after soybean, palm and rapeseed while, second in Europe after rapeseed. Sunflower is cultivated on area of about 26 mha with the seed production of 45 million tones in the world. It is largely grown in Russia, Argentina, China, Europe, USA and India (FAOSTAT 2013).

Sunflower was introduced as an oilseed crop in early sixties in Pakistan, but now it is the third most important source of edible oil after cottonseed and rapseed/mustard. It is grown on area of 0.214 million acres with the seed production of .092 million ton in the country (GOP 2015-16). It has shown wide range of adaptability over different types of environments which made it popular among the farmers (Sattar and Abbas 2014). Sunflower breeding programs in Pakistan generally focus on development of hybrid cultivars through heterosis breeding. Exploitation of heterosis or hybrid vigor is directly correlated with the selection of parental lines. It is believed that the genetic distance among the parental lines is a good predictor of heterosis. Principal Component Analysis is an excellent tool which can be used for the estimation of genetic diversity among the parental lines by drawing a two or three dimensional scatterplot with minimal loss of the variability (Uzma, Muhammad et al. 2014). Individuals in aggregation are closely related to each other in the scatter plot. In this way differences among the individuals can be estimated and the possible groups can be identified. The original variables are

transformed linearly into a new set of variables which are known as principal components (Mohammadi and Prasanna 2003; Ramzan, Noor et al. 2014). These principal components are uncorrelated and represent different properties of the original data. Because the principal components are independent of each other therefore should be interpreted separately (Mohammadi and Prasanna 2003; Tabrizi 2009; Tabrizi, Şahin et al. 2011). Previously Uzma, Muhammad et al. (2014) applied principal component and cluster analysis to approximate genetic diversity and character association among sunflower lines and hybrids. Tabrizi (2009); (2011), Arshad, Khan et al. (2010) and Ghaffari, Farrokhi et al. (2011) estimated genetic diversity of single cross hybrids using principal component analysis. Tersac, Vares et al. (1993), de la Vega and Chapman (2001), Sankar, Vanaja et al. (2004) and Ghaffari, Farrokhi et al. (2011) also demonstrated the effectiveness of principal component analysis in selection of best hybrids or genotypes in their experiments.

Keeping in view the significance of this multivariate technique, current study was carried out to group similar hybrids, selection of best hybrids and to assess the proportional contribution of variation contributed by each principal component in the expression of various qualitative and quantitative traits in sunflower.

MATERIAL AND METHODS

This study was carried out at the Department of Plant Breeding and Genetics University of Agriculture Faisalabad during 2014-15. The plant material consisted of a set of 32 sunflower hybrids (Table 1.).

Table 1. List of 32 F_1 single cross sunflower hybrids

Hybrids	Parentage	Source	Hybrids	Parentage	Source
H-1	A12 × HBRS-5	PBG UAF*	H-17	V12 × L44	PBG UAF*
H-2	L49 × HBRS-5	〃	H-18	V18× L44	〃
H-3	L52 × HBRS-5	〃	H-19	L33× L44	〃
H-4	L54 × HBRS-5	〃	H-20	L35× L44	〃
H-5	A30 × L42	〃	H-21	L38 × L53	〃
H-6	L45 × L42	〃	H-22	L48 × L53	〃
H-7	L61 × L42	〃	H-23	L62 × L53	〃
H-8	V1 × L42	〃	H-24	V9 × L53	〃
H-9	G32 × A19	〃	H-25	V27 × L36	〃
H-10	A2 × A19	〃	H-26	HBRS1 × L36	〃
H-11	L50 × A19	〃	H-27	G82 × L36	〃
H-12	L37 × A19	〃	H-28	A23 × L36	〃
H-13	V3 × A41	〃	H-29	A1 × L31	〃
H-14	V6 × A41	〃	H-30	A18 × L31	〃
H-15	V10 × A41	〃	H-31	G40 × L31	〃
H-16	L41 × A41	〃	H-32	A45 × L31	〃

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These hybrids were evaluated in triplicate in the field using randomized complete block design. The planting scheme was 75 and 25 cm. All standard cultural and agronomic practices were performed for a good crop stand. Competitive/representative plants 10 in number were tagged

randomly for each entry in each replication. The data were recorded on plant height, head diameter, percent filled achenes per head, 100-achene weight, achene yield per plant, oil content, palmitic acid, stearic acid, oleic acid and linoleic acid contents. Principal Component Analysis (PCA) was used to arrange the entries in two dimensional biplots (Kroonenberg 1995) based on their field performance. Data were analyzed using XLSTAT software for computation of Principal Component Analysis (Kroonenberg 1995; Dong, Liu et al. 2007). The character loadings were used to calculate the accession component scores. The first two components were extracted for a two dimensional ordinations of accessions.

RESULTS AND DISCUSSION

PCA is a data reduction technique which is used to obtain small number of linear combinations with minimum loss of variability (Biabani and Pakniyat 2008; Sultana and Ghafoor 2008). In this technique, each principal component is uncorrelated with the other one but the variables in each component display correlations with each other. Number of principal components is always equal to the number of variables but the selected components are not always equal to the number of variables (Leite 2012). Usually first 2-3 principal components or components having eigenvalue greater than 1 are selected which are enough to explain maximum variability and only a small fraction of the total variability is lost (Biabani and Pakniyat 2008; Ijaz, Shabir et al. 2011; Ghaffari, Toorchi et al. 2012). In this study four principal components have been extracted which accounted for 69.28 % of the total variability. Only those principal components were retained which have Eigen value greater than or equal to 1. The proportion of each of the four components was 23.54, 20.08, 15.51 and 10.14 percent of total variance respectively (Table 2). Good separation of genotypes is highly influenced by the amount of variability represented by these components. Principal component provides suitable grouping of the genotypes if there exist any correlation among various traits or similarities among the genotypes (Tabrizi 2009).

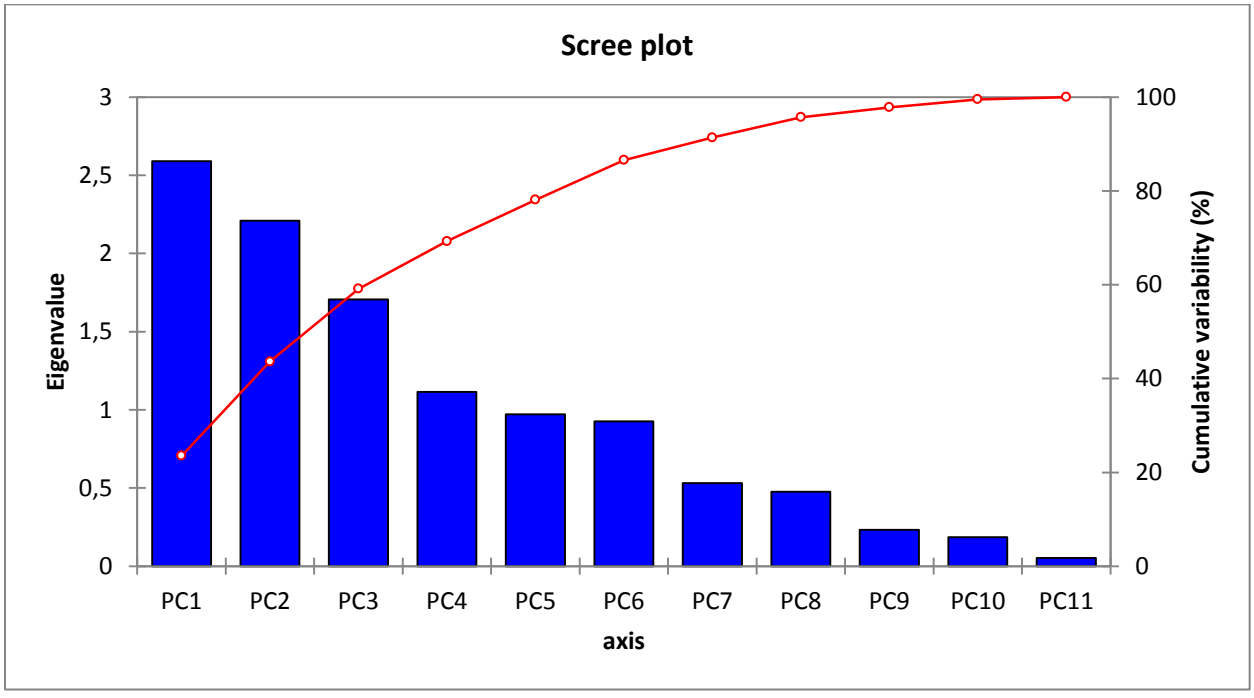

Fig 1. Scree plot diagram for quantitative and qualitative traits of 32 sunflower hybrids

Table 2. Principal components analysis of 32 single cross sunflower hybrids

	Eigenvalue	Variability (%)	Cumulative %
PC-1	2.59	23.54	23.54
PC-2	2.21	20.08	43.62
PC-3	1.71	15.51	59.13
PC-4	1.12	10.14	69.28
PC-5	0.97	8.83	78.12
PC-6	0.93	8.43	86.54
PC-7	0.53	4.84	91.37
PC-8	0.48	4.33	95.71
PC-9	0.23	2.12	97.82
PC-10	0.19	1.69	99.52
PC-11	0.05	0.48	100.00

Table 3 shows each component weight. Only those traits which have component weights greater than 0.5 were considered to be important and are highlighted in bold in Table 3. For example in first component achene yield per plant, 100-achene weight and harvest index had the highest weights respectively along with the positive signs. This indicates that the first principal component was associated with achene yield per plant. The sign and magnitude of the factor loadings with in same component shows the type of association between the two traits (Seiler and Stafford 1985; Tabrizi 2009). The highest factor loadings of achene yield per plant, 100-achene weight and harvest index with positive sign clearly shows the presence of a strong positive correlation among these traits (Dagustu 2002; Zia, Sadaqat et al. 2013). These relations can be easily seen in Fig. 1, where achene yield per plant, 100-achene weight and harvest index are at the right side of the biplot diagram (first component) and had a narrow angle with each other. A strong positive correlation between these three traits can also be verified from the correlation matrix in Table 4.

Second principal component had the highest factor loading for oleic acid and linoleic acid. This component was associated with the oil quality. The negative sign for oleic acid and positive sign for linoleic acid indicates the existence of a strong negative correlation between the two traits. This association can be viewed in the biplot as well where both the traits are close to the y-axis but in the opposite direction and far from the origin. The correlation estimates in Table 4 are also in conformity with these results. A negative correlation between oleic acid and linoleic acid is also well supported in the literature (Singh, Singh et al. 2002; Tahmasebi-Enferadi, Rabiei et al. 2004; Joksimović, Atlagić et al. 2006). Negative correlation between the two traits is due to combined action of two enzymes oleate desaturase and linoleic acid desaturase at the endoplasmic reticulum. Oleate desaturase converts the oleic acid into linoleic acid, whereas the linoleic acid desaturase converts the linoleic acid into oleic acid. Therefore, increase in oleic acid content will always be at the cost of linoleic acid and vice versa. (Mollers 2002; Tahmasebi-Enferadi, Rabiei et al. 2004; Zia, Sadaqat et al. 2013).

The third principal component was associated with the achene filling percentage. Factor loadings of head diameter and filled achenes were high but with opposite signs which shows a

strong negative correlation between the two traits. Fourth component was associated with plant height and this was the only trait which has considerable loading at this component.

Table 3. Loadings of the first four principal components of quantitative and qualitative traits of sunflower hybrids

Traits	PC-1	PC-2	PC-3	PC-4
Plant height	0.026	0.464	0.227	**0.741**
Head diameter	0.115	0.459	**-0.749**	0.082
Filled achenes	-0.201	-0.323	**0.782**	0.157
100-achene weight	**0.860**	-0.226	0.125	-0.087
Achene yield per plant	**0.903**	-0.022	-0.262	-0.080
Harvest index	**0.777**	-0.109	0.341	0.155
Oil content	-0.424	0.174	-0.192	0.298
Palmitic acid	0.115	-0.443	-0.220	0.439
Steric acid	-0.400	-0.291	0.060	-0.367
Oleic acid	-0.112	**-0.780**	-0.308	0.258
Linoleic acid	0.109	**0.834**	0.316	-0.118

Principal component analysis has been used as an efficient multivariate tool for identification of superior genotypes, inbred lines and hybrids in sunflower (Ghafari 2003; Ghaffari and Farrokhi 2008; Tabrizi 2009; Tabrizi, Şahin et al. 2011; Leite 2012; Uzma, Muhammad et al. 2014). This technique enables us to group the genotypes by using the weights of the traits on principal components. Achene yield per plant has the highest weight on first principal component followed by 100-achene weight and harvest index. H-1, H-31 and H-32 are the hybrids scattered around harvest index, 100-achene weight and achene yield per plant vector. These hybrids can be selected for higher achene yields based on the PCA. This can also be verified from the mean values of these hybrids in Table 5 which verifies that these three hybrids produced the highest achene yield. The second group consisted of H-4, H-6 and H-24. These hybrids had higher values of palmitic acid and filled achenes. The third group comprised of H-10, H-14 and H-16 which were clustered around linoleic acid vector. These hybrids were relatively taller with larger heads and had high linoleic acid content. The fourth group consisted of four hybrids i.e. H-2, H20, H23 and H-26. These hybrids had lower values of achene yield per plant and harvest index therefore were clustered together on the opposite side of achene yield per plant and harvest index vectors in the negative region. Hybrid H-5 and H-27 because of low values for majority of the traits were in negative region of the two components and far from the vector loadings and origin. Biplot provided a clear cut grouping of hybrids for multi-trait selection procedure. The hybrids positioned closer to the tail end of a vector have higher values for the corresponding trait and vice versa (Ghaffari 2014). For example H-31, the highest yielding hybrid, was positioned on the extreme right side of the biplot close to the achene yield vector, whereas H-12 and H-27 had the lowest achene yield and were positioned on the extreme left side of the biplot but opposite to the achene yield vector. It was also observed that vectors for achene yield and most of the related traits were projected towards the right side of the biplot whereas vectors associated with oil content and quality traits were projected towards the left side of the biplot. The hybrids related to these traits were also scattered around their respected vectors. For example the highest yielding hybrids H-31 (102.55g), H-1 (94.63g) and H-32

(91.45g) were grouped together in the lower right corner of the biplot around yield vectors whereas the hybrids H-12 (48.80%) and H-20 (46.83) with the high oil content were scattered around the oil content vector in the upper left corner of the biplot.

It is obvious from the results that H-1 and H-32 are the best hybrids with respect to achene yield and oil content, whereas H-12 had the highest oil content but low achene yield and H-31 had the highest achene yield but low oil content.

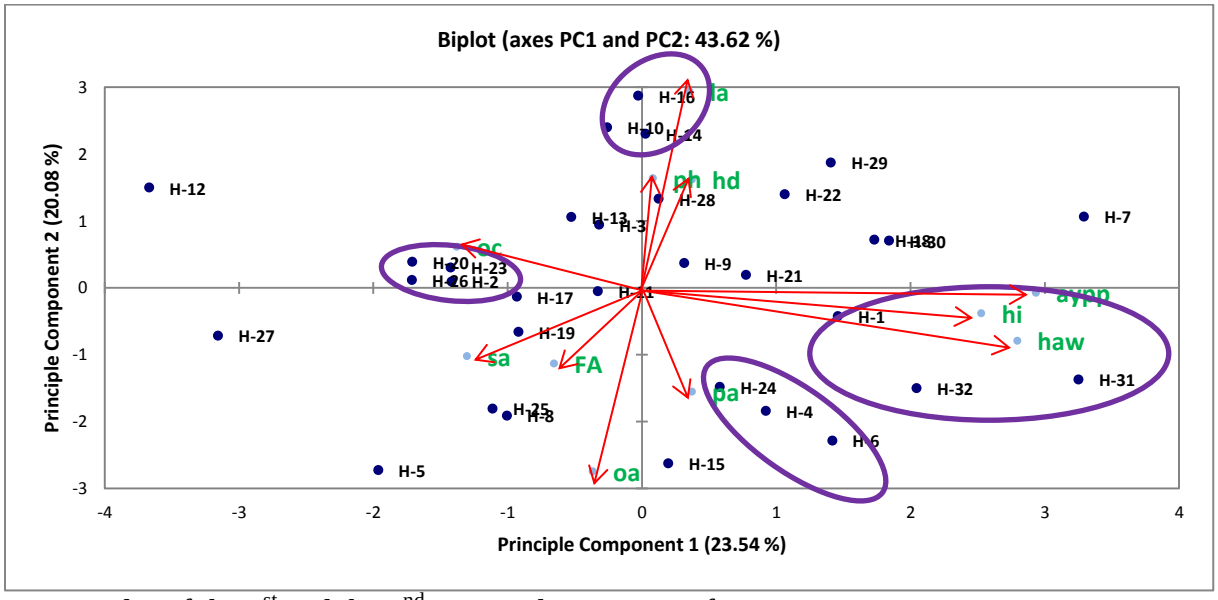

Fig. 2. Biplot of the 1st and the 2nd principal component for agronomic means

Table 4. Correlation (Pearson) coefficient of various plant traits in sunflower

	PH	HD	FA	HAW	AYPP	HI	OC	PA	SA	OA
HD	0.11									
FA	0.07	-0.57								
HAW	-0.04	-0.20	-0.11							
AYPP	-0.10	0.31	-0.32	0.73						
HI	0.11	-0.16	0.18	0.63	0.65					
OC	0.15	0.07	-0.12	-0.36	-0.21	-0.16				
PA	0.02	0.03	-0.04	0.18	0.00	0.08	-0.13			
SA	-0.22	-0.19	0.08	-0.13	-0.30	-0.18	0.14	0.08		
OA	-0.23	-0.15	0.07	0.01	0.01	-0.06	0.08	0.28	0.06	
LA	0.33	0.11	-0.12	0.00	-0.04	0.08	0.02	-0.31	-0.17	-0.75

PH = Plant height (cm), HD = Head diameter (cm), FA = Percent filled achenes (%), HAW = 100-achene weight (g), AYPP = Achene yield per plant (g), HI = Harvest index (%), OC = Oil content (%), PA = Palmitic acid (%), SA = Stearic acid (%), OA = Oleic acid (%), LA = Linoleic acid (%)

CONCLUSION

Principal component analysis is a useful technique for grouping and selection of promising breeding material based on their quantitative and qualitative traits. PCA showed that first four components contributed most of the variability (69.28%). First principal component has the highest proportion, and achene yield per plant, harvest index and 100-achene weight were the most important traits. Principle component analysis effectively grouped the high yielding hybrids (H-31, H-1 and H-32) in Quadrant-I, while hybrids (H-12 and H-20) with high oil content in Quadrant-III. Among the evaluated material H-1 and H-32 are the best hybrids with respect to achene yield and oil content.

REFERENCES

Arshad, M., M. A. Khan, et al. (2010). "Factor analysis in sunflower (*Helianthus annuus* L.) to investigate desirable hybrids." Pakistan Journal of Botany 42(6): 4393-4402.

Biabani, A. and H. Pakniyat (2008). "Evaluation of seed yield-related characters in sesame (*Sesamum indicum* L.) using factor and path analysis." Pakistan Journal of Biological Sciences 11(8): 1157-1160.

Dagustu, N. (2002). "Correlations and path coefficient analysis of seed yield components in sunflower (*Helianthus annuus* L.)." Turkish Journal of Field Crops 7(1): 15-19.

de la Vega, A. J. and S. C. Chapman (2001). "Genotype by environment interaction and indirect selection for yield in sunflower: II. Three-mode principal component analysis of oil and biomass yield across environments in Argentina." Field Crops Research 72(1): 39-50.

Dong, G., G. Liu, et al. (2007). "Studying genetic diversity in the core germplasm of confectionary sunflower (*Helianthus annuus* L.) in China based on AFLP and morphological analysis." Russian Journal of Genetics 43(6): 627-635.

FAOSTAT (2013). "Food and Agriculture Organization of the World Nations." Statistics Division.

Ghafari, M. (2003). "Use of principle component analysis method for selection of superior three way cross hybrids in sunflower." Seed and Plant Improvment Journal 19(4): 513-527.

Ghaffari, M. (2014). "Effectiveness Of different methods for screening of sunflower (*Helianthus annuus* L.) drought tolerant cultıvars." Türk Tarım ve Doğa Bilimleri 7(7): 1584-1589.

Ghaffari, M., I. Farrokhi, et al. (2011). "Combining ability and gene action for agronomic traits and oil content in sunflower (Helianthus annuus L.) using F1 hybrids." Crop Breeding Journal 1(1): 75-87.

Ghaffari, M. and K. Farrokhi (2008). Principal component analysis as a reflector of combining abilities. Proceedings of the 17th International Sunflower Conference, Cordoba, Spain.

Ghaffari, M., M. Toorchi, et al. (2012). "Morpho-physiological screening of sunflower inbred lines under drought stress condition." Turkish Journal of Field Crops 17(2): 185-190.

GOP (2015-16). "Economic Survey of Pakistan." Pakistan Bureau of Statistics, Ministry of Finance, Government of Pakistan.

Ijaz, R. N., A. S. Shabir, et al. (2011). "Principal component analysis for oil conservation tillage vs conventional tillage in semi arid region of Punjab province of Pakistan." Journal of Earth Sciences 3: 20-24.

