International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 21, 2018, pp.-7468-7471.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

PRODUCTIVITY AND ECONOMICS OF CERTIFIED ORGANIC BABYCORN (*Zea mays* L.) AS INFLUENCED BY DIFFERENT FORM OF ORGANIC MANURE AND INTERCROPPING WITH PULSES

ABDUL WAHAB HEKMAT*[1], THOMAS ABRAHAM[1], AHMADULLAH JOYAN[2], MANOJ KUMAR[1] AND MOHAMMAD AMIN AHMADZAI[3]
[1]Department of Agronomy, Sam Higginbottom University of Agriculture, Technology & Sciences, Allahabad, 211 007, Uttar Pradesh, India
[2]Department of Animal Science, Faculty of Agriculture, Paktia University, Gardiz, Afghanistan
[3]Department of Soil Science, Northwest A&F Science, Xian, China
*Corresponding Author: Email - wahabhekmat@gmail.com

Received: June 03, 2018; Revised: November 11, 2018; Accepted: November 12, 2018; Published: November 15, 2018

Abstract: A field experiments were conducted during zaid seasons of 2014 and 2015 to study the influence of intercropping and organic nutrient management practices on growth, yield, quality, nutrient status of the soil and nutrient uptake of babycorn under certified organic production system. Short duration intercrops [greengram (*Vigna radiata L.*) and clusterbean (*Cyamopsis tetragonoloba L.*)] along with control (no intercrop) were taken in main plot. Different sources of organic manure and their combination [goat manure at the rate of 4.8 t ha^{-1} (M_1), poultry manure at the rate of 4.62 t ha^{-1} (M_2), FYM at the rate of 24 t ha^{-1} (M_3), goat manure + poultry manure (M_4), goat manure + FYM (M_5) and poultry manure + FYM (M_6)] were assigned to sub plot in a split plot design. The experiment was replicated thrice. Result of the experiment revealed that cob yield of babycorn was improved by a margin of 6.25 and 4.01 percent in association with clusterbean and greengram, respectively over sole babycorn. Besides, a bonus yield of 1106 and 757 kg ha^{-1} of clusterbean and greengram was obtained. Among the manurial treatments application of poultry manure at the rate of 4.62 t ha^{-1} increase cob yield by 13.55% as compared to FYM alone. Babycorn in intercropping with clusterbean and greengram increased benefit cost ratio by 63.07 and 54.61 per cent over sole crop. Application of goat manure and poultry manure increased net return and benefit cost ratio by 76.17 and 89.78 per cent and 32.82 and 32.06 per cent respectively over FYM. Among the manurial treatments, treatments M_2 obtained the highest benefit cost ratio (1.73, 1.72 and 1.73) during both the years and mean value of two years.

Keywords: FYM, Poultry manure, Goat manure, Intercropping, Productivity, Babycorn

Citation: Abdul Wahab Hekmat, *et al*., (2018) Productivity and Economics of Certified Organic Babycorn (*Zea mays* L.) as Influenced by Different Form of Organic Manure and Intercropping with Pulses. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 21, pp.- 7468-7471.

Introduction

Maize (*Zea mays L.*) is the third most important cereal crop next to rice and wheat in India and also a predominant cereal in global agricultural economy [1]. Maize occupied 8.67 million hectare with 21.60 m tons production at average production of 2492 kg ha^{-1} during 2012. The demand of maize in India is expected to touch 42 million tons by 2025 of which 20 to 21% will be used for human consumption, about 60% as poultry and livestock feed and remaining 12 to 13% for industrial raw material. In Uttar Pradesh maize is cultivated in an area of 0.71 million hectares and production is 1.04 million tons with productivity of 14 to 65 kg ha^{-1} [2]. India has traditionally been a livestock rearing country. Neglect of forage crops led to a decline in the productivity of livestock. According to the National Commission on Agriculture, the fodder requirement for the existing livestock in India is around 1136 million tonnes, whereas the availability is 695 million tonnes, indicating a 61% deficit in fodder supply [3]. By-products of babycorn such as tassel, young husk, silk and green stalks are good cattle feed. High quality of forage has been notified as an important aspect of forage crop production. Thus, legume-based composition is considered as a management strategy in producing both high quality and quantity forage. Legumes, which are good source of protein, intercropped with non-legumes compensate their protein shortage [4]. Intercropping of legumes with forage maize not only improves the nutritive value of fodder but also help in maintaining the soil fertility. This eventually helps in meeting the N needs of cereals partially. The cost of synthetic and inorganic inputs consistently face inflation, on the other hand, organic sources are safe and relatively cheaper with additional multifarious benefits [5]. Systematic study of intercropping systems with babycorn under certified organic production is lacking. Therefore, the present study aims to explore the possibility of growing babycorn as food and green fodder during the zaid season in an intercropping system with legumes, and to assess the means for better resource management with respect to land use efficiency and complementarities.