Joksimović, J., J. Atlagić, et al. (2006). "Genetic control of oleic and linoleic acid contents in sunflower/control. ." Helia 29(44): 33-40.

Kroonenberg, P. M. (1995). "Introduction to biplots for G x E Tables. Research Report No. 51."

Leite, R. M. V. B. C. (2012). Grouping sunflower genotypes by reaction to alternaria leaf spot (*Alternaria helianthi*) and yield, International Sunflower Conference, 18., 2012, Mar del Plata & Balcarce. Proceedings... [Mar del Plata]: ISA: ASAGIR, 2012.

Mohammadi, S. and B. Prasanna (2003). "Analysis of genetic diversity in crop plants: Salient statistical tools and consideration." Crop Science 43(4): 1325-1348.

Mollers, C. (2002). Development of high oleic acid oilseed rape. Presentation at the 8th International Conference for Renewable Resources and Plant Biotechnology. Narossa R.

Ramzan, A., T. Noor, et al. (2014). "Correlation, cluster and regression analysis of seed yield and its contributing traits in pea (*Pisum sativum* L.)." Journal of Agricultural Research 52(4).

Sankar, G., M. Vanaja, et al. (2004). "Selection of consistent plant traits for sunflower growth using principal component analysis." Helia 27(41): 113-122.

Sattar, A. and S. Abbas (2014). "Yield response of autumn planted sunflower hybrids to zinc sulfate application." J. Agric. Res 52(4).

Seiler, G. J. and R. E. Stafford (1985). "Factor Analysis of Components of Yield in Guar." Crop Science 25(6): 905-908.

Singh, D. P., S. Singh, et al. (2002). "Heterosis for fatty acid composition over environments in sunflower (*Helianthus annuus* L)." Journal of Research 39(1): 1-5.

Sultana, T. and A. Ghafoor (2008). "Genetic diversity in ex-situ conserved Lens culinaris for Botanical Descriptors, Biochemical and Molecular Markers and Identification of Landraces from Indigenous genetic Resources of Pakistan." Journal of Integrative Plant Biology 50(4): 484-490.

Tabrizi, H. Z. (2009). "Estimation of genetic diversity of sunflower single cross hybrids using principle components analysis." Research Journal of Biological Sciences 4(9): 978-981.

Tabrizi, H. Z., E. Şahin, et al. (2011). "Principal components analysis of some F1 sunflower hybrids at germination and early seedling growth stage." Ataturk Üniversity Ziraat Faculty/ Journal of the Faculty of Agriculture 42(2): 103-109.

Tahmasebi-Enferadi, S., Z. Rabiei, et al. (2004). "Half-seed analysis for comparing linolenic acid synthesis between high and low oleic acid sunflower inbred lines." Helia 27(40): 63-72.

Tersac, M., D. Vares, et al. (1993). "Combining-groups in cultivated sunflower populations (*Helianthus annuus* L.) and their relationships with the country of origin." Theoretical and Applied Genetics 87(5): 603-608.

Uzma, A., F. K. Muhammad, et al. (2014). "Investigation of genetic divergence in local sunflower hybrids and inbred lines by applying morphological markers." International Journal of Agronomy and Agricultural Research 5(2): 154-163.

Zia, Z. U., H. A. Sadaqat, et al. (2013). "Correlation and path coefficient analysis of various traits in sunflower (*Helianthus annuus* L.)." Journal of Global Innovation in Agriculture and Social Sciences 1(1): 5-8.

Table 5. Mean values for different traits of 32 sunflower hybrids

	PH	HD	FA	HAW	AYPP	HI	OC	PA	SA	OA	LA
H-1	237.23	19.24	80.62	7.30	94.63	21.47	46.24	6.30	4.43	21.92	64.98
H-2	237.05	21.13	96.95	5.16	69.07	12.29	44.24	5.61	2.76	23.98	65.77
H-3	237.05	20.95	97.70	5.45	66.87	20.04	43.98	5.60	2.13	19.37	66.01
H-4	239.55	19.15	94.33	6.79	70.47	18.95	39.48	7.66	2.56	23.17	62.75
H-5	238.33	18.75	93.31	4.79	56.44	15.41	42.44	6.26	2.96	27.60	56.61
H-6	251.70	21.34	97.32	7.09	86.18	21.80	40.27	6.76	3.53	26.66	60.80
H-7	270.60	17.64	95.59	7.66	82.17	33.89	40.61	7.28	2.98	16.66	71.28
H-8	240.82	19.25	94.62	5.75	68.15	19.99	45.40	6.30	4.17	25.48	60.99
H-9	265.79	22.27	95.00	5.70	72.14	21.46	46.42	7.31	1.57	23.53	65.28
H-10	274.29	23.67	88.30	5.42	67.37	14.75	42.69	6.64	2.41	20.02	68.95
H-11	251.70	23.05	86.88	5.63	68.76	13.53	38.87	6.97	3.64	22.99	64.77
H-12	258.19	20.30	90.73	3.97	46.80	8.19	48.80	6.17	3.12	21.78	67.17
H-13	243.97	22.87	85.43	5.23	67.34	12.30	41.93	6.49	2.05	21.66	65.89
H-14	242.78	25.29	78.49	5.50	72.80	13.91	42.65	6.26	2.75	18.00	66.34
H-15	245.55	15.77	93.16	7.18	59.12	14.40	38.78	7.50	2.56	25.39	61.99
H-16	266.42	20.20	97.09	5.92	65.27	18.85	42.16	5.35	2.75	16.74	71.93
H-17	234.10	22.30	95.33	5.04	67.48	16.74	41.43	6.51	3.65	21.61	65.43
H-18	237.18	25.04	76.95	7.20	89.98	15.60	41.90	6.38	3.29	21.81	65.16
H-19	239.02	21.93	95.69	5.26	68.24	14.23	41.55	7.44	3.61	17.60	60.10
H-20	248.40	19.01	94.21	6.01	56.24	12.26	46.83	6.25	3.47	19.56	65.03
H-21	264.37	23.48	90.04	6.15	83.23	15.24	40.17	6.37	2.55	22.56	61.83
H-22	254.55	24.05	84.57	6.67	85.87	11.56	43.06	6.53	1.87	20.50	65.13
H-23	247.22	19.15	91.86	5.85	58.59	12.86	43.57	5.77	3.63	21.02	65.33
H-24	228.57	21.00	96.55	6.37	74.04	16.39	36.48	7.36	3.64	21.58	64.37
H-25	222.98	20.95	93.00	6.02	67.07	15.06	45.31	7.46	4.45	23.25	63.03
H-26	256.00	19.78	93.87	6.01	49.37	9.83	42.54	6.80	3.45	20.86	65.37
H-27	225.45	19.94	92.39	5.08	44.56	7.92	43.29	6.53	4.69	22.05	65.12
H-28	224.02	19.28	89.75	5.79	64.97	14.12	36.79	5.58	2.35	18.06	69.90
H-29	236.48	23.29	86.17	6.47	85.83	17.32	42.55	6.49	2.41	18.50	69.99
H-30	247.18	22.98	91.62	6.60	86.71	26.67	41.73	5.82	3.33	19.70	65.27
H-31	224.94	17.79	96.81	7.88	102.55	24.29	39.62	5.40	1.78	22.23	62.71
H-32	226.10	23.23	83.10	6.65	91.45	21.90	44.08	7.65	1.69	26.09	61.73

PH = Plant height (cm), HD = Head diameter (cm), FA = Percent filled achenes (%), HAW = 100-achene weight (g), AYPP = Achene yield per plant (g), HI = Harvest index (%), OC = Oil content (%), PA = Palmitic acid (%), SA = Stearic acid (%), OA = Oleic acid (%), LA = Linoleic acid (%)

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Effects of Growing Season and Root Presence on Some Yield Components and Fatty Acid Composition of Sesame in Cukurova Region

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Abstract
Sesame is harvested manually in Turkey. The traditional harvesting system which are ripped and bound in small bundles by labor and later dry plants are threshing. This system is being not only increases the cost of sesame, but also leads to a gradual decrease in planting area of sesame in Turkey. In the Turkey has been working on complete mechanization of sesame harvesting and threshing. Till now, the farmers do not prefer to mechanical harvest system because they are considering that the quality of seed are reduce by cutting the roots at the harvest. The main purpose of the study is to determine the relationship between root presence and seed quality in sesame. For this purpose, some quality parameters were compared to the seeds obtained from rooted and without root plants.It was carried out randomized complete split plot design, four replicates in Cukurova Region and for two years under main and second crops conditions. In the study, 1000 seed weight, fat-protein ration and fatty acid composition were determined in sesame seeds obtained from plants rooted and without root. As a result, this study found that root presence has no statistically significant effect on palmitic, stearic, oleic, linoleic acid. But, it was determined that root presence was a significant effect on seed weight ($P<0.05$). Despite could be determined that the growing season (main and second crop conditional) has statistically significant effect on stearic ($p<0.05$) and oleic acids ($p<0.01$), could not be determined this effect on palmitic and linoleic acid.

Keywords: Sesame, root presence, harvest, fatty acid composition.

INTRODUCTION

The sesame (*Sesamum inducum* L.) belongs to the family of *Pedaliaceae* and one of the oldest oil seeds known by humans. It contains about 50-60% seed oil with superior quality comparable to olive oil (Aslan *et al.*, 2007). Seeds of sesame are very rich in iron, magnesium, copper, calcium and vitamin B1 and E. It contain phytosterols associated with reduced levels of blood cholesterol (Bedigian, 2004). Sesame has an important place among oil plants with highest oil and containing an amount 25% of protein and sesame oil is remarkable stability to oxidation due to the present of lignins (Lee *et al*., 2008).

Sesame is grown in tropical zones as well as in temperate zones. Especially in Asia and Africa it is cultivated from centuries (Khan & *et al.*, 2016) and one of the traditional crops of Turkey, too. In Turkey Sesame genotypes has highest oil content changed between 40.0-61.8% (Tan, 2012). In despite of the nutritional value and oil quality of sesame seeds, research on this important crop has been not enough yet. Although seed yield in Turkey is higher than the world average, it is not satisfactory. Turkey sesame production at 289 332 da; and with 12.48% of this, which is 36 114 da, is total production of the Adana (TUİK, 2017). According to statistics between in 1966-1970 in terms of Turkey sesame planting area was ranked 4th in the World (İlisulu, 1973). The amount of sesame planting area in Adana (1970 s) was almost the same as total amount planting in Turkey in 2012. The production of sesame decrease year to year due to manual harvesting in Adana. Sesame is a highly profitable crop, but in order to reduce the cost of production even further, the mechanization of harvesting is

essential. Mechanization of some aspects of sesame farming, such as forming a ridge, mulching, and seeding, have been developed, but weeding and harvesting operations are entirely dependent on manual labor (Yilmaz *et al.*, 2008). The most important expense is human work in the harvesting by hand. In a study conducted by Ugurluay (2002), the most consumption time in the total process time was determined in to be pulled up the plants and to be made brunches by hand (107 h ha^{-1}). Harvesting is the most costly input at sesame cultivation. This cost was found to be 59% by Flip (1988). In another study, the cost of harvest was determined 54.5% at the main crop and 41.0% at the second crop condition (Vurarak *et al.*, 2014). High priority must be given to the solution of manually harvesting issue, and as a potential alternative to it, mechanized or semi-mechanized harvesting systems must be presented to the farmers. Thus, the harvesting cost that is about 70% of the production input cost will be able to be reduced. Yet, while doing this to reduce the cost, it also must be remembered that crop quality must not be affected negatively. In Turkey it was done a few researches on sesame harvesting mechanization (Ugurluay, 2002). Generally, harvesting loss was determined in that research, however, effect of machine harvesting on seed quality and fatty acid composition was not determined earlier studies. This issue in sesame farming needs to be solved in order to increase the production areas. High priority must be given to the solution of manually harvesting issue, and as a potential alternative to it, mechanized or semi-mechanized harvesting system must be present to the farmers.

Sesame cultivars grown all over the world have dehiscent capsules; therefore, 99% of the fields are harvested manually (Georgiev *et al.*, 2009). A lot of sesame varieties and ecotypes which have been grown for hundreds of year are distributed in various ecological regions of Turkey (Baydar *et al.*, 1999). Sesame is commonly grown in small-scale farms with less input and less mechanization in most of major sesame producing countries as well as in Turkey. Sesame yield is low, mainly attributed to low yield of the cultivars with an indeterminate growth habit, pest and diseases occurrence, insufficient weed control, uneven ripening of capsules, seed shattering, susceptibility to environmental stress, lack of mechanized harvest and lack of adequate research (Furat & Uzun, 2010). Sesame harvesting takes 5-8 days and lack of labor during the harvest period give rise to high cost and low yield (Tan, 2012). Together with that shed their seed. It is very important to harvest in sesame seeds if not timely harvested causing yield losses. Sesame yield could be improved by using better management practices and adapt to crop to the mechanical agricultural systems (Calıskan *et al.*, 2004).

It is very important that the sesame harvesting at time is correctly determined. The rightest harvest moment occurs when the seeds in the base of the stem start to open. A common feature in most variety, especially in dehiscent ones, is the speedy process of natural dehiscence of capsules, with eventual seed fall. This happens right after the best maturity stage, which, in case of late harvests, can mean great losses in production (Queiroga *et al.*, 2008). It is noteworthy that determining the ideal harvest moment for dehiscent sesame is hard because capsule maturity is uneven, for it is a plant that has indetermined growth (Banerjee & Kole, 2009). In Turkey, there is not a breeding program for the development of a new type of sesame cultivars with in dehiscent capsules and suitable for mechanized harvesting. According to mechanical harvesting of sesame, the cultivars should have an upright habitus with a limited number of branches, strong and lodging resistant stem. In order to decrease the losses in mechanized harvesting, the height at first branch and pod should be 25–30 cm from soil surface.

Harvesting by machine or used combine harvester is limited in the world. Generally, in Turkey sesame harvest method is to pull up maturity plants in the field two or three times. Sesame plants are pulled up from the roots of the sesame plants and ten of fifteen plants banding together are made bunch in the field. Bunches are pressed about seven or ten days

(Yilmaz *et al.*, 2008) and fallowing the bundles are then inverted, and the seed falls out (thresing). In the Turkey has been working on complete mechanization of sesame harvesting and threshing. In an effort to mechanize the harvest of sesame, have introduced recently the use of binders in Turkey. The binders were used to cut and bundle the sesame plants, manual labor was used to shock the cut plants, and combines were brought in to thresh the shocks. This methodology is very little used in Turkey and is considered "semi-mechanized harvest" because it still requires some manual labor. Till now, the farmers do not prefer to mechanical harvest system because they are considering that the quality of seed are reduce by cutting the roots at the harvest.

The fatty acids, as the other elements that from oil, are found in different forms of compositions in each of oil plants (Baydar, 1999). That's why, the factors that effect the amount of oil and fatty acids in the plant should be done accordingly in order to meet the need for the consuming purpose, whatever it is (Karaca & Aytaç, 2007). Tahini is widely used in foods in the Middle East and its quality related to oil and fatty acid contents (Ozcan, 1993). Quality of sesame seed rooted and without root of bunched plant is important both sesame farmers. Farmers can be easily prefer to mechanical harvesting if they know the impact of the harvest on quality.

One purpose of this research examined whether it is or not change seed oil and fatty acid composition. If this goal can be proved, the harvest of sesame in Turkey can quickly become using mechanization. Farmers can be easily prefer to mechanical harvesting if they know the impact of the harvest on quality.

The main purpose of the study is to determine the relationship between root presence and seed quality in sesame. For this purpose, some quality parameters were compared to the seeds obtained from rooted and rootless plants. It was carried out randomized complete split plot design, four replicates in Cukurova Region (in Adana province) and for two years under main and second crops conditions. In the study, 1000 seed weight, fat ration, protein ration and fatty acid composition were determined in sesame seeds obtained from root and without root plants.

MATERIAL AND METHOD

Source of plant material and climate values of region

Orhangazi-99 sesame variety was used as material in the experiment. This variety was preferred because it drops its lower leaves completely at the stage ripeness, and because it also has a slight lodging. The average yield of this variety change from 1 420 to 2 690 kg ha^{-1}. Average flowers is change 28-45 day, vegetation duration is between 92-100 days depending on environmental conditions. Additionally, it has a suitable number of side branches for harvesting, and its height is very suitable for harvesting the early capsules.

The experimental area Adana province which is located in Eastern Mediterranean Region of Turkey, soils are classified as clay. The region has warm and humidity climate in summer and the mean annual rainfall is between 650-800 mm, most of which fall in a major cropping season which extends from December to June. 2011 and 2012 climate data of experimental area are given in Table 1. Second year temperatures are higher than first year temperatures as shown in the Table 1.

Method

The study was conducted in the farming fields of Eastern Mediterranean Agricultural Research Institute for two years under main and second crop conditions in Adana province, Turkey (latitude 36° 51′ N, longitude 35° 20′ E and altitude 11.0 meter above sea level). It was carried out randomized complete split plot design with four replicates. Growing seasons (main and second crop conditions) were assigned to the main-plots and root presence (rooted and without root) to the sub-plots during the 2011-2012. The size of each plot was 2.8 m x 5

m, row spacing (four rows) was 0.7 m and the distance between plants in the row was 0.15 m, and 2-3 cm of depth. Seed rate was kept 2.5 kg ha^{-1} and agronomic practices were carried out consistently for all the experimental units during the growing season. The crop was fertilized with an amount of 70 kg N, and 50 kg of P_2O_5 ha^{-1} applied as basal dose prior to sowing. Right after sowing, irrigation was performed, and then, when plant height reached 10-15 cm, hoeing was performed for the first time, and right after that, irrigation was performed for the first time. Later on, irrigation was performed for three times and pesticide control against whitefly pest was performed for four times along sesames grown for second crop conditions. For main and second crop conditions sowing and harvesting dates are given Table 2. While main crop was sowing at the end of April, second crop was sowing at the end of June after wheat harvest. The main crop was harvested on August, second crop on September, 2011 and 2012. The traditional harvesting, after the plants were pull up from the roots of the sesame plants, ten or fifteen plants banding together are made bunched in the field. But at the alternative harvesting, before sesame plants are made bunched in the field, plant roots were cut, namely, they are made bunched without root. Bunches are pressed about 5-10 days. Bunches which including to dry and open capsules and grain are hit with thick stick to be provide the spilled of the grain from inside the capsule in threshing by hands is done.

Plant height (cm), number of branches per plant (branches $plant^{-1}$), stem thickness (mm) and height of first capsules (cm) were recorded on ten plants randomly chosen before harvesting. Biological yield of plant have given as mean. The following methods were applied to the seeds obtained from each of the parcel and replication to determine the 1000 seed weight, protein rate, oil rate and fatty acid compositions.

1000 seed weight (g): At maturity, the seed obtained from all the randomly selected five plants were weighed and calculated on the basis of number of plants threshed to get average weight of seeds plant.

Protein rate (%): It was determined with Kjeltec method by using the Kjeltec appliance (Anonymous, 1977).

Oil rate (%): Oil rates were determined an NMR appliance that work with Nuclear Magnetic Resonance system, within a level of 0 % moisture (Granlund & Zimmerman, 1975). Measurements for oil rates were done for each parcel in two parallels and then the average was calculated.

Fatty acid contents (Oleic, Linoleic, Palmitic, Stearic): The composition of fatty acid was determined by gas liquid chromatography (GC) (Christie, 1973) In according to the Turkish Food Codex given limit values for sesame seed, palmitic, stearic, oleic and linoleic acid must be changed 7.9-12.0%, 4.5-6.7%, 34.4-45.5%, and 36.9-47.9% respectively (Anonymous, 2009). Obtained data is compared to this codex limits.

Data analyzed

The data collected were statistical analyzed by using the computerized statistical programme JUMP7. Data were subjected to analyses of variance for the combination of two years, growing season and root presence. Analysis of variance was used to test the significance of treatment effects (Steel and Torrie, 1980) and Least significance difference (LSD) test at $P = 0.05$ was used to compare the treatment means.

RESULTS AND DISCUSSION

Some of the general parameters measured for the main and second crops of sesame between 2011 and 2012 are given in Table 3. According to Table 3, seed yield was higher by 14.5% at the main crop conditions than at the second crop conditions. Also, it was seen that second year of seed yield is increased in the second crops conditions. Number of branches per plant changes between 4.7 and 5.4 for two years. Its showed that effect of growing season on height of plant and height of first capsules. Second crop condition gave the shortest height to

first capsule compared to main crop condition. It can be said that height of first capsules is related to total temperature and environment. Differences due to environmental (total temperature and others) and growing season were significant. Brigham (1985), Karaca & Aytac (2007) reported that sesame yield is highly variable depending upon the growing environment, cultural practices and cultivars.

1000 seed weight

Statistical analysis indicated that growing season had a highly significant effect on 1000 seed weight. Data in Table (4) revealed that 1000 seed weight was significantly affected by growing season ($p<0.01$) and root presence ($p<0.05$). According to data of growing season and root presence, 1000 seed weight is the highest at main crop and without root conditions. 1000 seed weight ranged from 2.94 g to 3.07 g in growing season. But according to study of Mandi *et al.* (2007) found that second crops (3.11 g) had heavier seed than main crops condition (2.87 g).

Oil content

A perusal of Table 4 exhibits that there is no effect of growing season and root presence on oil content statistically. However, the oil content ranged from 54.10% to 55.98%. Different references reported that the total amount of temperature required to grow a sesame crop ranges from 2500°C to 3500°C (İlisulu 1973; Tan 2012). In this study, while total 2714°C average temperature measured during growing season for the main crop conditions, 2508°C average temperature measured during growing season for the second crop conditions. It can be said that temperature differences between main and second crop conditions is not effect on oil rate. But, oil content ranged from 54.10% to 55.83%.According to İlisulu (1973) sesame seeds contain average 40-60% oil. Tan (2012) reported that oil content of Orhangazi-99 variety has been changed between 55.3-57.9%. As seen in Table 3, oil contents were higher in main crop conditions (by 55.83%) than second crop conditions but these variations were not significant for growing season. Uzun *et al.* (2002) reported that oil content of sesame can be varied by climate conditions and it can decrease by delaying planting time. In additionally, seed oil content may vary considerably between genotype and seasons, and oil percentage tends to rise with increasing length of photoperiod (Weiss, 2000). Our results showed that oil content is inversely related to growing season.

Protein content

It is a fact that, both oil and protein raters for all oil plants are desired to be high, and that applies for sesame as well (Smith, 1991). It is determined that growing season was effective at ($p<0.01$) importance level on protein rate statistically. Protein content ranged from 18.39% to 21.17%. It was higher by 13.3% at the second crop conditions than at the main crop conditions. There is an inverse relation between oil and protein values (Wilcox & Shibles, 2001). Similar results are found in this study. However, root presence was not effective statistically on protein rate (Table 4).

Oil fatty acid composition

Results which are related oil fatty acid compositions according to the cases were given Table 5. According to combined variation analysis, an important level of a difference the effect of growing stages on the palmitic and linoleic fatty acid was not found statistically. On the other hand, growing season was found to be effective on the stearic fatty acid $p<0.05$ importance level, on oleic fatty acid $p<0.01$. There was no significant and statistically effect of root presence on fatty acid compositions. When these results are evaluated, it is possible to say that growing season is more effective on fatty acid composition compare to root presence.

Statistical analysis indicated that the effects on palmitic fatty acid neither growing season nor root presence. Palmitic fatty acid ranged from 10.77% to 10.84%. According to statistical analysis, it was determined that growing season is effective on stearic fatty acids statistically. The stearic acid is reduced 3.75 % at the second crop conditions compare to main

crop conditions. Stearic acid ranged from 6.40% to 6.65%. Growing season is effective on oleic acids statistically. Oleic acid is reduced 1.72% at the main crop conditions compare to second crop conditions. Oleic acid ranged from 40.38% to 41.09%. It was determined that the cases was no effects on linoleic acid statistically. There was no significant and statistically effect of root presence on linoleic acid compositions. Linoleic acid ranged from 40.32% to 40.49% (Table 5)**.** Genetic structure, development stages and fruit formation is effect of fatty acid content of cultivars (Karaca & Aytac, 2007). Oil quality is determined to its fatty acid compositions which is palmitic, stearic, oleic and linoleic fatty acid content percentage. Those values may change under different genetic, morphological, ecological, physiological, and cultural factors (Beatrice *et al*., 2006)

CONCLUSION

In the end of this study, it was determined that stearic and oleic fatty acid content may change under main and second crop conditions. This situation is thought to be related to the climate of the country.However, it was determined that root presence was not effective on fatty acid content. At the Turkish Food Codex declaration, palmitic fatty acid is ranged between 7.9-12.0%, stearic fatty acid 4.5-6.7%, oleic fatty acid 34.4-45.5%, linoleic fatty acid 36.9-47.9% (Anonymous, 2009). In our study, all results were found in the limits specified by Turkish Food Codex declaration.

At the end of this study, it can be said to sesame growers that seed quality of with root and without root is same. This result supported that sesame can be harvested with machine instead of harvest with hands. Therefore, the effect of different harvesting method on sesame quality were determined that can be potentially an alternative harvesting process which is the most difficult, time consuming and costly one is sesame farming.

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REFERENCES

Anonmyous 1977. Official methods of analysis. 124 Edition Section. A.O.A.C. 31.042-31.043. Washington, D.C. U.S.A.

Anonmyous 2009. Regulation on Turkısh food codex. http://www.tarim.gov.tr /Sayfalar/EN/Mevzuat.aspx?OgeId

Aslan C., Uzun B., Ulger S. & Cagirgan M. 2007. Determination of oil content and fatty acid composition of sesame mutants studied for intensive management contitions. *Journal of American Oil Chemistry Society*, 84: 917-920

Banerjee P.P. & Kole E.P.C. 2009. Analysis of genotypic diversity in sesame (Sesame indicum L.) based on some physiological characters. *Czech J. Genet. Plant Breed*. 45: 72-78

Baydar H., Turgut İ. & Turgut K. 1999. Variation of certain characters and line selection for yield, oleic and linoleic acid in the Turkish sesame (Sesame indicum L.) populations. *J. Agr. and Forest.* 23: 431-441

Beatrice A.W., Augustino O.O., Samuel G., Margareta W. & Anders S.S. 2006. Seeds oil content and fatty acid composition in east african sesame (*Sesamum indicum L.)* accession evaluated over 3 years. *Field Crops Research*, pp:1-7.

Bedigian, D. 2004. History and lore of Sesame in southwest Asia. *Economic Botany* 58(3): 329-353

Brigham, R.D. 1985. Status of sesame research and production in Texas and USA. *In: L.A. Ashi (ed)Sesame and Sunflower Status and Potentials Pubi*. 66: 73-74

Calışkan S., Arslan M., Arioğlu H. & İşler N. 2004. Effect of planting method and plant population on growt and yield of sesame in a Mediterranean type of environment. *Asian Jour. of Plant Sci*., 3(5): 610-613

Christie W.W. 1973. Lipid analysis. *Pergamon Press, Ltd.*, Oxford, England.

Flip M. 1988. Annual report of the food legume improvement program. *Icarda Aleppo*, Syria.

Furat S. & Uzun B. 2010. The use of agro-morphological characters for the assessment of genetic diversity in sesame (Sesame indicum L.). *Plant Omics*, 3(3): 85-88

Georgiev S.T., Stamaton S.T. & Deshev M. 2009. Requirements to sesame (*Sesame indicum L.*) cultivars breending for mechanized harvesting. *Bulgarian Journal of Agricultural Science*, 15(1): 26-30

Granlund M. & Zimmerman D.C. 1975. Oil content of sunflower seeds as determined by wide-line nuclear magnetic resonance (NMR). *Proc. N.D. Acad. Sci*., 27:128-133

Ilisulu K. 1973. Oilseed crops and breeding, Ankara University, Departman of Field Crops, Faculty of Agriculture

Karaca E. & Aytaç S. 2007. The factors affecting on fatty acid composition of oil crops. *OMU University, Agricultural of Sci*.,22(1): 123-131

Khan N., Khalil S.K., Amanullah A., Ali A., Ullah Z. & Ali M. 2016. Effect of nitrogen and sülfür on yield and yield components of sesame (Sesamun Indicum L.) in calcareous soil. *Pure Applied Biology*. http://dx.doi.org/10.19045 /bspab.2016.50061

Lee J., Lee Y. & Choe E. 2008. Effects of sesamol, sesamin and sesamolin extracted from roasted sesame oil on the therial oxidation of methyl linoleate. *LWT Food Sci. Tech.,* 41: 1871-1877

Mahdi A.R. 2007. Effect of sowing date on the performance of sesame (*Sesamun indicatium L.*) genotypes under irrigation contitions in northern Sudan. *African Crop Sci. Canf. Proc.,* 8: 1943-1946

Ozcan M. 1993. Physıcal and chewıcal properties and fatty acid compositions of sesame seed, sesame oil and tahin (sesame paste). *Depermant of Food Sci., Selcuk University Graduate School of Natural and Applied science*, page 42, M.S. thesis number : 28402

Queiroga V.P., Gondim T.M.S., Vale D.G., Gerone H.G.M., Moura J.A., Silva P.J. & Souza F.J.F. 2008. Produção de gergelim orgãnico nas comunidades de protutores familiares de Sao Francisco de Assis do Piaunî. *Campina Grande:* Algodão. Documentos. P 127

Smith K. 1991. Improvement of soybean composition to meet consumer/user demands. pp. 71–78

Steel R.G.D. & Torrie J.H. 1980. Principles and procedues of statistics. *New York, 2nd Edition Mc Graw Hill Book Comp.*

Tan Ş. 2012. Sesame cultivation. *Aegean Agricultural Research Institute, İzmir,* publisch number: 146

TUİK 2017. Crop production statistics. *Turkish statistical institute, https://biruni.tuik.gov.tr/bitkiselapp /bitkisel.zul.*

Uğurluay S. 2002. A research on determination of harvesting mechanization possiblities of sesame plant. *Cukurova Universty, Departman of Agri. Machinery Instıtute of Natural and Applied Sciences, Master Thesis*, Number: 119859

Uzun B., Ülger S. & Çağırgan İ.M. 2002. Comparison of determinate and ındeterminate types of sesame for oil content and fatty acid composition. *Tr. J. of Agriculture and Forestry.* 26: 269-274

Vurarak Y. & Bilgili M.E. 2014. Determination of variation of the oil and protein values of second crop sesame harvested with different methods. *12th International Congress on Mechanization & Energy in Agriculture* pp: 248

Yilmaz D., Çelik K. & Akıncı İ. 2008. Harvestıng and threshıng mechanızatıon of sesame plant. CIGR Internatıonal conference of agrıcultural engıneerıng XXXVII *congresso Brasıleıro De Engenharıa Agrícola-Conbea Brazil*

Weiss E.A. 2000. Oilseed crops. *Second Edition, Oxford, Blackwell Science*

Wilcox J.R. & Shibles R.M. 2001. Interrelationships among seed quality attributes in soybean. *Crop Science*, 41:11-14

Table 1. Temperature (°C), relative humanity (%), total rainfall (mm), and wind speed (m s^{-1}) for 2011 and 2012 in the experimental area

Months	Mean of temperature		Mean of relative humidity		Total rainfall		Mean of wind speed	
	2011	2012	2011	2012	2011	2012	2011	2012
April	16.5	18.1	65.4	68.3	117.3	36.0	0	9.7
May	20.1	20.8	70.2	74.0	30.0	97.0	0	9.7
June	24.5	26.7	72.4	66.2	0	35.5	9.4	7.5
July	27.9	29.3	71.5	65.3	0	18.3	8.8	10.6
August	28.8	29.3	68.6	62.5	0	0	9.7	10.2
September	26.9	27.0	65.7	64.9	0	0	9.6	10.0
October	20.7	22.6	49.7	61.9	6	51.9	11.7	35.0

Table 2. Experimental area sowing and harvest dates for main and second crop

Years	Process	Main crop	Second crop
2011	Sowing	04.05.2011	29.06.2011
	Harvest	12.08.2011	26.09.2011
2012	Sowing	28.04.2012	19.06.2012
	Harvest	06.08.2012	21.09.2012

Table 3. Some of plant parameters for main and second crop conditions

Parameters	Main crop			Second crop		
	2011	2012	Average	2011	2012	Average
Plant height (cm)	189.1	179.6	184.3	145.3	170.7	158.0
Stem thickness (mm)	13.3	12.5	12.9	11.9	14.2	13.1
Branches (per plant)	4.7	5.0	4.8	4.8	5.4	5.1
Height of first caps. (cm)	73.5	51.0	62.3	48.0	53.0	50.5
Seed yield (kg ha^{-1})	1728.2	1437.3	1582.8	1151.7	1553.8	1352.2

Table 4. Summary of the variation from average 1000 seed weight, oil content, protein content

Parameters	1000 seed weight (g)	Oil content (%)	Protein content (%)
Growing season			
Main crop	3.07±0.09a	55.83±3.36	18.39±3.03a
Second crop	2.94±0.38b	54.10±2.12	21.17±2.49b
$LSD_{(0.05)}$	0.0016	-	0.006
Root presence			
Rooted	2.98±0.30b	54.95±3.40	19.69±2.90
Without root	3.03±0.27a	54.98±2.40	19.86±3.29
$LSD_{(0.05)}$	0.0009	-	-
CV(%)	0.65	6.67	4.10
Growing season	0.0077^{**}	0.174^{ns}	$<.0001^{**}$
Root presence	0.021^{*}	0.968^{ns}	0.725^{ns}
Growing season*Root presence	0.94^{ns}	0.242^{ns}	0.548^{ns}

Means followed by similar letters in columns or rows are not significantly different according to least significant difference (LSD). * and ** significant at 0.05 and 0.01 level of probability, respectively.

Table 5. Summary of the variation from average palmitic, stearic, oleic and linoleic fatty acid.

Parameters	Palmitic (%)	Stearic (%)	Oleic (%)	Linoleic (%)
Growing Season				
Main crop	10.79±0.62	6.40±0.43b	41.09±0.47a	40.32±1.16
Second crop	10.82±0.43	6.65±0.74a	40.38±0.53b	40.49±1.21
$LSD_{(0.05)}$	-	0.004	0.0042	-
Root Presence				
Rooted	10.77±0.50	6.53±0.62	40.81±0.60	40.44±1.14
Without root	10.84±0.60	6.51±0.61	40.62±0.64	40.36±1.21
$LSD_{(0.05)}$	-	-	-	-
CV(%)	0.99	2.47	0.93	0.73
Growing season	0.708^{ns}	0.023^{*}	0.0001^{**}	0.431^{ns}
Root presence	0.462^{ns}	0.834^{ns}	0.173^{ns}	0.674^{ns}
Growing season*Root presence	0.201^{ns}	0.388^{ns}	0.845^{ns}	0.060^{ns}

Means followed by similar letters in columns or rows are not significantly different according to least significant difference (LSD). * and ** significant at 0.05 and 0.01 level of probability, respectively.

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Effect of Inoculation of Earthworms and Soil Microorganisms on Soil Structure and Productivity of Alfalfa

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Abstract

The paper deals with exploration the influence of earthworms and soil microorganisms on soil structure and productivity of alfalfa. The observation was carried out on Chromic-Vertic Luvisols (fine texture) from Sofia field (Bulgaria) in pot experiment. The inoculations were made with three ecological groups of lumbrids: anecic (*Lumbricus terrestris*), epigeic (*Eisenia fethida*) and endogeic (*Aporrectodea rosea*, *Aporrectodea caliginosa* and *Octolasion lacteum*) earthworms. The inoculation with soil microorganisms was provided with nitrogen-fixing bacteria from genus Rhizobium. The soil structure of studied treatments was characterized by indicators derived from the soil water retention curve and total porosity. The most pronounced effect of inoculations of earthworms and microorganisms was found in the volume of macropores which increased with depth while in the control variant it decreased with depth. The results showed that interaction between earthworms and soil microflora increased the biomass of alfalfa. Our study demonstrated that earthworms and soil microorganism have positive effect on the aeration of roots and yield of forage crops.

Key words: Alfalfa, Earthworms, Forage crops,Soil microorganisms, Soil structure.

MATERIAL AND METHOD

The experiment was carried out during 2017. Chromic-Vertic Luvisol was used in this study. Soil was collected from top layer (0-20 cm) of crop field from Chelopechene village, Sofia County. The soil was characterized with fine texture. Organic carbon content was 1.61 %, the available nitrogen content was 8.6 mg/kg, the available phosphorus content (P_2O_5) – 13.5 mg/100 g, the exchangeable potassium content (K_2O) – 23.0 mg/100g and the soil pH (H_2O) was 6.1. The soil was air-dried and sieved through a 2.0 mm sieve. The experiment was carried out using 10 L pots. The soil in each pot was mixed with 250g cow dung and, additionally, 250g cow dung were added in the center of the top soil. Three pots were prepared for each variant. All pots were arranged in the greenhouse.

The earthworms were collected from Sofia field by digging and hand sorting. Six earthworms were inoculated in each pot. The nitrogen-fixing bacteria *Rhizobium melliloti* strain 116 was used for alfalfa seed inoculation. The strain was obtained from soil microorganisms collection of the Soil microbiology Department of the Institute of Soil Science, Agrotechnologies and Plant Protection "N. Poushkarov", Sofia. The experiment was designed with seven variants: 1) controls without inoculation, 2) inoculation with endogeic earthworms (*Aporrectodea rosea*, *Aporrectodea caliginosa* and *Octolasion lacteum*), 3) inoculation with anecic earthworms (*Lumbricus terrestris*), 4) inoculation with epigeic earthworms (*Eisenia fethida*), 5) mixed inoculation with the epigeic, endogeic and anecic earthworms, 6) mixed inoculation with the epigeic, endogeic and anecic earthworms and *Rhizobium melliloti* strain 116 and 7) inoculation with *Rhizobium melliloti* 116.

Fifty alfalfa seeds (cultivar Pleven 6) were planted in each pot. After the emergence of the fifth leaf, only 15 plants were kept per pot. The soil was irrigated daily to maintain the moisture content at approximately 60% of the soil field capacity. The shoots were collected, when the plants were at the blooming phase. The shoots were cut at the soil surface and the biomass was weighed. After that the shoots were dried with oven drying at 60^{o}C for 48h. At harvesting the roots were collected and their fresh and dry biomass was determined.

Vertically oriented cores were sampled at the end of the experiment at 0-5 cm and 10-20 cm soil depth in 100 cm^3 metal cylinders for determination of bulk density (ISO 11272:1998). Soil water retention at suction less than 33 kPa was determined using the undisturbed soil cores (100 cm^3) by a suction plate method similar to those proposed in ISO 11274: 1998. The drainage of the wetted samples at suction (P) 1, 5, 10, and 33 kPa (pF 1.0, 1.7, 2.0, and 2.5) was done by suction type apparatus (Shot filters G5 with diameters of pores 1.0-1.6 μm). Total porosity (P_t) was calculated using the measured bulk density and particle density 2.65 $g.cm^{-3}$. Volume of air filled pores at given suction P was calculated as the difference between soil total porosity P_t and the measured volume of water content (θ) retained at this suction. The effective pore diameter δ corresponding to P was calculated by Jurin's formula: $\delta=4*\sigma/P$, where the surface tension is $\sigma=7.29*10^{-2}$ N m^{-1} and P is in Pa. The effective diameters of pores corresponding to suctions 1, 5, 10, and 33 kPa, are 300, 60, 30, and 10 μm, respectively.

Statistical analyses of the study were conducted using SPSS software. Data on soil physical properties are presented as mean ± standard deviation. Means of plant biomass are compared by Least Significant Differences (LSD) test at p=0.05.

RESULTS AND DISCUSSION

Alfalfa is widely grown throughout the world as forage for cattle, and is most often harvested as hay, but can also be made into silage, grazed, or fed as greenchop. Alfalfa usually has the highest feeding value of all common hay crops (Nikolova et al., 1995). The

productivity and nutritive value of alfalfa defined her as a leading perennial legume forage crop (Georgieva and Nikolova, 2012). It is used less frequently as pasture. When grown on soils where it is well-adapted, alfalfa is often the highest-yielding forage plant, but its primary benefit is the combination of high yield per hectare and high nutritional quality (Lenkov, 1973). Alfalfa is known for its tolerance to drought, heat, and cold and for the remarkable productivity and quality of its herbage. The plant is also valued for soil improvement and it is grown as a cover crop and as a green manure (Bratanov, 1987).

Earthworms are considered as ecosystems engineers with great impact on physical, chemical and biological properties of the soils (Lavelle et al., 2007). Availability of earthworms can increase soil aeration and drainage, whilst soil gut passage can improve soil crumb structure and lead to enhanced water holding capacity. The activity of earthworms has a decisive role in the formation of macro- and microaggregates (Six et al., 2005). The incorporation of organic material and its mixing with mineral soil can also lead to increased nutrient availability (Butt, 2011). Earthworms in a soil resulted in improved forage crop yields and a better quality of grasslands (Edwards et al., 1980).

Soil microorganisms influence plants and their growth may be limited, or promoted by the soil microorganisms (Turbe et al., 2010). Soil microorganisms are involved in many processes like: soil structure formation, decomposition of organic matter and the cycling of carbon, nitrogen, phosphorus, and sulphur (Van Elsas et al., 1997). In addition, microorganisms play key roles in promoting plant growth and in changes in vegetation (Doran et al., 1996).

RESULTS AND SUGGESTIONS

The results showed that the fresh and dry biomass of alfalfa increased in all variants with earthworms **(**Table 1). The highest values of biomass were registered in variants with anecic earthworms, mixed inoculation with the three ecological groups of earthworms and mixed inoculation with earthworms + *Rhizobium melliloti* 116 (treatment 3, 5 and 6). The inoculation with epigeic earthworms had slightly positive effect on the fresh and dry biomass of alfalfa. The single inoculation with *Rhizobium melliloti* 116 (treatment 7) had no significant effect on alfalfa biomass at the first blooming stage.