Materials and Methods

Field experiments were conducted during zaid seasons of 2014 and 2015 at Crop Research Farm, Block E of SHUATS Model Organic Farm (SMOF), Department of Agronomy, Allahabad School of Agriculture, SHUATS, Allahabad, Uttar Pradesh, India. The soil of the experimental area was sandy loam with moderately alkaline pH (7.60 and 7.40); low in organic carbon (0.37 and 0.39%) and available N (163.30 and 170.35 kg ha^{-1}), medium in available P (14.80 and 15.50 kg ha^{-1}) and high in available K (256.00 and 261.00 kg ha^{-1}) during zaid 2014 and 2015 seasons respectively. Babycorn hybrid (Golden baby), Greengram (SAMRAT) and Clusterbean (Pusa Nawbahar) varieties were chosen for the study. The experiments were laid out in split plot design with three replication on a plot size of 6.35 x 4.0m. In main plots, cropping systems (Sole babycorn, babycorn + greengram and babycorn + clusterbean) and in sub plots, different sources of organic manure and their combination with each other [goat manure at the rate of 4.80 t ha^{-1} (M_1), Poultry manure at the rate of 4.62 t ha^{-1} (M_2), FYM at the rate of 24 t ha^{-1} (M_3), goat manure + poultry manure (M_4), goat manure + FYM (M_5) and poultry manure + FYM (M_6)] were assigned. Before sowing, lines were formed in the field as per the spacing in treatments. Babycorn and component crop seeds were pre-treated with biofertilizers, sown in line and covered with the soil. Lines were formed in between two babycorn rows and intercrops were sown.

Table-1 Effect of intercropping and organic nutrient management on growth attributes of babycorn

Treatment	Growth attributes of babycorn at 50 DAS											
	Plant height (cm)			Number of leaves plant^{-1}			Leaf area (cm^2 plant^{-1})			Dry matter production (g plant^{-1})		
	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
Cropping system (C)												
C_1: Sole Babycorn	113.47	113.16	113.23	10.43	9.83	10.4	3332.46	3644.66	3488.56	110.6	118.85	114.72
C_2: Babycorn + Greengram (1:1, additive series)	114.84	114.66	114.75	10.75	9.76	10.65	3400.42	3740.53	3570.48	117.07	126.19	121.63
C_3: Babycorn + Clusterbean (1:1, additive series)	116.58	119.56	118.07	10.85	10.11	10.86	3503.93	3915.36	3709.65	118.88	130.8	124.84
SE(d) ±	2.152	1.4844	1.3654	0.2095	0.2056	0.1341	33.43	71.01	48.84	0.76	1.09	0.58
CD (P=0.05)	NS	4.1208	3.7904	NS	NS	0.3722	92.8	197.12	135.59	2.11	3.04	1.61
Manures (M)												
M_1: Goat Manure (4.80 t ha^{-1})	114.91	114.53	114.72	10.57	9.6	10.6	3457.13	3613.26	3535.2	116.22	125.49	120.86
M_2: Poultry Manure (4.62 t ha^{-1})	120.93	122.26	121.6	10.97	10.33	10.94	3628.26	4089.45	3858.86	118.59	131.76	125.18
M_3: Farm Yard Manure (24.00 t ha^{-1})	110.77	112.04	111.41	10.53	9.6	10.43	3254.75	3574.97	3414.86	114.04	121.74	117.89
M_4: Goat Manure (2.40 t ha^{-1}) + Poultry Manure (2.31 t ha^{-1})	114.08	114.62	114.35	10.53	9.93	10.56	3379.4	3719.57	3549.48	112.47	122.98	117.73
M_5: Goat Manure (2.40 t ha^{-1}) + FYM (12.00 t ha^{-1})	113.08	114.6	113.84	10.55	9.82	10.48	3363.62	3759.48	3561.55	114.24	121.78	118.01
M_6: Poultry Manure (2.31 t ha^{-1}) + FYM (12.00 t ha^{-1})	116.02	116.73	116.21	10.91	10.13	10.78	3390.46	3844.37	3617.42	117.53	127.93	122.73
SE(d) ±	2.9353	4.5287	2.2128	0.2312	0.3093	0.1288	89.3	148.81	103.74	1.27	1.22	1.96
CD (P=0.05)	5.9938	NS	4.5186	NS	NS	0.2631	182.35	303.87	211.84	2.59	2.51	1.97
Cropping System x Manures (C x M)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table-2 Effect of intercropping and organic nutrient management on cob yield and green fodder yield of babycorn