Table 1. Shoot biomass of alfalfa at the first cutting. Means with the same letter are not significantly different at p=0.05. LSD – Least Significant Difference

Treatment	**Fresh biomass (g)**	**Dry biomass (g)**
1. control	48.83 a	12.16 a
2. endogeic earthworms	55.86 bc	13.6 bc
3. anecic earthworms	57.6 cd	14.6 cd
4.epigeic earthworms	51.66 ab	12.43 ab
5. mixed inoculation with earthworms	59.00 c	15.3 d
6.mixed inoculation with earthworms + Rhizobium melliloti 116	61.66	15.5 d
7.Rhizobium meliloti 116	47.6 a	12.23 a
LSD $_{p=0.05}$	5.26	1.19

At the end of the experiment the fresh and dry biomass of alfalfa were nearly twice higher (Table 2). The results revealed positive effect of mixed inoculation with earthworms and nitrogen-fixing bacteria. The highest values of biomass were registered in variants with

endogeic earthworms, anecic earthworms and mixed inoculation with the three ecological groups of earthworms + *Rhizobium melliloti* 116 (treatments 2, 5 and 6). At this stage of the experiment *Rhizobium melliloti* 116 showed positive effect on the alfalfa fresh and dry biomass. The inoculation with epigeic earthworms also increased the yield of alfalfa.

Table 2. Shoot biomass of alfalfa at the second cutting. Means with the same letter are not significantly different at p=0.05. LSD – Least Significant Difference

Treatment	**Fresh biomass (g)**	**Dry biomass (g)**
1. control	87.07 a	17.93 a
2. endogeic earthworms	102.5 d	22.83 e
3. anecic earthworms	103.96 cd	22.4 de
4.epigeic earthworms	93.1 ab	21.1 cd
5. mixed inoculation with earthworms	93.9 abc	19.46 ab
6.mixed inoculation with earthworms + Rhizobium melliloti 116	102.03 bcd	20.8 bcd
7.Rhizobium meliloti 116	93 ab	20.3 bc
LSD $_{p=0.05}$	10.82	1.63

The fresh and dry roots biomass of the alfalfa at the end of the experiment is shown on Figure 1. No significant differences between the variants were found except in treatment 3. Anecic earthworms (variant 3) have slightly positive effect on the fresh root biomass of alfalfa. They create deep permanent vertical burrows in the soil, which improve the root growth.

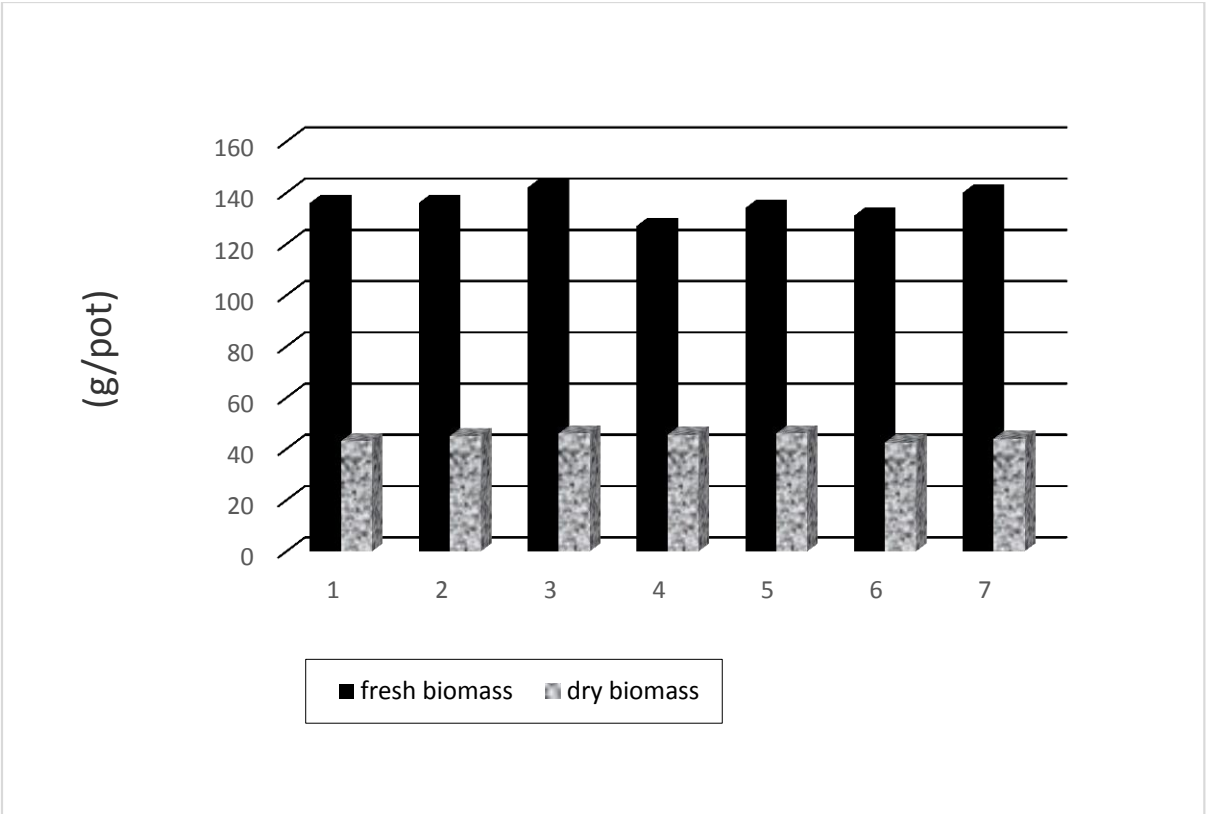

Figure 1. Root biomass of alfalfa. Legend: 1. control, 2. endogeic earthworms; 3. anecic earthworms; 4.epigeic earthworms; 5. mixed inoculation with earthworms; 6.mixed inoculation with earthworms + Rhizobium melliloti 116; 7. Rhizobium meliloti 116

As it was expected, the inoculations with earthworms had positive effect on the soil aeration in all treatments. This was expressed in bulk density decreasing and respectively in total porosity increasing in depth (Table 3). The relative decrease of soil bulk density at 10-20 cm depth was the highest (16% and 18%, respectively) in anecic earthworms and earthworms + *Rhizobium melliloti* 116 variants. The treatments with anecic earthworms (variant 3, 5, and 6) had slightly more compacted surface 0-5 cm soil layer and, respectively, the total porosity was 2-3% less than in the control (Table 3).

Table 3. Bulk density and soil porosity at the end of the experiment

Treatment	**Depth, (cm)**	**Soil moisture (%)**	**Bulk density ($g.cm^{-3}$)**	**Total porosity (%v/v)**
1. control	0-5	15.4	1.12	57.8
	10-20	17.4	1.20	54.8
2. endogeic earthworms	0-5	14.8±0.2	1.15 ±0.03	56.7±1.3
	10-20	14.1	1.06	59.9
3. anecic earthworm	0-5	17.8±2.0	1.17 ±0.03	55.8±1.2
	10-20	13.7	1.00	62.2
4. epigeic earthworms	0-5	13.9±1.2	1.14 ±0.02	56.9±0.7
	10-20	12.8	1.08	59.3
5. mixed inoculation with earthworms	0-5	17.2±0.5	1.19 ±0.02	54.9±0.8
	10-20	13.9	1.10	58.4
6. mixed inoculation with earthworms + Rhizobium melliloti 116	0-5	17.1±1.4	1.18 ±0.05	55.4±1.9
	10-20	15.6	0.99	62.8
7. Rhizobium melliloti 116	0-5	13.5±0.7	1.10 ±0.02	58.4±0.7
	10-20	12.4	1.10	58.6

The experiment set up explained the homogeneity of water retention properties in depth in the control variant. (Table 4) The endogeic earthworms (variant 2), mixed inoculation with earthworms + *Rhizobium melliloti* 116 (variant 6), and inoculation with *Rhizobium melliloti* (variant 7) did not increase the water retention at suctions less than 33 kPa. The treatments with anecic earthworms increased the water content hold at -33 kPa in the surface 0-5 cm by near 3%w/w. Slight increase (by 1%w/w) was observed also in the treatments with epigeic earthworms (variant 4) and mixed inoculation with earthworms (variant 5) (Table 4). The increased water retention capacity can be explained with initiation of microaggregate formation within worm casts in the surface layer.

Table 4. Soil water retention (W, %w/w) at different potential (kPa) and depth of the soil.

treatment	Sampling depth ,cm	- 1 kPa	- 5 kPa	-10 kPa	-33 kPa
1. control	0-5	26.0	23.0	21.5	21.4
	10-20	25.7	22.1	20.8	20.1
2. endogeic earthworms	0-5	26.9±1.2	22.9±0.6	21.4±0.6	20.9±0.4
	10-20	26.4	22.9	21.2	20.3
3. anecic earthworms	0-5	29.5±2.9	26.0±2.9	24.3±2.3	24.0±2.2
	10-20	27.6	23.5	21.6	20.4
4. epigeic earthworms	0-5	28.3±1.7	24.5±1.8	22.9±1.8	22.3±1.8
	10-20	25.0	22.2	20.9	20.7
5. mixed inoculation with earthworms	0-5	28.6±1.2	24.3±1.1	22.7±0.8	22.2±0.7
	10-20	27.0	23.1	21.2	20.7
6. mixed inoculation with earthworms + Rhizobium melliloti 116	0-5	25.5±1.7	22.0±1.2	20.5±1.1	19.8±1.2
	10-20	26.5	22.4	20.7	20.3
7. Rhizobium melliloti 116	0-5	27.4±0.1	23.2±0.2	21.4±0.4	20.7±0.2
	10-20	26.4	21.8	19.6	16.5

The amount of air-filled soil pores increased in 10-20 cm soil depth in all studied variants of inoculations (Table 5). It can be concluded that the increase of total porosity in depth was on the account of the increasing of large macropores (Table 5). The increase of soil aeration capacity (volume of pores with diameter greater than 60 μm) in depth is highest (10%vol. and 12%vol.) at the variants with inoculation of anecic earthworms and mixed inoculation with earthwormss (Figure 2). The improvement of soil aeration status allowed the roots of alfalfa to reach more nutrients and water in the soil which resulted in the highest biomass formation (Tables 1 and 2) found in this experiment.

Table 5. Size (effective diameter in μm) distribution of air-filled soil pores (%vol.)

treatment	Sampling depth, cm	>300 μm	>60 μm	>30 μm	>10 μm
1. control	0-5	28.7	32.1	33.7	33.9
	10-20	23.9	28.2	29.8	30.7
2. endogeic earthworms	0-5	25.8±3.6	30.4±2.7	32.2±2.7	32.7±2.4
	10-20	31.8	35.6	37.4	38.3
3. anecic earthworm	0-5	21.3±1.3	25.3±1.3	27.3±0.7	27.7±0.7
	10-20	34.5	38.6	40.5	41.7
4. epigeic earthworms	0-5	24.6±0.6	29.0±0.9	30.9±0.9	31.4±0.9
	10-20	32.3	35.4	36.8	37.0
5. mixed inoculation with earthworms	0-5	20.8±2.8	25.9±2.7	27.8±2.3	28.4±2.1
	10-20	28.5	32.9	35.0	35.6
6. mixed inoculation with earthworms + Rhizobium melliloti 116	0-5	25.3±5.2	29.4±4.5	31.1±4.2	31.9±4.4
	10-20	36.6	40.6	42.3	42.8
7. Rhizobium melliloti 116	0-5	28.2±1.2	32.8±0.9	34.8±0.7	35.6±0.8
	10-20	29.7	34.8	37.2	40.5

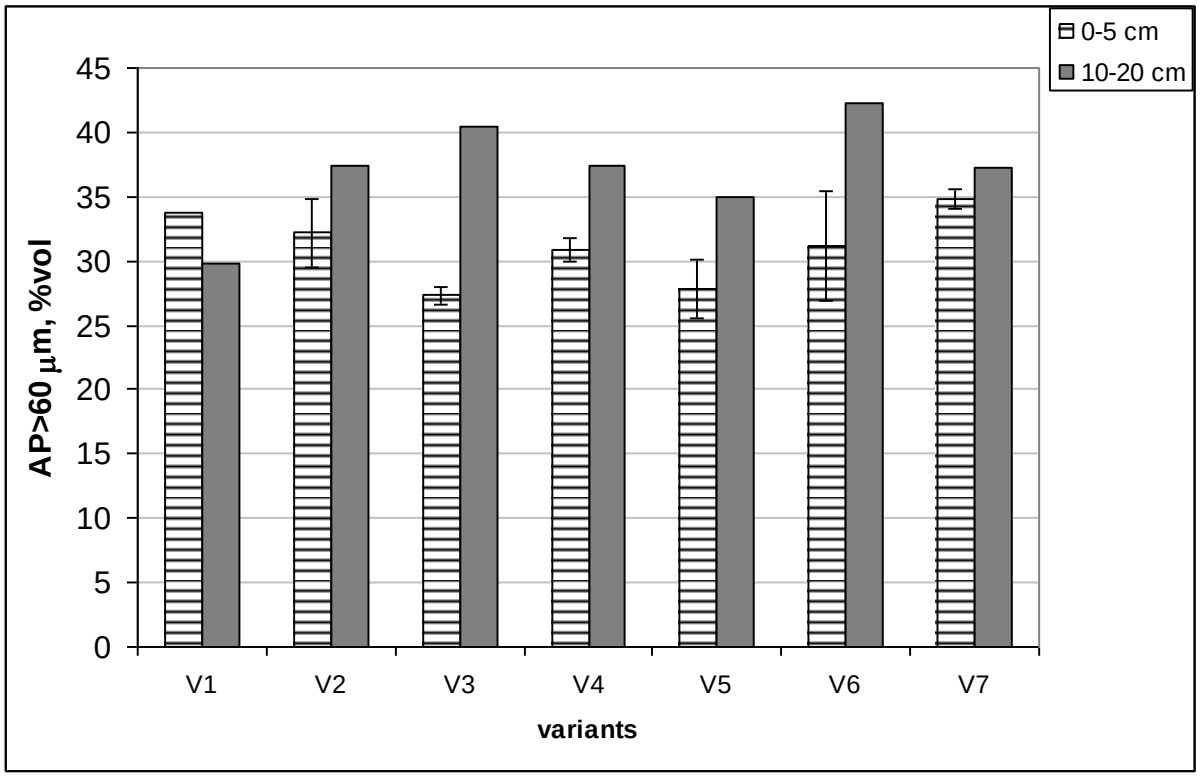

Figure 2. Soil aeration capacity (volume of soil pores>60 μm).

In conclusion, the inoculation of soil with earthworms and nitrogen-fixing bacteria in conditions of a pot experiment with alfalfa increased the crop productivity and improved the soil aeration status. The treatments had positive effect on soil aeration capacity in depth. Results obtained suggested that earthworm inoculations could be successfully used in practices to improve soil structure and productivity of alfalfa.

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REFERENCES

Bratanov, K., 1987. Agricultural encyclopedia, Vol II, Bulgarian Academy of Sciences, p. 704. (in Bulgarian).

Butt, K. R., 2011. The Earthworm Inoculation Unit Technique: Development and Use in Soil Improvement Over Two Decades, In: A. Karaca (Ed.), Biology of Earthworms. Springer, Berlin, 87–105.

Doran, JW, Sarrantonio M, Liebig MA, 1996. Soil health and sustainability, Advanced Agronomy. 56:2–54.

Edwards, C. A., J. R. Lofty, 1980. Effects of earthworm inoculation upon the growth of direct drilled cereals, Journal of Applied Ecology, 17, 533–543.

Georgieva, N. and I. Nikolova, 2012. Density and reduction of the stand at alfalfa varieties (Medikago sativa L.), Banat's Journal of Biotechnology, 3(2), p.18-22.

Lavelle P., S. Barot, M. Blouin, Th. Decaëns, J.J. Jimenez, P. Jouquet, 2007. Earthworms as key factors in self-organized soil systems. In: Cuddington K.J.E.B., W.G. Wilson, A. Hastings (Eds.): Ecosystem Engineers: From Plants to Protists, Theoretical Ecology Series, V chapter. The Netherlands. Elsevier, p. 77-106.

Lenkov, L., 1973. Horticulture, Zemizdat, p.264. (in Bulgarian).

Nikolova, M., E. Andres and K. Glas, 1995. Potassium – nutrient element for yield and quality, International Potash Institute, Basel, Switzerland. p.60.

Six, J., Bossuyt, H., Degryze, S., Denef, K., 2004. A history of research on the link between (micro) aggregates, soil biota, and soil organic matter dynamics, Soil Tillage Research, 79, p.7–31. http://dx.doi.org/10.1016/j.still.2004.03.008

Turbé A, A. Toni, P. Benito, P. Lavelle, N. Ruiz, W.H. Van Der Putten, E. Labouze, S. Mudgal, 2010. Soil biodiversity: functions, threats and tools for policy makers. Bio Intelligence Service, IRD, and NIOO. Report for EC, p.250.

Van Elsas JD, Trevors JT., 1997. Modern Soil Microbiology, New York: Marcel Dekker.

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Determining The Yield and Yield Components of Several Genotypes of Hungarian Vetch (*Vicia pannonica* Crantz) With Winter Sowing Under Siirt Ecological Conditions

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Abstract

The study aims to determine the yield and yield components of several lines and varieties of Hungarian Vetch with winter sowing under Siirt ecological conditions. The trials were conducted in the trial and demonstration area under the Department of Field Crops according to randomized complete block design with 3 replications. In this study, Hungarian vetch varieties (Anadolu Pembesi-2002, Ege Beyazı-79, Tarm Beyazı-98, Budak) and lines (Line-3, Line-10, Line-2109) were used.

The heights of the varieties used in this research ranged from 36.00 to 51.67 cm, the fresh hay yield from 6427 to 20427 kg ha^{-1}, the hay yield from 2224 to 3954 kg ha^{-1}, the number of sub-branches per plant from 2.00 to 3.67, the crude protein ratio from 22.12% to 27.23%, the crude protein yield from 584 to 986 kg ha^{-1}, the acid detergent fiber (ADF) ratio from 28.55% to 31.44%, and the neutral detergent fiber (NDF) ratio from 33.11% to 39.16%. Out of the sample cultivars, it is determined that the most acceptable varieties for either gender yield or hay quality are Anadolu Pembesi and Ege Beyazı.

Keywords: Winter sowing, Hungarian Vetch (*Vicia pannonica* Crantz), hay yield, yield components

INTRODUCTION

Hungarian Vetch (*Vicia pannonica* Crantz) is an annual forage legume species, a cool-season plant able to survive freezing without any damage even in tough winters and grow in high altitude conditions, as well as water-efficient and drought-tolerant. This can be grown as main crop or intercrop in almost any ecological and edaphic conditions in every region in our country (Acıkgoz, 1991).

Hungarian vetch with winter sowing in the province of Siirt where winters are not much severe will grow fast in spring and complete its development without much water. However, no growing is possible for its spring sowing without irrigation.

Roughage sources in our country are inadequate to meet our livestock's needs. The yield and quality of pasture grounds that are the most valuable forages have considerably reduced due to unseasonable and excessive grazing or something else. It is suggested that since range improvement is highly time-consuming, costly and laborsome, the most effective way is to enhance planting and production of forage in field agriculture in order to close the shortage of roughage in a short time (Tosun 1996).

For long years, the breeding and maintenance work of our meadow and pasture areas used in non-compliance with amenajman rules are also made insufficiently. Therefore, they are degrading day by day and the roughage shortage is getting wider. The plantation areas for forage crops have expanded by means of the state aids under livestock breeding subsidies but not up to the desired level. For this, it is necessary to increase supports and explain the

importance of forage to farmers. The production costs, particularly feed costs, are very high. The farm gate prices for milk and dairies are low. Major one of the most fundamental factors for operational profitability are lowering input costs and raising product quantities and prices. In order to have profitable livestock enterprises and satisfactorily animal products, roughage resources should be effectively utilized. The local farmer folks cannot produce forage plants at a sufficient level. The amount of quality roughage obtained from current forage production remains non-satisfactory, and therefore the shortage is at the highest level.

In a study on Hungarian vetch (Acar et al., 2009) in which row spaces were 15, 30, and 45 cm, seed numbers 6, 7.5, 9, 10.5 and 12 kg decare, it was reported the row space was 30 cm at optimum level in terms of seed and hay yield, the seed quantity 9 kg decare, and the hay quantity 4078 kg ha^{-1}. In the study on the forage feeding values of Hungarian vetch, common vetch and hairy vetch at different harvests, Turgut et al. 2006) stated that the crude protein ratios in earlier inflorescence ranged from 23.2% to 19.6% in common vetch, 24.1% to 17.9 % in Hungarian vetch, and 20.2% to 16.0 % in hairy vetch, and the NDF ratios from 35.9 % to 44.3 %, 43.9% to 54.0 %, and 37.0% to 42.7%, *respectively*. In the study of Akkopru et al. (2007) conducted with 20 cm and 40 cm row spaces and 5 seeds (100, 150, 200, 250, and 300 per sq meter) in Van ecological conditions, it was observed that the highest fresh hay yield was 8116 kg ha^{-1}, obtained from the pair of 40 cm and 300 seeds per sq meter. Yuksel et al. (2007) performed a study on Hungarian vetch in Isparta conditions to determine a number of morphological, biological and agricultural traits in the year 2006 and reported that randomly selected 10 plant species were observed and measured on 11 different days (March 17, March 24, March 31, April 7, April 14, April 21, April 28, May 5, May 19, and May 26) at one-week intervals during their vegetation, related to plant height, root length, branch number, leaf length, leaf number, leaflet number, leaflet length, leaflet width, plant weight, root weight, and hay ratio, and according to the study results, the plant height ranged from 5.0 cm to 74.6 cm and the branch number from 2.7 to 3.2 in Hungarian vetch within the period from the commencing sampling period to the forming time.

In the study made on several vetch cultivars, Tosun et al. (1991) used Menemen (hairy vetch) and Ege Beyazı (Hungarian vetch) whose plant heights were respectively 62 cm and 41 cm and fresh hay yield and hay yield were respectively 3290 kg ha^{-1} and 2200 kg ha^{-1}; Balabanlı (1992) used in the study on Hungarian vetch that the highest hay yield was 3488 kg ha^{-1} obtained from the parcel in the row spacing of 17.5 cm x 1 cm and with winter sowing; in the study that Bakoglu et al. (2004) conducted with 4 Hungarian vetch (*Vicia pannonica* Crantz) lines (5, 16, 23, and 28) and Ege Beyazı variety and determined that though seed yield and its several traits vary with line and variety, the fresh hay yield was 1635.81 kg, the hay yield 322.41 kg, and caly x yield 231.47 kg per decare, and the mean plant height 46.20 cm, the branch and sub-branch numbers were 2.50 and 2.15 respectively; Orak et al. (2005) conducted an adaptation study with 5 Hungarian vetch lines, 1 population, 1 variety (Ege Beyazı) at 3 locations in Thrace Region between 2002 and 2004, and the average plant height of line and variety ranged from 61.9 cm to 83.3 cm, the branch number of the plant 2.2 to 4.1, the fresh hay yield 8881 kg ha^{-1} to 16859 kg ha^{-1}, and the hay yield 2033 kg ha^{-1} to 4058 kg ha^{-1}; Suzer and Demirhan (2005) performed a study to identify the relevant several winter vetch cultivars and the mixture of vetch and grain, with the cultivars and varieties of Efes-79 (hairy fruit vetch), Menemen-79 (hairy vetch), Karaelçi (common vetch), husband vetch, Tarm Beyazı-98 (Hungarian vetch), Ege Beyazı-79 (Hungarian vetch) in Edirne ecological conditions for two years between the years of 2000 and 2003 and observed that with plain sowing, the fresh hay yield of Tarm Beyazı was 31150 kg ha^{-1} while the fresh hay yield of Ege Beyazı was 4040 kg ha^{-1}, and the mean plant height was 71 cm in Tarm Beyazı and 53 cm in Ege Beyazı. In 2003, in the study of Sahar (2006) with the aim of discovering appropriate vetch varieties in Van ecological conditions, Ege Beyazı-79 was used as Hungarian vetch

variety, and Efes-79 as vetch variety, and according to the study results, the plant height was 43.5 cm, the fresh hay yield 7340 kg ha^{-1}, dry matter yield 2168 kg ha^{-1}, the crude protein ratio 17.4%, and the crude protein yield 379 kg ha^{-1} for Hungarian vetch.

In another study to investigate several traits of 12 Hungarian vetch variety and lines at five different locations in Southern Anatolian Region from 2008 to 2009 and 2009 to 2010, Sayar (2011) found that according to two-year average results, the flowering day number ranged from 165.7 to 177.9 days, the fresh hay yield 2.462 kg decare to 3.133 kg decare, the hay yield 531.5 kg decare to 699.8 kg decare, the plant height 56.5 cm to 60.9, the branch length 71.0 cm to 79.1 cm, and the branch number 2.9 to 3.2. Unal et al. (2011) studied several phonological and morphological traits of 4 Hungarian vetch and a variety of its at Haymana and Ankara locations in the years of 2006-07 and 2007-08, and two-year average results revealed that the crude protein yield of variety and lines ranged from 16.9 to 22.8 kg decare, the crude protein ratio 21.5 to 23.2%, the plant height from 32.28 to 37.20 cm and the branch number 2.53 to 3.86 per plant. In a research conducted at the location of Ankara Field Crops Central Research Institute between the years of 2010 and 2011, Mutlu (2012) observed that the highest fresh hay yield was 52329 kg ha^{-1}, obtained from Seğmen-2002 variety in full flowering season and 36863 kg ha^{-1} from Tarm Beyazı-98 variety in half flowering season, and the highest hay yield was 8431 kg ha^{-1}, found on Seğmen-2002 variety and 36863 kg ha^{-1} on Tarm Beyazı-98 variety in full flowering season, and in the same period, the highest average point was 44375 kg ha^{-1} in fresh hay yield and 7563 kg ha^{-1} hay yield, and the highest crude protein ratio was 20.5% for Seğmen-2002 and 19.9% for Tarm Beyazı-98 in the earlier flowering, and the highest crude protein yield was 1535 kg ha^{-1}, obtained from Seğmen-2002 in full flowering season, and 1083 kg ha^{-1} from Tarm Beyazı-98 in half flowering. In the study made by Sayar et al. (2012) with 12 different genotypes of Hungarian vetch on the farming land at Village Çagıl in the town of Kiziltepe in Mardin between the years of 2009 and 2010, it was found that the fresh hay yield ranged from 12270 to 23360 kg ha^{-1}, the plant height from 44.90 to 54.33 cm, the hay yield 2950 to 5750 kg ha^{-1}, the branch number 2.23 to 3.06, and out of the genotypes of Hungarian vetch in Kiziltepe conditions, the highest fresh hay yield and hay yield was obtained from the varieties of Oguz-2002 and Anadolu Pembesi-2002. In a study conducted in Diyarbakir ecological conditions, for Ege Beyazı variety the mean plant height was 45.2 cm, the fresh hay yield 12690 kg ha^{-1}, the hay yield 2910 kg ha^{-1} (Basbag et al. 2001). In Kirşehir conditions, intercropping Hungarian vetch (*Vicia pannonica* Crantz) with Italian ryegrass (*Lolium multiflorum* L) were experimented in a study and the quality features including the ratios of crude protein, NDF, ADF and ADL and the LER values were studied. The values obtained ranged from 11.58 to 17.86%, 37.12 to 59.67%, 28.69 to 39.66%, 6.22 to 7.84% and 1.09 to 1.27%, *respectively.* The highest ratios was from Italian ryegrass with plain sowing while the highest fresh hay yield and hay yield were discovered on the mixture of Hungarian vetch (80%) and Italian ryegrass (20%). The lowest NDF and ADF ratios were obtained from Hungary vetch with plain sowing. According to the study results, as the portion of Hungary vetch in the mixtures was rising, the crude protein ratio was increasing and however the NDF and ADF ratios were decreasing. Consequently, the mixtures of Hungarian vetch (80%) and İtalian ryegrass (20%) was found to be superior than the cultivars and other mixtures with crude plantation in terms of yield and quality (Simsek, 2015). In the province of Siirt, there are plantation areas of pasture-meadow (124.000 ha) and forage (8.000 ha) (Anonymous, 2015a). It was estimated that the hay crop was 190.000 tons, 130.000 tons from pasture-meadow area and 60.000 tons from forage plantation area.

However, there are livestock including 23.000 cattle and 750.000 ovine (equivalent to 102.000 (BBHB)) in the province of Siirt (Anonymous, 2015a). The annual average quantity of roughage need for these animals is 370.000 tons while the shortage for forage crops is about 180.000 tons. The hay produced (190.000 tons) is sufficient only for 51% of livestock.

Therefore, it is necessary to raise the forage plantation portions in field agriculture in eliminating or diminishing the roughage shortage.

MATERIALS AND METHOD

Materials

This study was conducted in the trial and demonstration area under the Department of Field Crops in the Faculty of Agriculture at Siirt University in 2006. The materials used in the study were 4 Hungarian vetch ((*Vicia pannonica* Crantz) varieties (Tarm Beyazı-98, Anadolu Pembesi-2002, Ege Beyazı-79, and Budak) and 3 Hungarian vetch lines (Line-3, Line-10, and Line-2109).

Ecological Characteristics For The Research Field

Siirt province has a mostly continental climate. On its eastern and northern parts, winters are more severe and snowy, and on its southern and south-western parts, summers are hotter and arid while winters are mild climate. Mean precipitation quantity of the years of 2015 to 2016 is 833.6 mm, annual average rate of relative humidity is 51.2 %, and January is the highest month with 70.5 %. While long years average for temperature is 13.5 ^{0}C, the mean temperature of the trial crop season of 2015 to 2016 is 15.3 ^{0}C (Anonymous, 2016).

Table 1. The ecological data for the research field

	Temperature (°C)		**Precipitation (mm)**		**Relative Humidity (%)**	
Months	Long Years (1950-2015)	2015-2016	Long Years (1950-2015)	2015-2016	Long Years (1950-2015)	2015-2016
September	25.1	31.5	5.3	0.1	34.0	18.5
October	18.1	20.7	48.7	189.6	50.3	52.3
November	10.4	12.5	80.2	41.0	64.0	58.3
December	4.8	6.6	93.8	70.4	72.4	57.1
January	3.2	2.7	80.0	200.6	72.0	72.5
February	4.5	9.9	99.1	63.8	66.6	62.5
March	8.7	11.9	107.3	136.6	61.3	56.2
April	14.3	19.2	99.7	66.8	58.2	41.5
May	19.7	22.3	57.8	64.7	49.9	41.9
Average in total	13.5	15.3	666.6	833.6	56.4	51.2

For the trial season the total average values of temperature and precipitation are higher, and that of relative humidity lower than those for long years term, as can be seen in Table 1.

Soil Properties For The Research Field

A soil analysis was made with the soil specimens taken prior to sowing in the Laboratory of Science and Technology Research Center Directorate under the Siirt University, and a number of physical and chemical properties for the soil samples from the trial area were identified.

Table 2. A number of physical and chemical properties for the trial area (0 to 20 cm)*

Nature (%)			pH	Salt (EC) mmhos/cm	Lime ($CaCO_3$) (%)	Organic Matter (%)	Receivable Phosphor (P_2O_5) kg/da	Receivable Potasium (K_2O) kg/da
Clay	Silt	Sand						
51.32	41.64	7.04	6.87	602	0.64	0.90	1.67	114

*:The assays were done in the Laboratory under Science and Technology Application and Research Centre Directorate.

As can be understood in Table 2, the soil from the trial area is clay-sandy in nature, with little lime concent, low quantity of receivable phosphor, rich in potasium, and poor in organic matter.

RESULTS AND DISCUSSION

The F values and the significance levels of variance analysis results for Hungarian vetch varieties are presented in Table 3.

Table 3. The F values and significance levels of Hungarian vetch (*Vicia pannonica* Crantz) varieties and lines

V.K.	Plant height	Fresh hay yield	Hay yield	Sub-branch number	Crude protein ratio	Crude protein yield	ADF	NDF
$F_{var.}$	18.98**	5.42**	8.79**	5.16*	4.97*	4.09*	4.63*	10.08**

*: Significant at P<0.05; **: Significant at P<0.01

Plant height (cm) and fresh hay yield (kg ha^{-1})

According to the variance analysis of Hungarian vetch varieties and lines, there was a statistically significant difference between the varieties for plant height and fresh hay yield ($p \leq 0.001$) (see Table 3). The mean plant height is 42.38 cm; the highest value is 51.67 cm in the Budak variety, and the lowest value is 36.00 cm in the Anadolu Pembe variety. The mean fresh hay yield is 9203 kg ha^{-1}; the Anadolu pembe has the highest fresh hay yield (10427 kg ha^{-1}) and the lowest value is obtained from Line-3 (6427 kg ha^{-1}) (See Table 4).

Table 4. Duncan Test results and averages of plant height and fresh hay yield for Hungarian vetch varieties and lines

Plant height (cm)			Fresh hay yield (kg ha^{-1})		
Variety	Mean	Group**	Variety	Mean	Group**
Budak		a	Anadolu		a
	51.67		Pembesi	10427	
Ege Beyazı	47.33	a b	Ege Beyazı	9729	a
Line-10	41.67	b c	Line-2109	9666	a
Line-2109	41.00	c	Line-10	9646	a
Tarm Beyazı	41.00	c	Budak	9625	a
Line-3	38.00	c	Tarm Beyazı	8906	a b
Anadolu		c	Line-3		b
Pembesi	36.00			6427	
Total Average	42.38		Total Average	9203	

**: There is no significant difference between the values in the same letter group according to Duncan's 1% test.

The study results for plant height yield are lower than the values found by Süzer and Demirhan (2005) and Basbag et al. (2001) and higher than those by Unal et al. (2011) and equal to those by Yuksel et al. (2007) and Sayar et al.(2012).

The findings obtained for fresh hay yield are lower than the values by Mutlu (2012), Sayar et al. (2012), and Sayar (2011) and equal to those by Sahar (2006), Akkopru et al. (2007).

In Siirt conditions, acording to the trial study made with the row spacing (20 cm) using the 100 kg ha^{-1} seed, the lowest plant height was of Anadolu Pembesi variety despite other higher parameters. Based on other varieties and lines, it is observed that the germination rate is higher in the Anadolu Pembesi seeds, and therefore the plant number per decare is so big to cover the parcel area. Furthermore, the significant differences could be caused by ecological and edaphic properties in the trial field of study, low organic matter, plant number per decare, variety properties, excessive temperature, growing season, ecological factors, cultural processes, and genotypic properties.

Hay yield (kg ha^{-1}) and sub-branch number (per plant)

According to variance analysis results, there is a statistically significant difference between the varieties and lines for hay yield ($p \leq 0.01$) and sub-branch number ($p \leq 0.05$) (see Table 3). In the study, it was found that mean hay yield is 3257 kg ha^{-1} while the highest hay yield is 3954 kg ha^{-1} in the Anadolu Pembesi variety and however the lowest hay yield is 2224 kg ha^{-1} in Line-3.

Mean sub-branch number is 2.95 per plant. The highest sub-branch number is 3.67 per plant in Anadolu Pembesi and Line-3 while the lowest sub-branch number 2.00 per plant in the Budak variety (see Table 5).

Table 5. Duncan Test results and averages of hay yield and sub-branch number for Hungarian vetch varieties and lines

Hay yield (kg ha^{-1})			Sub-branch number (per plant)		
Variety	Mean	Group**	Variety	Mean	Group**
Anadolu		a	Anadolu		A
Pembesi	3954		Pembesi	3.67	
Budak	3667	a b	Hat-3	3.67	A
Ege Beyazı	3681	a b	Hat-10	3.33	a b
Hat-10	3243	a b	Ege Beyazı	3.00	a b
Hat-2109	2798	a b	Hat-2109	2.67	a b
Hat-3	2224	b c	Tarm Beyazı	2.33	a b
Tarm Beyazı	3235	c	Budak	2.00	B
Total Average	3257		Total Average	2.95	

**: There is no significant difference between the values in the same letter group according to Duncan's 1% test.

The study results for hay yield are higher than those by Tosun et al. (1991), Sahar (2006), and Balabanli (1992) and lower than those by Sayar et al. (2012), Mutlu (2012), Sayar (2011), Basbag et al. (2001), Suzer and Demirhan (2005), and Bakoglu et al. (2004) and equal to those by Orak et al. (2005).

The findings in the study for sub-branch number are lower than those by Orak et al. (2005) and higher than those by Bakoglu et al. (2004) and equal to those by Yuksel et al. (2007), Unal et al. (2011), and Sayar et al.(2012).

The lower yield and yield differences could be caused by such factors as ecological and edaphic properties in the trial field, low organic matter, plant number per decare, variety properties, and excessive temperature.

Crude protein ratio (%) ve crude protein yield (kg ha^{-1})

According to variance analysis results, there is a statistically significant difference between the varieties for crude protein ratio and crude protein yield ($p \leq 0/05$) (see Table 3). Average value of crude protein ratio is 25.07 %, and the highest crude protein ratio is 27.23% in Line-2109, and the lowest 22.12% in Anadolu Pembe. Mean crude protein yield is 810 kg ha^{-1}, and the highest crude protein yield is 956 kg ha^{-1} in the Ege Beyazı variety, and the lowest 584 kg ha^{-1} in Line-3 (see Tablo 6).

Table 6. Duncan Test results and averages of crude protein ratio and crude protein yield for Hungarian vetch varieties and lines

	Crude protein ratio (%)		**Crude protein yield (**kg ha^{-1}**)**		
Variety	Mean	Group**	Variety	Mean	Group**
Line-2109	27.23	a	Ege Beyazı	956	a
Line-3		a	Anadolu		a
	26.27		Pembesi	874	
Ege Beyazı	25.98	a b	Budak	861	a b
Tarm Beyazı	25.67	a b	Tarm Beyazı	829	a b
Line-10	24.66	a b	Line-10	796	a b
Budak	23.54	a b	Line-2109	772	a b
Anadolu		b	Line-3		b
Pembesi	22.12			584	
Total Average	25.07		Total Average	810	

**: There is no significant difference between the values in the same letter group according to Duncan's 1% test.

The study results for crude protein ratio are higher than those by Mutlu (2012), Sahar (2006), Unal et al. (2011), and Simsek (2015).

The findings for crude protein yield are lower than those by Mutlu (2012) and higher than those by Unal et al. (2011) and Sahar (2006).The researchers argued that crude protein yield is more realistic criterion for selection by yield than hay yield, and for nutritional value, the maximum crude protein yield per decare for forage plant is more significant than hay yield (Carpici, 2009). In this study, higher crude protein yield could not be achieved, and it is concluded that this might be caused by a number of factors, particularly insufficiency of organic matter in soil, ecological factors ve antigonistic effect among nutrient elements.

ADF (Acid Detergent Fiber) (%) ve NDF (Neutral Detergent Fiber) (%)

According to variance analysis results, the statistically significant difference is 5% for varieties and lines for ADF ratio and 1% for NDF ratio (see Table 3). Averages of ADF and NDF percentages are 30.02% and 35.85% respectively. The highest ADF and NDF ratio are respectively 31.44% ve 39.16 % in Anadolu pembesi, and the lowest 28.55% and 33.11% in Line-2109 (see Table 7).

Table 7. Duncan Test results and averages of ADF and NDF ratios for Hungarian vetch varieties and lines

ADF ratio (%)			NDF ratio (%)		
Variety	Mean	Group**	Variety	Mean	Group**
Anadolu Pembesi	31.44	A	Anadolu Pembesi	39.16	a
Tarm Beyazı	30.83	a b	Budak	38.02	a b
Ege Beyazı	30.74	a b	Ege Beyazı	36.83	a b c
Budak	30.27	a b	Tarm Beyazı	35.23	b c d
Line-3	29.38	a b	Line-3	34.94	b c d
Line-10	28.96	b	Line-10	33.64	c d
Line-2109	28.55	b	Line-2109	33.11	d
Total Average	30.02		Total Average	35.85	

**: There is no significant difference between the values in the same letter group according to Duncan's 1% test.

The study results for ADF ratio are lower than those by Mutlu (2012) and Simsek (2015) and however for NDF ratio lower than those by Mutlu (2012), Simsek (2015), and Turgut et al. (2006).

CONCLUSIONS

This study aims to determine the Hungarian vetch varieties for winter plantation in the Siirt ecological conditions, and as a conclusion, the results obtained reveal that there is statistically significant effect for fresh hay yield, hay yield, plant height, and NDF ratio ($p \leq 0.01$). Furthermore, it is found that there are significant differences for sub-branch number, crude protein ratio, crude protein yield, and ADF ratio ($p \leq 0.05$). According to the trial results, the plant height values are ranging from 36.00 cm to 51.67 cm, the fresh hay yield from 6427 to 10427 kg ha^{-1}, the hay yield from 2224 to 3954 kg ha^{-1}, sub-branch number from 2.00 to 3.67 per plant, the crude protein ratio 22.12% to 27.23 %, crude protein yield 584 to 956 kg ha^{-1}, ADF ratio 28.55% to 31.44% and NDF ratio 33.11% to 39.16 %. In this study the highest values are 10427 kg ha^{-1} for fresh hay yield, 3954 kg ha^{-1} for hay yield, 3.67 per plant for sub-branch number, 31.44% for ADF ratio, and 39.16 % for NDF ratio in the Anadolu Pembesi variety, 51.67cm for plant height in the Budak variety, 27.23 % for crude protein ratio in Line-2109, and 956 kg ha^{-1} for crude protein yield in the Ege Beyazı variety. In forage legumes including vetch, the difference between NDF and ADF ratios is desired to be around 10 %. In the present study, the average of NDF and ADF ratios ranges from 35.23% to 30.02%, and the highest ADF-NDF percentage from 39.16% to 31.44 %. The study results reveal that the Anadolu Pembesi variety for fresh hay yield, hay yield, sub-branch number, ADF ratio and NDF ratio, the Budak variety for plant height, Line-2019 for crude protein ratio, and the Ege Beyazı variety for crude protein yield are featured. When considering the yield and yield components of the varieties and lines according to the one-year studied parameters, the Anadolu Pembesi variety is more significant in the Siirt ecological and edaphic conditions. In order to more clearly determine the yield differences and nutritional values of the varieties studied, further studies can be conducted in a more

extensive way that they are cultivated as winter and summer crops and aftercrop at different locations in the Siirt province for at least two years.