Treatment	Cob yield (t ha^{-1})			Green fodder yield (kg ha^{-1})		
	2014	**2015**	**Pooled**	**2014**	**2015**	**Pooled**
Cropping system (C)						
C_1: **Sole Babycorn**	1.74	1.85	**1.79**	20.1	20.36	**20.23**
C_2: **Babycorn + Greengram**	1.82	1.91	**1.87**	20.86	21.21	**21.04**
C_3: **Babycorn + Clusterbean**	1.88	1.93	**1.91**	21.96	22.17	**22.06**
SE(d) ±	28.14	51.98	30.29	0.461	0.388	0.331
CD (P=0.05)	78.11	NS	84.09	1.281	1.077	0.919
Manures (M)						
M_1: **Goat Manure (4.80 t ha^{-1})**	1.78	1.89	**1.84**	20.34	21.12	**20.73**
M_2: **Poultry Manure (4.62 t ha^{-1})**	1.97	2.02	**2**	23.79	22.82	**23.31**
M_3: **Farm Yard Manure (24.00 t ha^{-1})**	1.71	1.8	**1.76**	19.51	20.25	**19.88**
M_4: **Goat Manure (2.40 t ha^{-1}) + Poultry Manure (2.31 t ha^{-1})**	1.84	1.89	**1.86**	20.64	21.04	**20.84**
M_5: **Goat Manure (2.40 t ha^{-1}) + FYM (12.00 t ha^{-1})**	1.77	1.86	**1.81**	20.51	20.9	**20.71**
M_6: **Poultry Manure (2.31 t ha^{-1}) + FYM (12.00 t ha^{-1})**	1.81	1.94	**1.88**	21.04	21.34	**21.19**
SE(d) ±	42.17	64.81	43.46	0.761	0.959	0.704
CD (P=0.05)	86.12	132.35	88.76	1.562	NS	1.439
Cropping System x Manures (C x M)	NS	NS	NS	NS	NS	NS

Table-3 Economics of different treatment combinations of cropping systems and manurial application in babycorn, greengram and clusterbean during both the years and mean of two year

Treatment	Net return (₹ ha^{-1})			Benefit cost ratio (returns per rupee)		
	2014	2015	Mean	2014	2015	Mean
Cropping system (C)						
C_1: Sole Babycorn	13200.43	16544.29	14872.36	1.27	1.34	1.3
C_2: Babycorn + Greengram	50638.54	56012.15	53325.34	1.95	2.07	2.01
C_1: Babycorn + Clusterbean	62349.02	60438.95	61393.98	2.14	2.1	2.12
C_2: Sole Greengram	5690.42	5467.23	5578.831	1.16	1.16	1.16
C_1: Sole Clusterbean	11014.82	10026.82	10520.82	1.3	1.28	1.29
SE(d) ±	1588.66	1383.378	1414.125	0.037	0.028	0.031
CD (P=0.05)	3663.467	3190.076	3260.978	0.087	0.065	0.072
Manures (M)						
M_1: Goat Manure (4.80 t ha^{-1})	32400.5	34242.85	33321.67	1.72	1.76	1.74
M_2: Poultry Manure (4.62 t ha^{-1})	36190.82	35598.15	35894.49	1.73	1.72	1.73
M_3: Farm Yard Manure (24.00 t ha^{-1})	18193.95	19633.5	18913.73	1.3	1.32	1.31
M_4: Goat Manure (2.40 t ha^{-1}) + Poultry Manure (2.31 t ha^{-1})	32169.22	32377.34	32273.28	1.67	1.68	1.68
M_5: Goat Manure (2.40 t ha^{-1}) + FYM (12.00 t ha^{-1})	25644.99	27649.52	26647.25	1.48	1.52	1.5
M_6: Poultry Manure (2.31 t ha^{-1}) + FYM (12.00 t ha^{-1})	26872.39	28685.97	27779.18	1.49	1.53	1.51
SE(d) ±	30521.76	31300.94	30882.11	1.326	1.345	1.335
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Cropping System x Manures (C x M)	NS	NS	NS	NS	NS	NS