In Turkey, the percentage of forage plantation areas was 2.5% to 3% in the 1990's and has recently become about 11 % by means of the state aids provided by the Ministry of Food, Agriculture and Livestock while that is 25% to 30% in developed countries (Anonymous, 2015b). In our country, despite the fact that the agricultural land is nearly 27 million ha, it is estimated that area of 5 million ha is fallowed (Anonymous, 1999). One way to increase the portion of forage plantation within the field crops is to cultivate the catch crops such one-year forage plants as vetch, field pea, grasspea in the fallowed lands. In addition, the state aids for forage crops should progressively continue. Certified seeds must be used to gain quality and high yield in forage production. Seed supply for farmers at a reasonable cost is required for sustainable cultivation of efficient and quality crops. Therefore, the seed prices should be kept low, and the selective supports raised to encourage the production and use of certified seeds. Additionally, the relevant institutions and agencies should provide for producers information utility about variety, harvest and cultivation techniques in forage plantation and promote and enhance forage production through demonstration works.

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REFERENCES

Acar, Z., Ayan, İ., Gunaydın, G., 2009. Crop Rotation. Faculty of Agriculture, Ondokuz Mayıs University, Lesson Book Nr. 62, Samsun.

Acıkgoz, E., 1991. Forage Agriculture, Uludag University Publication, Bursa, 1991.

Akkopru, E., Sabancı, C.O., Ertus, M.M., 2007. Effect of Seed Quantity and Row Spacing Distance on Yield and Several Yield Characteristics in Hungarian Vetch (*Vicia pannonica* Crantz), VIIth Turkish Congress of Field Crops, 25-27 June 2007 Erzurum (Proceedings) s:235-238.

Anonymous, 1999. Agricultural Structure and Production. Turkish Statistical Institute Publications, Ankara.

Anonymous, 2015a. Governorship of Siirt, Database of Provincial Directorate, Ministry of Food, Agriculture and Livestock.

Anonymous, 2015b. Activities of Directorate General of Plant Production, Ministry of Food,Agriculture and Livestock, November 2014.http://www.tarim.gov.tr/sgb/Belgeler/SagMenuVeriler/ BUGEM.pdf (Accessed 05.02.2015).

Anonymous, 2016. Database of Siirt Directorate of Meteorological Station.

Bakoglu, A., Kokten, K., Karadavut, U., 2004. An Adaptation Study of Several Varieties and Lines of Hungarian Vetch (*Vicia pannonica* Crantz) in Bingol dry conditions. IIIth Symposium of Bingol.

Balabanli, C., 1992. Researches on the effects of different cultivation rates and times on the yield and yield components of Hungarian Vetch (*Vicia pannonica* Crantz), Doctoral thesis, p.70, Ankara.

Basbag, M., Saruhan, V., Gul, İ., 2001. An adaptation study of several annual forage legumes in Diyarbakir ecological conditions, IIth Turkish Field Crops Congress, 17-21 September 2001, Tekirdag, p. 169-173.

Carpıcı, B.E, 2009. Evaluation of Plant Density and Nitrogen Applications at different quantities in silage corn cultivation for stress physiology, Doctoral thesis. *Institute of Science, Uludag University*, Bursa, p.242.

Mutlu, Z., 2012.A Study on the effect of Crop Time on Hay Yield in Several Winter Vetches. Department of Field Crops, İnstitute of Science, Ankara University. Master Thesis.

Orak, A., Nizam, İ., Kamburoglu, İ., Gurcubuk, M., Moralar, E., 2005. A Study on the Adaptation of Several Hungarian Vetch (*Vicia pannonica* Crantz) Lines to Thracian Ecological Conditisons. VIth Turkish Field Crops Congress, 5-9 September, 2005, Vol.: II, 773-778, Antalya.

Sayar, S., 2011. Researches on determining genotype x environment interactions and stabilities of several Hungarian Vetch (*Vicia pannonica* Crantz.) varieties and lines by valuable agricultural traits in Diyarbakir ecological conditions. Doctoral Thesis, p., 271, Diyarbakir.

Sayar, M.S., Karahan, H., Han, Y., Tekdal, S., Basbag, M., 2012. Determining the Hay Yield of Several Hungarian Vetch (*Vicia pannonica* Crantz) Genotypes and its influencing characteristics, and their correlations in Kiziltepe ecological conditions Research Journal of Agricultural Sciences 5(2): 126-130, 2012 ISSN: 1308-3945, E-ISSN: 1308- 027X.

Suzer, S., Demirhan, F., 2005. Determination of the Winter annual forage plants (*Vicia* spp.) and their mixtures with cereal grains with high hay yield and adapted to Thracian conditions. VIth Turkish Field Crops Congress, Vol. II, p., 935-940, Antalya.

Sahar, A.K. 2006. A Study on the hay and seed yields of several vetch varieties and lines. Department of Field Crops, İnstitute of Science, Yuzuncu Yıl University, Master Thesis, p. 30, Van.

Simsek, S., 2015. Determining the effects of different mixture ratios of Hungarian Vetch (*Vicia pannonica* Crantz) and Italian ryegrass (Lolium multiflorum Lam.) on Yield and Quality. Department of Field Crops, İnstitute of Science, Faculty of Agriculture, Ahi Evran University. PYO-ZRT, 4003/2.13.005.

Tosun, M., Altinbas, M., Soya, H., 1991. Correlations between fresh hay and seed yields and some agronomic characteristics in several common vetch (*Vicia* sp.) species. IIth Turkish Congress for Meadow, Pasture and Forage Crops , 28-31 May 1991, İzmir, 574-583.

Tosun, F., 1996. Yesterday, today and tomorrow of forage plant breeding with meadow and pasture and in Turkey. IIIth Turkish Congress for Meadow, Pasture and Forage Crops, 17-19 June 1996, 1-15, Erzurum.

Turgut, L., Yanar, M., Kaya, A., 2006. The crude nutrient content of several vetch species harvested at different maturity stages and in situ rumen degradability. Journal of Faculty of Agriculture, Ataturk University, 37 (2), 181-186, Erzurum.

Unal, S., Mutlu, Z., Firincioglu, H.K., 2011. Performances of some winter Hungarian vetch accessions (*Vica pannonica* Crantz.) on the highlands of Turkey. Turkish Journal of Field Crops, 16(1); 1-8.

Yuksel, O., Balabanli, C., Karadogan, T., 2007. Monitoring the course of development in Hungarian vetch *(Vicia pannonica* Crantz.). VII. Turkish Field Crops Congress, 25-27 June, Erzurum, p. 239-243.

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RURAL FARMERS' PERCEPTION OF COMMUNAL CONFLICTS IN BENUE STATE, NIGERIA

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Abstract
The study assessed rural farmers' perception of communal conflict in Benue State. Multi-stage random sampling was adopted in selecting four Local Government Areas. In each of the local government areas selected, three villages were purposively selected based on occurrence of communal conflicts in the area. Simple random sampling was used in administering structured questionnaire through interview to the 120 respondents. Data collected were analyzed through descriptive statistics and graph. Results of the findings revealed that 57.50% of communal conflicts were caused by land disputes, 38% communal conflicts reduced development, 65% communal conflicts caused social vices and promoted negative cohesion, 62% communal conflicts reduced volume of trade, 22.09% leaders and political appointees of communities involved in communal conflicts should be removed and 12.0% land communities are fighting over it should be taken over by government. It is recommended that proper boundary demarcation should be carried out in all places to avoid communal conflicts.

Keywords: Rural, farmers, perception, communal, conflicts, Benue State

INTRODUCTION

Conflict is that form of social interaction in which the actors seek to obtain scare reward by eliminating or weakening other contenders. This may take the form of a fistfight, threats, or total destruction (Ekong, 1988). In Nigeria, village/community conflict may arise where there is difference of opinion between group leaders or in situations where one group tends to be exploiting the other. This often triggers off a strong defence reaction resulting in the reappearance of old grievances with each group trying to obtain dominant position over the other. The use of pressure groups by a section of the community to gain advantage over the rest may precipitate conflict (Onigwu and Olawale, 1999).

Competition over scarce resources, particularly land and water, often causes or exacerbates communal conflict (Homer-Dixon, 1999; Kahl, 2006; Ban, 2007). Communal conflict involves groups with permanent or semi-permanent armed militias but does not involve government. However, it can escalate to include government forces, as in the massacres in Darfur, Rwanda and Burundi. These conflicts have the potential to escalate to civil war when government is perceived to be supporting, tacitly or otherwise, one communal group at the expense of the other (Kahl, 2006).

The increase in competition for arable land has often times led to serious manifestation of hostilities and social friction among different user-groups in many parts of the world. Conflicts have not only heightened the level of insecurity, but have also

demonstrated high potential to exacerbate the food crisis in many affected countries due to loss of farmer lives, animals, crops and valuable properties (Cotula *et al*., 2004).

In their explanation of the spate of conflicts in Africa, analysts have used economic and non-economic factors. One of the often cited non-economic factors is the concept of state failure, which has been blamed for conflict in Somalia, Rwanda, Liberia and Sierra-Leone (Herbst 2002). A state is supposed to provide essential public goods such as law and order, defence, contract enforcement and infrastructure. In Africa, however some states provide very few of these things. Indeed, many states are unable to exercise control over much of their territory, not to speak of providing order or public goods (Richardson, 2002).

Militarization is another concept that has been used to explain conflict in Nigeria. In his study of armed conflicts in Nigeria, Mohammed (2000) found a causal linkage between military expenditure and armed conflict. But Omitoogun (2001) was more cautions, suggesting that the relationship between militarization and conflict was rather tenuous and indirect. Military expenditure, he argued, amasses out expenditure on social programmes and thus reduces the quality of life of citizenry. It is thus, the welfare-reducing effects of militarization that causes conflict and not proliferation of arm in the society.

Angya (2005) conflict is the number one enemy of development. In order for any society to effectively develop through harnessing its human, material and financial resources, there is need for a harmonious and peaceful co-existence. It is within this harmonious condition that development thrives best. For a number of societies, this condition attracts investment and encourages completion of projects. Conflict is not only an enemy of progress but it is also a number one cause of psychological trauma that affects children, women and men. The causalities during conflicts often range from the highly placed to the lowest in the society; it is not a respecter of persons. During conflict, community cohesion and solidarity increase and this positive effect can be directed for a more efficient attainment of group goals.

According to Kaufmann (1999), loss of livelihood have many causes in the world today, some of them are amendable policy changes, while others are not and have to be met by addressing the challenges they pose. Nigeria is particularly severely challenged by the social consequences resulting from scarcity of job opportunities in relation to the number required as a result of the unavoidable part of the population increase. Failures to meet such challenges create opportunities for extremely vile crises. The loss of livelihood resulting from environmental scarcity of arable land and water form a special case of growing importance. Although roughly half of human population now at the turn of the century is living in cities, agriculture is still by far the largest single source of livelihood and income. Loss of livelihood as a result of environmental scarcity of arable land and water result to livelihood conflicts (Ohlsson, 1999).

In the twenty-first century, violent conflicts are overwhelmingly a phenomenon of countries with low income per capita, which also suffer from food insecurity (Blattman and Miguel, 2010; Collier *et al.,* 2003; Fearon and Laitin, 2003). Rates of development matter as well as levels of development. Civil conflict, protest, rioting and social conflict are all more prevalent during periods of slow or negative economic growth (Miguel *et al.,* Sergenti, 2004; Blattman and Miguel, 2010). Economic shocks are strongly correlated with civil conflict; economic shocks redistribute incomes and political power and can create incentives for rebellion, while reducing the capacity of governments to repress or accommodate potential challengers (Blattman and Miguel, 2010).

Societies with greater economic inequality experience more civil conflict, though the type of inequality matters. Vertical inequality – inequality across households – has not been robustly linked to political conflict (Cramer, 2003; Hegre and Sambanis, 2006), though there is some evidence to suggest that vertical inequality makes civil and guerrilla wars more likely

when a country's wealth is in the form of immobile assets such as natural resources (Boix, 2008).

Individual perception on issues differ among people, in the case of communal conflicts people view it depending on how it is perceived, to many it is considered to be very disintegrative. In contrast, Ekong (1988) reported that until there is public conflict, people might not know that certain nagging issues exist. Thus conflicts lead to clear definition of issues. Once such issues are identified, it can be resolved amicably. The general objective of the study is to assess rural farmers' perception of communal conflicts, while the specific objectives are to describe the causes of communal conflict; identify the effects of communal conflicts on development; describe the effects of communal conflicts and social vices; find out effects of communal conflicts on volume of trade; ascertain the removal of community leaders and political appointees from communities involved in communal conflicts and find out land communities are fighting over it should be taken over by government.

MATERIAL AND METHODS

Benue State is one of the 36 states in Nigeria. It has one of the longest stretches of river systems in the country (Anon. 2004). Benue State lies in the North-central region of Nigeria and share boundaries with five other states: Nassarawa to the north, Taraba to the east, Cross-Rivers to the south, Enugu to the south-east and Kogi to the west. The state also shares a common boundary with the Republic of Cameroon in the south-east. It is made up of 23 Local Government Areas (LGAs), occupying a landmass of 30,955 square kilometres and has a population of 4,219,244 (NPC, 2006).

The state experiences tropical climate with two distinct seasons, the rainy season which lasts from April to October with annual rainfall of 1500-1800mm, and the dry season which begins in November and ends in March. Temperature fluctuates between 23^{o}C and 38^{o}C in the year. The state is made up of several ethnic groups. Most of the people are farmers, while the inhabitants of the riverine areas engage in fishing as their primary or secondary occupation (Anon. 2004).

Stratified purposive and simple random sampling technique was used. In the first stage four LGAs in the state were purposively selected out of 23 LGAs on the basis of frequent occurrence of communal conflicts. The LGAs were Gboko, Katsina-Ala, Konsisha and Ushongo. The second stage involved the selection of three villages in each of the LGAs. The third and the final stage, in each of the villages selected simple random sampling was used in selecting (20) twenty thus giving a total of 120 respondents. Structured questionnaire was administered to the respondents (people affected by communal conflicts). Data for the study were collected from primary sources only. A 5 point Likert-type scale was used in obtaining data on perception of the respondents. Data collected were analyzed using descriptive statistics and graph.

Likert-type scale ranking:
SA = Strongly Agreed = 4
A = Agreed = 3
Ni = Undecided = 0
D = Disagreed = 2
SD = Strongly Disagreed = 1

RESULTS AND DISCUSSION

Table 1: Distribution of Respondents According to Causes of Communal Conflicts

Causes	Frequency	Percentages
Land disputes	69	57.50
Livestock grazing	21	17.50
Political positions	18	15.00
Militant groups	12	10.00

Results in Table 1 depicted that land disputes 57.50%, livestock grazing 17.50%, political positions 15.0% militant groups 10% are major causes of communal conflicts. Majority (57.50%) of the respondents communal conflicts were caused by land disputes. Land is essential for farming, therefore the need for every farmer to acquire land which is a scarce resource necessitated conflicts. Without land there is no farming, land is necessary for farming and the bigger a piece of land, the more the quantity of crops planted and harvested which in turn boost both the social and economic status of a farmer. The finding is similar to Failola and Ihonvbere (1995); Angya (2005) who reported that the major occupation of most Nigerians is farming, hence the need to acquire and use land for farming which has been a root of several crises. Similarly Bur (2000) also reported that communal conflict has destroyed a lot, for instance, the Ipav and Ukan communal clash of 2004 in Benue State which led to the death of hundreds of people and displacement of many others was linked to land dispute.

In contrast, Kughur *et al.* (2017) reported that communal crises were caused by religion, because of the increasing employment of religion as a political weapon in the struggle for power, people preach in their places of worship drawing a distinction line between various religions. This has created a lot of disparity between Muslims and Christians. The findings corroborate Onigwu and Olawale (1999) who reported that farmers, pastoralists, fishermen, foresters, have clashed throughout Nigeria over control and use of land resources.

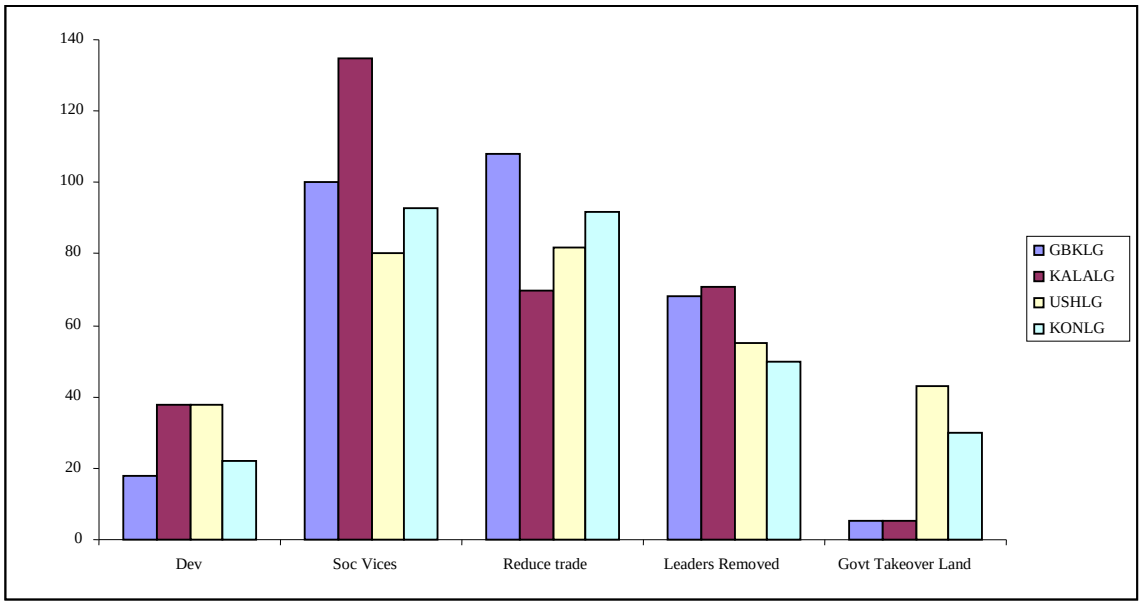

Figure 1: Distribution of Respondents According to Effects of Communal Conflicts on Development

Figure 1 showed that Katsina-Ala and Ushongo LGAs have the highest proportions of 38.0% and Gboko LGA has the lowest proportion of 17.0% indicating that communal conflicts does not encourage development. During conflict, residents of areas involved in conflict do not have time to concentrate on other issues except to run away for their life. Konshisha and Katsina-Ala LGAs share boundaries with Taraba and Cross-Rivers States, therefore during conflict; people especially young able-bodied men who are able to loot property of victims of communal conflict tend to acquire wealth within a short period of time and it is seen as a positive development to the residence of the two LGAs. On the contrary, other people involved in the looting to acquire wealth during communal conflicts may lose their lives. The issue of looting to acquire ill-wealth during communal conflict may lead to persistent conflicts especially inter-state communal conflicts.

The finding contradicts Angya (2005) who reported that communal conflict is the number one enemy of development. Alcira (2000) similarly reported that initiation, development and completion of project can only take place in an environment characterized by peace. The finding also contradicts Kughur *et al.* (2017) who reported that during communal conflict, depending on its intensity lives are lost and other property destroyed which inhibits development.

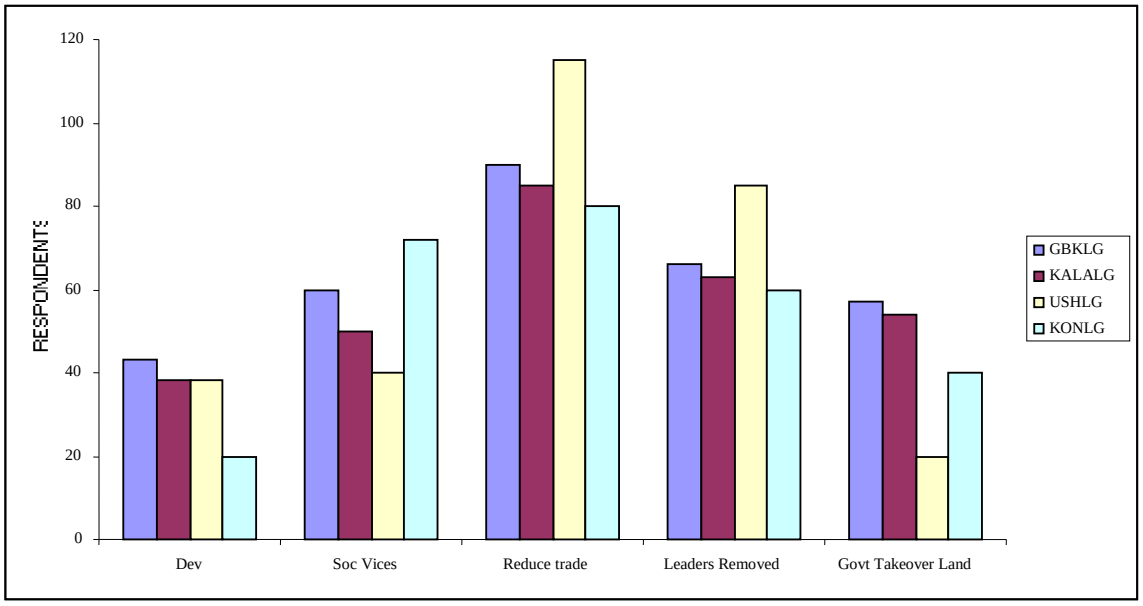

Figure 2: Distribution of Respondents based on Communal Conflicts cause Social Vices

Figure 2 showed that Konshisha LGA has the highest proportion of 65.0% and Ushongo LGA with the lowest proportion of 40.0%. A major (65.0%) proportion of the respondents in Konshisha LGA, communal conflicts cause social vices. Konshisha LGA shares boundary with Cross-Rivers and Taraba States. Due to frequent communal conflicts experienced in the area residents hardly have time to embark on meaningful development projects. During conflicts; lives, crops and other property are destroyed.