Babycorn, greengram and clusterbean seeds were hand dibbled. Organic manures were applied as per the treatment (on equal N basis) and incorporated in lines uniformly. All the agronomic practices were carried out uniformly to raise the crop. To record various growths and yield observations on babycorn and component crops a sample consisting of five plants were selected at random. Plant height of five randomly selected babycorn plants was recorded at and interval of 10 days and it was measured from the base of the plants to the tip of last fully emerged leaf, average value for each treatment was computed and

expressed in cm. Number of leaves per plant of babycorn and component crops were counted from five tagged plants in each plot and the mean value was calculated. Leaf area of babycorn was measured from the base to the tip, the leaf breadth was taken at the midst point of the leaf lamina, the product of the leaf length and breadth was multiplied by the factor 0.75 and the sum of all the leaves was expressed as leaf area in cm^2 plant. To determine the plant dry weight for babycorn and component crops five plants were randomly uprooted from sampling zone of each plot, the samples were air dried and then kept in oven for 72 hours at 70° C, dry weight per plant was then calculated and the average was expressed in g $plant^{-1}$.

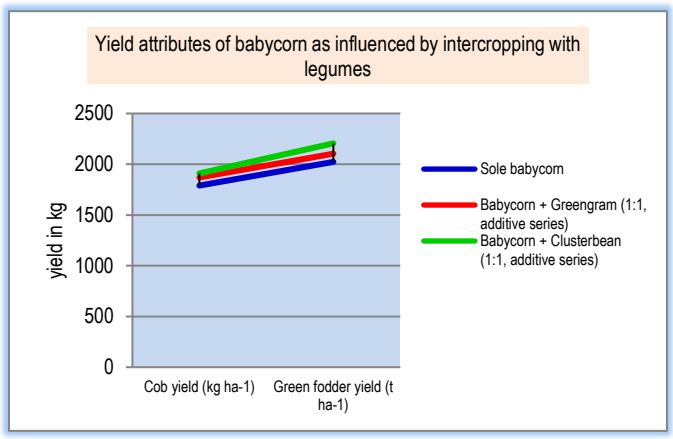

Fig-1 Effect of intercropping on cob yield and green fodder yield of babycorn

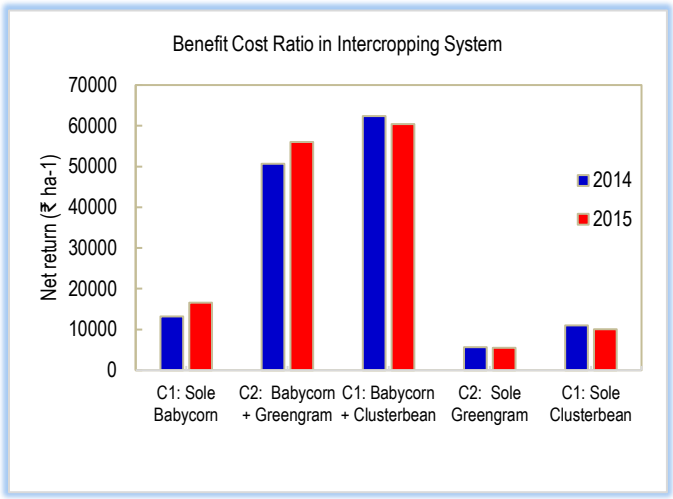

Fig-2 Illustrates the Benefit Cost Ratio in Intercropping System

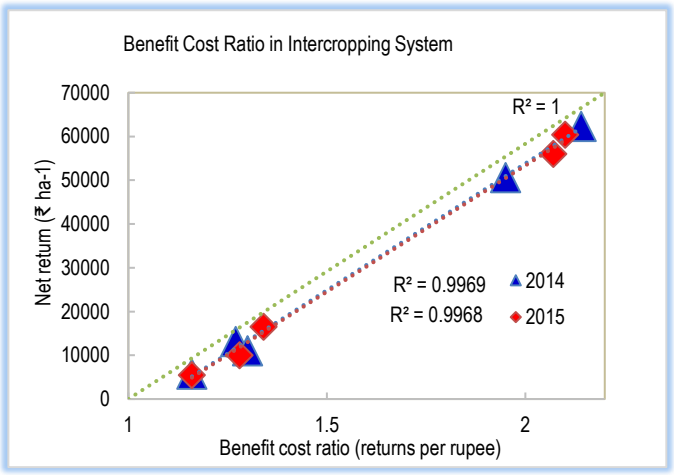

Fig-3 Demonstrates the correlations between Net Return (ha^{-1}) and Benefit Cost Ratio

Result and Discussion

Growth and Growth Attributes: The data can be recorded and analyzed for growth and growth attributes of babycorn [Table-1]. Among intercropping treatments, Babycorn + clusterbean registered maximum plant height (118.07 cm), number of leaves $plant^{-1}$ (10.86), leaf area (3709.65 cm^2) and dry matter production (124.86 g), followed by babycorn + greengram as compared to sole cropping of babycorn. Maximum growth parameters registered in intercropping as compared to monocropping might be due to the higher nitrogen contribution by legume component to cereal crop. Further, it might also be due to the faster and vigorous growth of babycorn which resulted in more efficient utilization of available resources. In addition, it could be attributed to better light utilization by crop canopy composed of plants with different foliage architecture [6]. In general, the maximum Plant height (121.60 cm), number of leaves per plant (10.94), leaf area (3858.86 cm^2) and dry matter accumulation (125.18 g) of babycorn were recorded in poultry manure amended plots as compared to goat manure and FYM. This increment might be due to quicker availability of nutrients from the poultry and goat manures. In addition, it might be due to the easily and faster decomposition rate and subsequent release of nutrients by the poultry manure into the soil and the fact that 40-60% of the organic nitrogen in poultry manure are normally mineralized during the crop growth period. These finding are in conformity with [7, 8, and 9].

Yield and Yield Attributes

The data on yield and yield attributes of babycorn were statistically analyzed and have been presented in [Table-2]. Yield attributes showed positive and significant response to babycorn intercropped with greengram and clusterbean in comparison to sole crop of babycorn. The positive effect of intercrops lead to increase in vigor and growth resulting in enhanced dry matter production of babycorn. In pooled analysis the significantly higher cob yield (1912 kg ha^{-1}) and (1872 kg ha^{-1}) was observed in treatment babycorn + cluster bean (1:1, additive series) and babycorn + greengram (1:1, additive series) as compared to sole babycorn (1799.49 kg ha^{-1}). Further, significantly higher green fodder yield (22.06 and 21.04 t ha-1), was recorded in treatments babycorn + cluster bean (1:1, additive series) and babycorn + greengram (1:1, additive series) as compared to sole babycorn (20.23 t ha^{-1}), which could be attributed for better growth parameters and ultimately dry weight per plant. The increase in yield attributes was also probably due to high nitrogen fixation by component crops and as a consequence, increases of N uptake of associated maize [10]. It might also be due to nitrogen fixing behavior of legume and higher canopy cover, thereby resulting in the reduced evapotranspiration and encouraging the babycorn to use the natural resources (water, nutrient, light) more efficiently [11]. These finding are in conformity with [12]. Significantly higher babycorn yield was observed in treatment with application of 4615 kg ha^{-1} poultry manure (23.79, 22.82 and 23.31 kg ha^{-1}) during both the years of investigation and pooled analysis. During both the years and pooled analysis the cob yields in babycorn increased by (15.12, 12.04 and 13.55) per cent as compared to FYM alone. Higher cob yield registered in poultry manure and goat manure treatments was might be due to higher mineralization potential of poultry manure enabling it to actively and quickly release of its nutrients for plant uptake and use [13].