Communal conflict causes social vices; this is clearly seen in destruction of life and property by the stronger community involved in the conflict. During communal conflict, youth within the warring communities engage in looting of property especially where residences of such areas have fled to other areas to escape being lynched by the crises. Conflicts leads to destruction of existing cordial relationship that has been built over several years, and also physical structures.

In contrast, Ekong (1988) observed that until there is public conflict, people might not know that certain nagging issues exist. Thus, conflicts lead to clear definition of issues, once such issues have been identified, they can be resolved amicably.

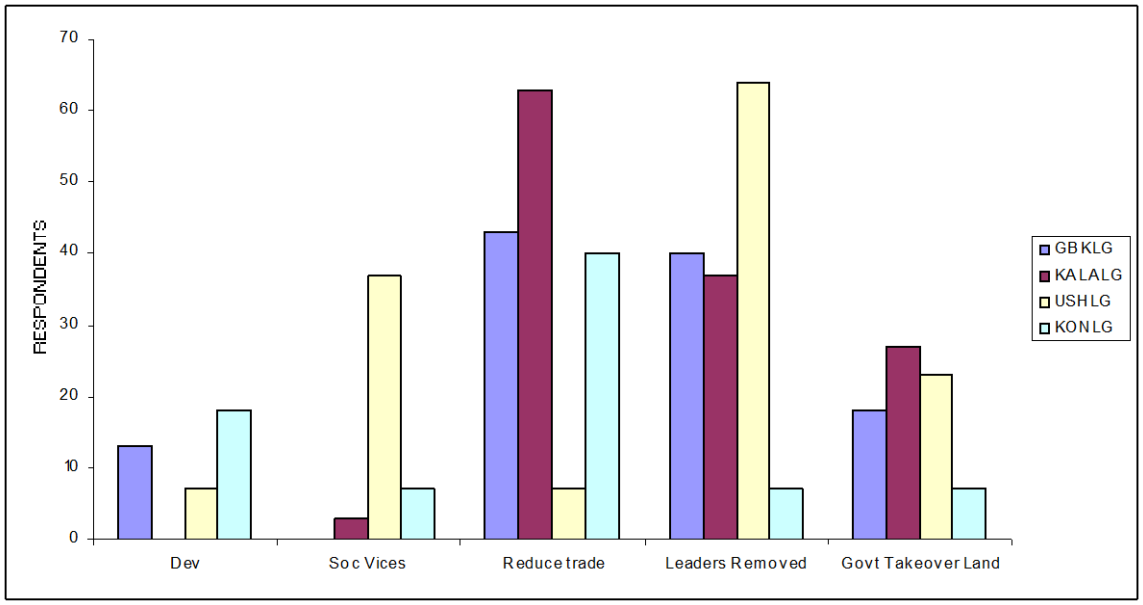

Figure 3: Distribution of Respondents by Effects of Communal Conflicts on Volume of Trade

Figure 3 indicated that Katsina-Ala and Ushongo LGAs have the highest and the lowest proportions of 62.0% and 7.0% respectively. Majority (62%) of the respondents' communal conflicts reduced volume of trade. During communal conflict, relationships that have been built for many years are destroyed and physical facilities like buildings, roads/bridges, livestock, farms and markets places among others things are destroyed. The destruction of market places/centres leads to reduction in volume of trade because agriculture is mainstay of the rural settlers the income generating activity can no longer be practiced, market places that were used for the exchange of goods and services no longer exist. Human beings who are the main participants in the exchange of goods and serves also flee the conflict areas for the fear of been killed. Conflicts lead to displacement of people who are the main stakeholders in trading.

The finding confirms Deininger (2003); Justino (2011) who reported that communal conflicts reduce market efficiency. Contraction in the supply of goods and higher transactions costs cause price increases and reductions in the size of trade. Similarly, Abadie and Gardeazabal (2003); Justino and Verwimp (2013) observed that conflicts lead to decline in aggregate agricultural production also drop in household income and consumption.

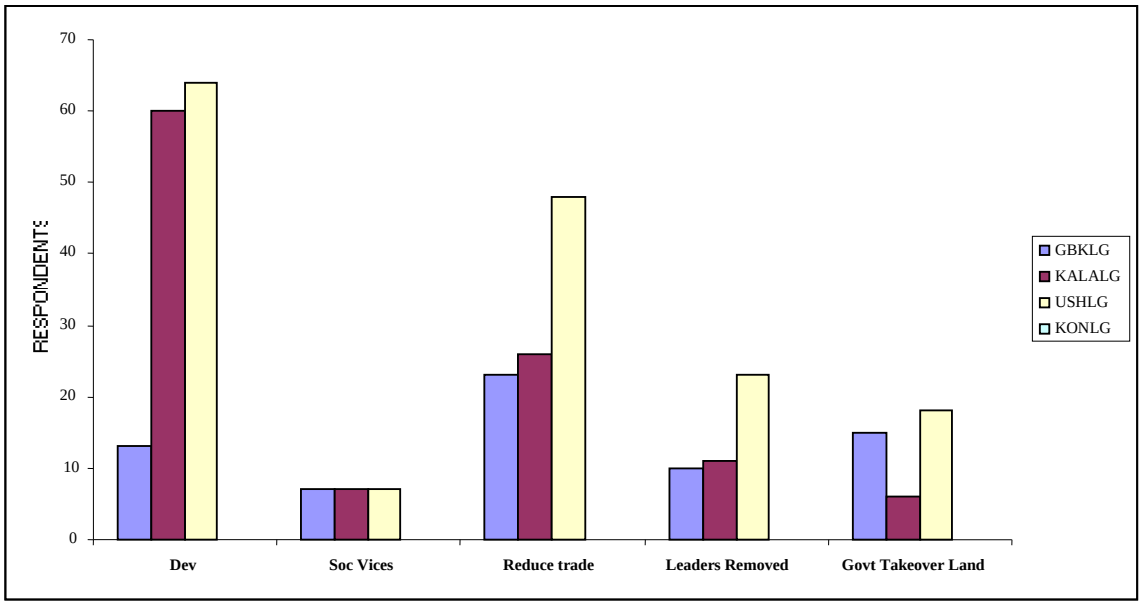

Figure 4: Distribution of Respondents by removal of Community Leaders and Political Appointees of Communities involved in Conflicts

Figure 4 depicted 22.09% of the respondents in Ushongo LGA and 7.0% in Katsina-Ala LGA. The appointment of both community leaders and political office holders is done on rotational basis within the political districts that make up a communal/political area in Benue State. The traditional rulers and political appointees would try to do everything humanly possible to ensure that there is no communal conflict within their domain during their time as traditional ruler or political appointee. On the contrary, their opponents would attempt to instigate communal conflict so that those appointed to such exalted positions are removed.

Similarly, the financial incentives attached to such positions are very attractive which make many people compete for it. On the other hand the removal of some people appointed to such positions would create more anarchy. Angya (2005) affirmed that political and traditional positions are symbol of authority. Therefore, those who have ascended to such positions always wish to remain there mostly in African and this often causes serious crises.

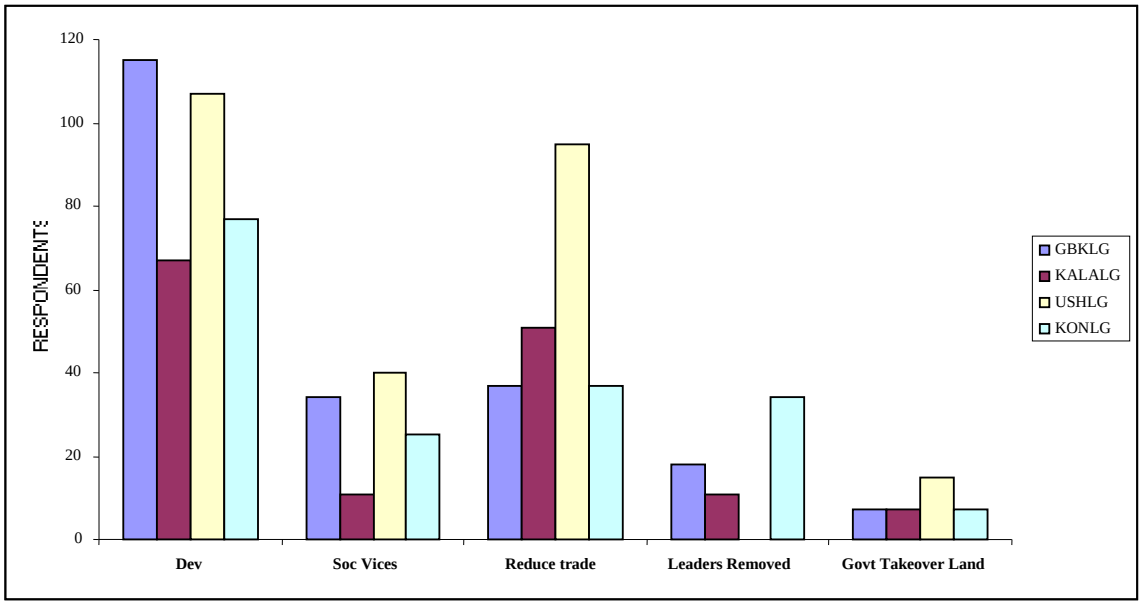

Figure 5: Distribution of Respondents based on Land Communities are Fighting over it should be taken over by Government

Figure 5 revealed that a meagre proportion of the respondents 12.0% in Ushongo LGA strongly disagreed that land communities are fighting over it should be taken over by government, while Gboko, Katsina-Ala and Konshisha LGAs have the same proportions of 8.0% each. Land is a very important resource to all human beings, apart from its use for farming it is use for construction of residential and recreation centres among others.

Land is an important resource for human beings. Apart from its use for cultivation of crops it can also be sold to get money therefore, people in the study area would not want government to take over their land irrespective of whatever situations. Majority of the people in study area are farmers who use land for planting of crops, livestock grazing among others hence, any attempt to take over their scare resource because of communal would be resisted.

Faiola and Ihonvbere (1985); Angya (2005) affirmed this, when they stated that the major occupation of Nigerian is farming and the need to acquire and use it for farming is the root cause of several crises.

CONCLUSIONS

The rate of conflicts in the world today is very high; in Nigeria, conflicts occur within and between communities, it could be farmer-farmer, politicians and farmer-herdsmen among others. The perception of people on conflicts differs depending on how it affects them. The study revealed that communal conflicts in the area were caused by land disputes. Communal conflict is an enemy of development, it caused a lot of social vices, reduce volume trade and community and political leaders of people involved conflicts should not be removed and land communities are fighting over should not be taken over by government.

REFERENCES

Abadie, A. and Gardeazabal, V. (2003). The economic costs of conflict: A case study of the Basque Country. *American Economic Review 93*(1), 113-132.

Alcira, K. (2000). Creating partnership for disaster mitigation. The Disaster Management of the World Bank. *Journal of Agricultural and Rural Development.* (1)15,16. World Bank Bonn, Germany

Angya, C.A. (2005). Theatre as a tool for peacemaking: A tool for peacemaking: Another look at inter- communal conflicts in Benue State. Taming the Tiger 1 Conference on Causes of Conflict in Benue Valley. The Centre for Peace and Development Studies, Benue State University, Makurdi. March 16,17

Anon. (2004). Anonymous Benue State Government Dairy

Ban, K. (2007). A Climate Culprit in Darfur. *Washington Post*, 16 June.

Blattman, C. and Miguel, E. (2010). Civil War. *Journal of Economic Literature* 48(1): 3–57.

Boix, C. (2008). Economic Roots of Civil Wars and Revolutions in the Contemporary World. *World Politics*, 60 (3): 390–437.

Brück, T. (2004). The welfare effects of farm household activity choices in post-war Mozambique. DIW Berlin Discussion Papers No. 413.

Bur, A. (2000). Communal Crises and its Impact on Community Development: In Bur (ed). *Communal Relation: Conflicts and Crises Management Strategies.* Aboki Publishers, Makurdi, Nigeria

Collier, P., Elliot, L., Hegre, H., Hoeffler, A., Sambanis, N. and Reynal-Querol, M. (2003). *Breaking the Conflict Trap: Civil War and Development Policy*. Oxford, Oxford University Press.

Cotula, L., Toulmin, C. and Hesse, C. (2004). Land Tenure and Administration in Africa: Lesson of Experience and Emerging Issues, IIED. Retrieved on Oct. 10 2005, from http://www.iies.org/drylands/pubs /documents/LT-cotula.pdf.

Cramer, C. (2003). Does Inequality Cause Conflict? *Journal of International Development*, 15(4): 397–412.

Deininger, K. (2003). Causes and consequences of civil strife: micro-level evidence from Uganda. Oxford *Economic Papers* 55(4), 579-606.

Egwu, G.S. (2001). Ethnic and Religious Violence in Nigeria Research Monograph, African Centre for Democratic Governance.

Ekong, E.E. (1988). *An Introduction to Rural Sociology. 2nd edition.* Dove Educational Publishers, Uyo, Nigeria.

Eteng, I. (1996). Understanding the Nature and Roles of Civil Society in Democracy in Nigeria, the Mass Media and Democracy. A Publication of Civil Liberties Organization. Lagos, Nigeria.

Faiola, T. and Ihonvbere, J. (1985). *The Rise and Fail of Nigeria's Second Republic, 1979-1984.* Zed Books Ltd., London.

Fearon, J.D. and Laitin, D.D. (2003). Ethnicity, Insurgency, and Civil War. *American Political Science Review*, 97(1):75–90.

Hegre, H. and Sambanis, N. (2006). Sensitivity Analysis of Empirical Results on Civil War Onset. *Journal of Conflict Resolution*, 50 (4): 508–535.

Hembe, G.N. (2000). The Political and Economic Impact of Communal Crisis in Tivland : in Bur (ed). *Communal Ration: Conflict and Crises Management Strategies*. Aboki Press Makurdi, Nigeria.

Herbst, J.T. (2002). *States and Power in Africa; Comparative Lessons in Authority and Control.* Princeton University Press

Homer-Dixon, T. (1999). *Environment, Scarcity, and Violence*. Princeton, Princeton University Press.

Justino, P. (2011). *War and poverty oxford handbook of the economics of peace and security* in M. R. Garfinkel and S. Skarpedas (ed). Oxford, Oxford University Press.

Justino, P. and Verwimp, P. (2013). Poverty dynamics, violent conflict and convergence in Rwanda. *Review of Income and Wealth* 59(1): 66–90.

Kahl, C. (2006). *States, Scarcity, and Civil Strife in the Developing World. Princeton,* Princeton University Press.
Kaufmann, K.H. (1999). The role of demographic and resource-stress in Kosovo conflicts. Accessed from http//www.igc.org/desip/stressInKosovo.html on July, 2007

Keen, D. (1998). *The Economic Functions of Violence in Civil Wars. International Institute for Strategies Studies*. London 320:301 – 320.

Kughur, P. G., Daudu, S. and Iornenege, G. M. (2017). Effects of communal crises on selected crops production among farmers in Langtang North Local Government Area of Plateau State, Nigeria.

International Journal of Education, Culture and Society, 1, 33-37. http://www.sciencepublishing- group.com/j/ijecs. doi: 10.11648/j.ijecs.20170201.15

Lamachand, R. (1989). Burundi: the killing fields, revisited. *Journal of Opinion* **Vol.** 18 No.1.21

Lewis, A.C. (1969). *Continuities in the Study of Social Conflict.* The Press, New York, USA

Miguel, E., Satyanath, S. and Sergenti, E. (2004). Economic Shocks and Civil Conflict: An Instrumental Variables Approach. *Journal of Political Economy*, 112(4): 725–753

Mohammed, N.A.L. (2000). Civil Wars and Military Expenditure.www.worldbank.org/resear ch/conflict/pa per/civil.htm accessed on 15/08/2005.

NPC (2006). National Population Commission. National Population Housing Census.

Ohlsson, L. (1999). Environment, Scarcity and Conflict – A study of Mathusian Concerns. Department of Peace and Development Research, University of Goteborg. http//:www.padrigu.gu.se/ohlsson/files/esl.html. accessed on 20/05/2009.

Omitoogun, W. (2001). Military Expenditure and Conflict in Africa. DPMN Bulletin **Vol**. viii. (1):8-13

Onigwu, O. and Olawale, I.A. (1999). *Community Conflicts in Nigeria Management, Resolution and Transformation.* Spectrum Books Ltd, Ibadan, Nigeria

Renner, M. (2000). Working for the Environment: A Growing Source of Jobs. World Watch Paper No. 152. *World Watch Institute.*

Richardson, J. (2002). States and Power in Africa. *Journal of Economic Literature.* **Vol.** XI

Tseor, T. (2005). Crisis of Conflict Management in Contemporary Nigeria. A Case Study of the 2001Tiv Massacre. Taming the Tiger 1 Conference on Causes of Conflicts in Benue Valley. The Centre for Peace and Development Studies, Benue State University, Makurdi. March 16-17.

Tyubee, B.T. (2005). Influence of Extreme Climate on communal Disputes and violence in Tivland, Benue State: In the proceedings; taming the Tiger I Conference on causes of conflicts in Benue Valley. The Centre for Peace and Development Studies. Benue State University, Makurdi 16-17 March.

Factors Affecting use of Print Media among Farmers in Bwari Area Council of Federal Capital Territory, Abuja

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Abstract

The study assessed the use of print media among farmers in Bwari Area council of the Federal Capital Territory. Stratified purposive and simple random sampling technique was used in selecting 150 respondents from five (5) council wards. Data were collected using structured questionnaire, data collected were analyzed using descriptive and inferential were used. The findings revealed that the respondents were age between 21-40 years 58.9%, married 55% had Higher National Diploma/Bachelor degree 28.1%, household size of between 6-10 persons 45.2% with farming experience of less than 10 years 37%, estimated annual income of at least ₦50,000.0 35.5% with a farm size of more than 4 hectares. The results further indicated that the type of information available on the print media was prices of agricultural produce 54.1%, type of print media mostly source for was newspapers 88.4%, print media mostly accessed newspapers 92.5%, reason for preference of a particular source easy access 65.8%, constraints faced was low level of education 87.7% and logit regression showed that none of the socio-economic characteristics was significant. It it recommended that adult classes should be organized for the farmers to improve their level of education.

Keywords: Factors, use, print, media, farmers.

INTRODUCTION

It is imperative that the generated information from these sources reach farmers or intended users and ultimately meet their needs. It should be noted that accessibility of agricultural information by farmers differs from locality to locality. Respondents got agricultural information from friends and relatives; this means that once a few of the farmers have access to agricultural information through other sources like the media, extension workers and local leaders, they share the information with their friends and relatives.

Agriculture forms the backbone of many developing economies and serves as the means of revenue of almost 50% of the world's population (Abdullah *et al.*, 2005). Nigeria is predominantly an agrarian country, having sufficient natural resources, suitable climatic conditions, good soils, favourable topography, water and human resources, thus the country has huge potentials for agricultural production (Mallah, 2005 and Khan, 2006). Agriculture has played an important role in generating economic growth for several decades in Nigeria it employs more than 65% of the total work force. However, average per hectare yield of farmers of various crops is far less than that obtained at the research stations (FAO, 2008). This low yield may be attributed to non-adoption of the latest agricultural technologies and

poor farm management by farmers (Farooq *et al.,* 2007). Abbas *et al.,* (2008) argue that lack of information adapted to local needs and lack of technical knowledge at farm level are the important factors responsible for this low yield.

Information is therefore considered as one of the most important resources in agriculture that assists farmers to make decision and appropriate actions for farming purposes. Agricultural information dissemination is a crucial point in agricultural technology development and transfer. It is crucial because if it is not done properly and through the appropriate channel it would not serve the purpose it was intended to serve. Importance of information in agricultural production can never be over emphasized. Information generally is considered as being an essential production factor in agriculture (Zijp 2002, Dutoit and Mc Connell, 1995). Munyua 2000 observed that scientific and technical information are particularly important in both subsistence and commercial agricultural production system.

Information is one of the basic human needs after air, water, food and shelter (Stanley, 1990). Camble (1992) in agriculture, information is required to manipulate factors of production such as land, labour and capital resources into meaningful and productive use. It is this recognized capacity of information to facilitate and bring about significant changes within an individual, group or a country that makes it so vital in the development process.

According to Adedoyin (1990), a steady flow of accurate, understandable and factual information links the scientists with the farmers and for any agricultural progress, farmers must know, understand and act in accordance with information. Therefore, the productivity of farmers depends largely on the availability and access of accurate and reliable information.

Apata (2010) the print media is a printed form of technological apparatus which is capable of reproducing the same message simultaneously for a large number of people over a given period of time appearing in a printed form. This may be through large printing press, broadcasting transmitters, film-camera, bill board exhibitions and audio-visual system of messages. Olowu and Oyedokun (2000) print media such as newspapers, magazines, newsletters, leaflets, pamphlets and posters have been widely used to disseminate information to farmers by governments, non-governmental organizations and other concerned groups. In this regard, the print media like newspapers, magazines, leaflets, etc, can be harnessed to provide information and even make up for shortage of trained extension personnel in a developing country like Nigeria.

Information disseminated through print media tools like newspapers and magazines are mostly made to cover all agricultural innovations which are of importance to farmers. A striking thing about the print media is its detailed nature. Another point of interest is that the print media can easily afford the dissemination of information to illiterate farmers through the interpretation of content into local dialects comprehensible to farmers. The print media is also of significance as information on the printed form can be better handled and documented for futuristic purposes by the users (Apata, 2010).

Nigeria is a nation blessed with plenty of both natural and human resources in the area of agriculture that could have maintained the sustainability of food production. Unfortunately, Nigeria continues to experience poor yield in agricultural production due to poor or non-dissemination of research findings to the end users. According to Ekoja (2003), farmers' decision and other management functions for the farm depend on experience and nature of agricultural information available to them. Agricultural messages to farmers need to be well refined for proper and adequate utilization. This is rarely achieved due to poor agricultural extension system.

According to Hussain (2005); Farooq *et al.* (2007), print media include all forms of printed materials including words, diagrams and pictures that are used to disseminate precise and unambiguous information on a mass scale. Print media consist of newspapers, magazines, newsletter, books/booklets, posters, pamphlets, leaflets, folders, brochures,

bulletins, circulars, wall newspapers and handbills. The printed word with its properties of transportability and translatability offer the opportunity to quickly disseminate agricultural information among farmers

According to Kashmira (2015), print media is a process that uses ink on paper to show images and text by making use of printing press. The primary use of print media is to spread information daily on events and news; it is the fastest way to reach the public. There are various types of print media which help different people to target a particular segment of people, these includes book, handbill or flyer, pamphlet billboard, banner, newsletter and magazine among others.

The accessibility and utilization of agricultural innovations made available on print media is limited by interest of the farmers, language barrier, literacy level of the farmers and relevance of the information among others. However, print media could be cost effective/inexpensive if magazine or newspaper space is free and writers would be writing a regular column for a newspaper or magazine.

MATERIALS AND METHODS

Bwari is one of the six (6) Areas Councils in the Federal Capital Territory (FCT), Abuja, Nigeria. Bwari area council is located at North East of the FCT Abuja, Nigeria, which is located just north of the confluence of the Rivers Niger and Benue. FCT is bordered by Niger State to the West and North, Kaduna State to the Northeast, Nassarawa State to the East and South and Kogi State to the Southwest. The original inhabitants of Bwari area are the Gbagyi speaking people. The mineral resources in the Area are casseterite, clay, dolomite, gold, lead/zinc, marble and tantalite.

Bwari is made up of several ethnic groups such as Gbagyi, Koro, Fulani and other minority migrants in the area. Bwari area council lies between Longitude 10^0 N and Latitude 8^0 E. Bwari LGA has land mass of about 914km^2 and a population of 229,274 (NPC2006). Two distinct seasons are observed in the area; the rainy season which kicks off from March to November, and the dry season which commences from November to February. The environment is favoured by climate that permits the cultivation of different food crops such as; yam, banana, groundnut, and maize.

The population of the study consisted of all the rural farmers in Bwari Area Council. Due to the enormity of this population, five (5) council wards were deliberately selected Kuduru, Shere, Ushafa, Usuma and Kawu out of ten (10) council wards based on farmers' use of print media. In each of the council wards selected, 30 (farmers) respondents were selected randomly, thus given a total of 150 respondents.

Data were collected using primary and secondary sources. Primary data were gathered using a well-structured questionnaire, while secondary data were obtained from journals, textbooks government documents and internet.

Data collected were analysed using descriptive statistics such as frequencies, percentages, mean scores while logit regression was used to determine the relationship between variables.

The model specification is as follows:

$Z = \alpha + b_1 \times_1 + b_2 \times_2 + \ldots\ldots\ldots b_6 \times_6$

Where z = probability that respondents will use print media (1 = use, 0 = do not use)

α = Constant

b_1 . b_2 = Coefficients of explanatory changes in Z caused by changes in X

X_1 = Age in years

X_2 = Education level, number of years spent for education.

X_3 =Household size 1, 2, 3, etc.

X_4 = Farming experience in years

X_5 =Annual income in Naira 1, 2, 3, etc.
X_6 = Farm size in hectares 1, 2, 3, etc.

RESULTS AND DISCUSSION

Table 1: Socio- economic Characteristics of Respondents

Variables	Frequency	Percentage
Age		
21 -40	86	58.9
41 – 60	49	33.6
60 and above	10	6.8
≤ 20	1	0.7
Marital Status		
Married	81	55.5
Single	41	28.1
Separated	21	14.4
Widowed	3	2.0
Educational level		
HND/Bachelor Degree	41	28.1
ND/NCE	40	27.4
Primary	37	25.3
Non-formal	28	19.2
Household size		
6-10	66	45.2
At least 5	44	30.1
11-15	28	19.2
16 and above	8	5.5
Farm size (hectares)	**Frequency**	**Percentage**
4 and above	69	47.3
At least 1	30	20.5
2	27	18.5
3	20	13.7
Farming experience (Years)		
At least 10	54	37
21 and above	44	30.1
11-15	35	24
16-20	13	8.9
Annual Income (Naira)		
At least 50, 000.0	52	35.5
50,001- 100,000.0	51	34.9
150,000.0 and above	28	19.2
100,001-150,000.0	15	10.3

Results in Table 1 show age of respondents 21-40 58.9%, 41-60 33.6%, 61 and above 6.8%, and at least 20 0.7%. Majority (58.9%) of the respondents were between 21-40 years of age. This implies that a good number of the respondents were within the active age and therefore needed information to be productive in their agricultural activities. Age plays a significant role in adoption of innovations. Young people are receptive to adoption of innovations and old people are conservatives. Young people could read and write, interact with their peers at different locations using different means all these therefore, predisposes a young person to adoption of innovations. Bembridge (1984) reported that as people get older, they may be more willing to take risk. However, they work fewer hours and this is likely to affect their farm output. Younger farmers are expected to work on a more acreage as they are stronger than older farmers. As farmers get older the farm output decreases (Bembridge, 1984). This could be why farming activity needs a strong healthy person and older farmers are not easily willing to change to new farming practices that may increase farm output (Elias *et al*., 2013).

Results in Table 1 indicate that married 55.5%, single 28.1%, separated 14.4% and widow 2.0%. Majority (55.5%) of the respondents were married. Married people have more responsibilities than people who are not married. Farmers with family responsibilities tend to adopt innovations to improve their farm production; this is because adoption of technology leads to increase production of agricultural production and the more the farm produce, the more the resources to cater for the family.

Results in Table 1 reveals that HND/Bachelor degree 28.1%, ND/NCE 27.4%, primary education 25.3%, while non-formal education 19.2%. A small (28.1%) proportion of the respondents acquired HND/Bachelor degree. This is an indication that the literacy level among respondents is reasonable. The literacy level determines the use of print media. The higher the literacy level of the respondents the more the use of the print media. Print media is a source of information that the user does not need assistance from anybody for him/her to make of the information. Like the electronic one, many senses are used for the comprehension of the information.

Results in Table1 shows household size 6-10 45.2%, ≤5 30.1%, 11-15 19.2%, and>16 5.5%. A reasonable (45.2%) proportion of the respondents had household size of 6-10 persons. In the traditional African culture, having a large family size was an indication that the person is wealthy. However, people are becoming aware of what it cost to maintain a large family and are now conscious that a large family means spending more resources. However, in the villages especially where manual labour is practiced people are resources that are used on the farm for manual labour. Therefore, the larger the family size the more the people is available for manual labour.

Results in Table 1 depicts farming experience in years less than 10 years 37.0 %,more than 21 30.1%,11-15 24.0%, and 16-20 8.9%. A meagre (37.0%) proportion of respondents had farming experience of at least 10 years. This shows that a good number of the respondents were experienced in farming. Farming experience is a very important factor among farmers as it helps in decision making in different ways including but not limited to the kind of enterprise to practice, where to source for credit, membership in farmers organization among others.

Results in Table 1 show the estimated annual income in Naira at least ₦50,000 35.5%, ₦50,001-100,000 34.9%, more than ₦150001 19.2%, and ₦100,000-150000 10.3%. This indicates that a meagre (35.5%) proportion of the respondents had annual income of at least ₦50,000. The amount income obtained by a farmer is determined by the level of investment. In Nigeria, majority of the farmers operate at subsistence level. A reasonable number of them do not have resources to acquire agricultural inputs expected to increase their production, therefore the value of what is invested is small, so also the corresponding value of what is obtained.

The Results in Table 1 shows farm size in hectares, more than 4.00 47.3%, less than 1.00 20.5%, 2.00-2.00 18.5%, and 3.00-3.00 13.7%. A reasonable (47.3%) of the respondents had farm size of less than 4 hectares. This is an indication that farmers had large farm size. However the land is usually scattered at different locations making it difficult to mechanize their agricultural production.

Table 2: Distribution of Respondents by Types of Agricultural Information Available on Print Media

Type of information	Frequency*	Percentage*
Prices of agricultural produce	79	54.1
Agricultural innovations	74	50.7
Credit facilities	73	50.0
Land tenure systems	71	48.7
Prices of agricultural inputs	71	48.6
Methods of preservation	68	46.6
Weather and climate reports	66	45.2
Agricultural imports and exports commodities	59	40.4
Sustainable agricultural practices	58	39.7
Organic agriculture	57	39.0

*Multiple responses

The results in Table 2 shows that prices of agricultural produce, 54.1%; agricultural innovation, 50.7%; credits facilities, 50.0%; land tenure systems, 48.7%; prices of agricultural inputs, 48.6%; methods of preservation, 46.6%; weather and climate reports, 45.2%; agricultural imports and export commodities, 40.4%; sustainable agricultural practices, 39.7%; organic agriculture, 39.0% and others 3.4%. Majority (54.1%), prices of agricultural produce was one of the agricultural information available on print media. Information on prices of agricultural produce is very important to farmers as they are informed especially on how much agricultural produce are sold at different markets in different locations. The information on prices of agricultural produce is a very important to farmers as with the information, they compare the prices of the same farm produce at other places with how much the same produce is sold in their location and decide where to sale their farm produce and get more profit. The issue of where to sale farm for more money is for profitability, this is because farming is practiced as a business.

Table 3: Distribution of Respondents According to Sources of Information on Print Media

Sources of information	Frequency*	Percentage*
Newspapers	129	88.4
Books	65	44.5
Magazines	55	37.7
Pamphlets	53	36.3
Banners/posters	51	34.9
Handbills	44	30.1
Billboards	42	28.8
Journals	40	27.4
Bulletins	25	17.1
Newsletters	19	13.0

*Multiple responses

Results in Table 3 indicates sources of information, newspapers, 88.4%; books, 44.5%; magazines, 37.7%; pamphlets, 36.3%; banners/posters, 34.9%; handbills, 30.1%; billboards, 28.8%; journals, 27.4%; bulletins, 17.1% and newsletters, 13.0.%. Majority (88.4%) obtained news on agricultural information through newspapers. This means that newspapers were available and provided the agricultural information required by farmers. Newspapers are common in Nigeria especially within the township; people who are literate make use newspapers as a source of information. This because newspapers are produced in different parts of the country and distributed depending on the type of newspaper used; some of the newspapers are produce on daily basis, weekly basis and monthly basis.

Table 4: Distribution of Respondents based on Print Media mostly accessed by Respondents

Print media mostly accessed	Frequency*	Percentage*
Newspapers	135	92.5
Books	79	54.1
Magazines	77	52.7
Pamphlets	67	45.9
Banners/posters	66	45.2
Billboards	52	35.6
Handbills	40	27.4
Journals	30	20.5
Bulletins	26	17.8
Newsletters	24	16.4

***** Multiple responses

Results in Table 4 depict the print media mostly accessed by farmers: newspapers, 92.5%; books, 54.1%; magazines, 52.7%; pamphlets, 45.9%; banners/posters, 45.2%; billboards,35.6%; handbills, 27.4%; journals, 20.5%; bulletins, 17.8% and newsletters, 16.4%. Majority (92.5%) of the respondents mostly accessed newspapers. This means that newspapers were one of the print media that was available to farmers most of the times. The finding confirms Irfan (2006) who reported that an overwhelming majority was aware and had accessed newspapers, posters, pamphlets books and magazines on agricultural information.

Table 5: Distribution of Respondents by Reasons for Preference to Information Sources

Reason	Frequency*	Percentage*
Easy access	96	65.8
Quality of information	89	61.0
Easy of language used	82	56.2
Low cost	78	53.4
Relevance of information	66	45.2
Timely information	64	43.8

*Multiple responses

Results in Table 5 reveal that easy access 65.8%, quality of information 61.0%, easy of language used 56.2%, low cost 53.4%, relevance of information 45.2% and timely information 43.8%. Majority (65.8%) newspapers were easily accessed. The ability to access information with ease could encourage farmers to utilize such information sources. Easy access to agricultural information has made the use of neighbours and relations as one of the frequently used information by farmers in most rural areas in Nigeria. In the case of newspapers, the distribution channels of most functional national newspapers effective and this allows for quick and timely dissemination of information.

Table 6: Distribution of Respondents based on Constraints faced by Respondents in Accessing Agricultural Information on Print Media

Factor	Frequency*	Percentage*
Low level of education	128	87.7
High cost of accessing print media	88	60.3
Untimely provision of information	69	47.3
Provision of inadequate information	66	45.2
Non-availability of agricultural information print media	38	26.0
Provision of irrelevant information	53	24.0

***** Multiple responses

Results in Table 6 shows that low level of education 87.7%, high cost of accessing print media 60.3%, untimely provision of information 47.3%, provision of inadequate information 45.2%, non-availability of information on print media 26.0%, and irrelevant information 24.0%. Majority (87.7%) of the respondents had low level of education. This implies that not every farmer in the area can read the information provided in the print media. Level of education determines the ability to read and write. Education is an important aspect that plays a vital role in developing positive attitude among the respondents regarding an innovation. Therefore, it is believed that the higher the level of education of the farmers, the better their ability to read and write. For example, primary school leavers cannot read and understand what a university graduate can read. The result confirms Aroyewun *et al.* (2014) who reported that education is the main and vital weapon for bringing about desirable change in the behaviour of an individual.

Table 7: Logit Regression Showing the Socio-economic Factors affecting the use of Print Media by Respondents

Variable	Coefficient
Age	0.013(0.132)
Educational level	0.184(1.509)
Household size	-0.005(0.017)
Farming experience	-0.014(0.300)
Annual income	0.000(1.558)
Farm size	-0.012(0.745)
Constant	-0.616(0.507)
Chi-square	6.018
Homer and Lemeshow chi-square	10.323

The result in Table 7 shows that chi-square (6.018) was not significant at all conventional levels (P> 0.10). This implies that the socio-economic factors included in the model were not significantly related to the level of print media used.

CONCLUSIONS

Access to agricultural information by farmers cannot be overemphasized, farmers require timely and adequate information to increase farm production and ultimately improve their standard of living. Print media provide farm information to farmers especially for those that are able to read the print media. The information accessed by farmers range from prices of agricultural produce, climate change, farmers mostly accessed newspapers and were faced with several constraints including low level of education, untimely provision and and irrelevant information. It is recommended that adult education classes should be organized for the farmers and timely provision information.

REFERENCES

Abbas, M., Lodhi, T.E. Bashir, A. and Mahmood, M.A. (2008). Dissemination of wheat production technologies and interface of out-reach efforts with farmers. *J. Agric. Res*. 46(1). Available at: http://www.jar.com.pk/displayprods.asp

Abdullah, A., Gillani, W.A. Naveed, S. Amanullah, K. and Kashif, H. (2005). Computerized farm guide: Using ICT for better dissemination of agriculture extension information. Center for Agro- Informatics Research, National University of Computer and Emerg. Sci., Islamabad, Pakistan.

Adedoyin, S. F. (1990). Linkages in the development and delivery of agricultural research information by Nigerian research institutes. unpublished Ph.D. Thesis submitted to the Department of Communication and Language Arts, University of Ibadan. Pp. 23, 24.

Apata,O. M. (2010). Farmers' use of newspapers as channels of agricultural information in Ekiti State, Nigeria. *Journals of Environmental Issues and Agriculture in Developing Countries, Volume 2 (2 & 3), 1-2*

Bembridge, T.J. (1984). A Systems approach to the study of agricultural development problems in Transkei. Unpublished Ph.D. Thesis, University of Stellenbosch, Stellenbosch.

Camble, E. (1992). Access to and utilization of quality information in rural development programmes in Bama Zone of Borno State. Unpublished PhD. Thesis submitted to the Department of Library Archival, and Information Studies, University of Ibadan, Pp. 170.

Dutoit, S. and Mc Connell, C. (1995). *Agriculture and Development. A research work in North America land*. Grant: University Press.

Ekoja I.I. (2003). Farmers Access to Agricultural Information in Nigeria. *Bulletin of the American Society for Information and Technology http/findarticles.com.* Washington D.C.: World Bank.

Elias, A., Nohmi, M.,Yasunobi, K. and Ishida, A. (2013). Effect of agricultural extension programme on smallholders' farm productivity: evidence from three peasant associations in the highlands of Ethiopia. *Journal of Agricultural Science*, 5 (8), 1916-9752.

FAO. 2008. FAOSTAT. Available at: http://faostat.fao.org/site/567/default.aspx#ancor

Farooq, S., S. Muhammad, Chaudhary, K.M. and Ashraf, I. (2007). Role of print media in the dissemination of agricultural information among farmers. *Pak. J. Agric. Sci. 44*(2), 378-380.

Farooque, S. (2004). The present and prospective role of print media in the dissemination of agricultural information among the farmers of tehsil Tandoallahyar, district Hyderabad. M. Sc. (Hons.) Thesis, Dept. of Agric. Ext., Univ. of Agric. Faisalabad, Pakistan.

Hussain, M. (2005). Mass media. In: R. A. Memon and E. Bashir (eds.). *Extension Methods* (3rd ed.). National Book Foundation, Islamabad. Pp: 208-261

Irfan, M. (2005). Comparative effectiveness of mass media in the dissemination of agricultural technologies among farmers of Lahore district. M.Sc. (Hons.) Thesis, Department of Agricultural Extension, University of Agriculture, Faisalabad, Pakistan. Pp. 647-650

Khan, M.H. (2006). *Agriculture in Pakistan: Change and Progress1947-2005*. Vanguard Books (Pvt) Ltd., Lahore, Pakistan.

Khan, S.A. (2005). Introduction to extension education. In R.A. Memon and E. Bashir (eds.). *Extension Methods* (3rd ed.). National Book Found, Islamabad, Pakistan. Pp. 3-32.

Mallah, M.U. (2005). Extension programmes in Pakistan. In R.A. Memon and E. Bashir (eds.). *Extension Methods* (3rd ed.). National Book Found, Islamabad, Pakistan. Pp. 35-59.

Maningas, R. V., Perez, V. O., Macaraig, A. J., Alesna, W. T. and Villagonzalo, J. (2005).

Electronic information dissemination through the farmers' information and technology services (FITS)/Techno Pinoy program. Bringing information and technology within the reach of the farmers. from http://jsai.or.jp/afita/afita-conf/2000/part08/p231.pdf, 2000

Maningas, R. V., Perez, V.O.G., Macaraig, A.J.T., Alesna, W.T. and Villagonzalo, S.O. (2000). Electronic information dissemination through the farmers' information and technology services

(FITS)/ Techno Pinoy program: bringing information and technology within the reach of the farmers. Available at: http://zoushoku.narc.affrc.go.jp/ADR/AFITA-/afita/afita conf/2000/part08/p231.pdf
Miller, L.E. and K.L. Smith 1983. Handling nonresponse issues. *J. Ext*. 21(5), 45-50.

Munyua O. (2000). *The Value of Information.* New York: Press.

Olawoye, J. E. (1996). Agricultural production in Nigeria. In: T. Babaloye and A. Okiki (eds), Utilizing research findings to increase food production: what the mass media should do in taming hunger. The role of mass media. Proceedings of the one-day Seminar, organized by the Oyo State Chapter of the Media Forum for Agriculture, IITA, Ibadan.

Olowu, T. A. and Oyedokun, O. A. (2000). *Farmer Accessibility of Agricultural Marketing Information.* Ado-Ekiti: Bayo Publishers.

Stanley, K.N. (1990). A critique of information system and service in Kenya and the role of Kenya National Library Service in cooperation in system and service in Kenya. Born Education Service and Documentation Centre, Bonn. Pp. 33-98.

Zijp, W. (2002). *Changing the Way World Bank thinks about and supports Agricultural Extension.* Washington D.C.: World Bank.