Economics of Babycorn

Economic feasibility of the treatment combination used in the present study was assessed by computing the cost of cultivation, gross return, net return and benefit cost ratio [Table-3], during both the years and mean value of two years. Higher gross return, net return and benefit cost ratio registered in intercropping system as compared to sole cropping of babycorn and component crops. This might be due to the greater share in the combined yield. In addition, it might also be due to higher yield and comparably less expenditures under intercropping [14] and better utilization of resources from the common pool [15]. Result of the experiment also revealed that sole application of poultry manure, goat manure and their combination with each other and FYM gave higher net return and benefit cost ratio over rest of the manurial treatment. This might be due to the comparatively lower cost involved in production of crops and higher returns from the investments.

These findings are in agreement with [16].

Conclusion

From the results of the study during both the years, it may be concluded that, inclusion of legumes under certified organic production system, particularly clusterbean and greengram, enhances the yield (1912 and 1872 kg ha^{-1}) of babycorn as compared to sole cropping (1799 kg ha^{-1}). However, there was a marginal reduction (7.13 and 4.26%) in yield of greengram and clusterbean under intercropping with babycorn, which was compensated by additional yield of babycorn (112.5 and 72.25 kg ha^{-1}), intercropped with legume component crops (clusterbaen and greengram). In addition, intercropping of babycorn + greengram and babycorn + clusterbean in 1:1 additive series was found to be the most effective treatments under experimental conditions, for obtaining higher gross return (₹ 107040.65 and ₹ 117009.29 ha^{-1}), net return (₹ 53325.34 and ₹ 61393.98 ha^{-1}) and benefit cost ratio (2.01 and 2.12) over sole cropping. There was increase in yield of babycorn by 13.55% due to application of poultry manure at the rate of 4.62 t ha^{-1} as compared to FYM alone. However, application of goat manure and poultry manure increased net return and benefit cost ratio by 76.17 and 89.78 per cent and 32.82 and 32.06 per cent respectively over FYM.

Application of research: Intercropping of legumes with forage maize not only improves the nutritive value of fodder but also help in maintaining the soil fertility. This eventually helps in meeting the N needs of cereals partially. The cost of synthetic and inorganic inputs consistently face inflation, on the other hand, organic sources are safe and relatively cheaper with additional multifarious benefits.

Research Category: Organ manure, Intercropping system

Abbreviations:

%	:	Percentage
&	:	and
/	:	per
@	:	at the rate of
₹	:	Indian Rupees
M	:	Manures
C	:	Cropping system
CD	:	Critical Difference
cm	:	centimeters
cm2	:	centimeter square
et al.	:	Co-workers/ and other
FYM	:	Farm Yard Manure
g	:	gram
ha	:	Hectare
K	:	Potassium
kg	:	Kilogram
kg ha^{-1}	:	Kilogram per hectare
N	:	Nitrogen
P	:	Phosphorus
plant^{-1}	:	per plant
SEd	:	Standard Error of difference
SMOF	:	SHUATS Model Organic Farm
t ha^{-1}	:	tones per hectare
U.P.	:	Uttar Pradesh
GPB	:	Genetic and Plant Breeding

Acknowledgement / Funding: Author are thankful to Sam Higginbottom University of Agriculture, Technology & Sciences, Allahabad, 211 007, Uttar Pradesh, India

***Research Guide or Chairperson of research**: Prof Dr Thomas Abraham
University: Sam Higginbottom University of Agriculture, Technology & Sciences, Allahabad, 211 007, Uttar Pradesh

Research project name or number: PhD Thesis

Author Contributions: All authors equally contributed.

Author statement: All authors read, reviewed, agreed and approved the final manuscript

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

References

[1] Ullah A., Bhatti A., Gurmani Z.A. and Imran M. (2007) *Journal of Agricultural Science* 45(2): 113-117.
[2] GOI, New Delhi. (2013) *Annual Report 2012, Government of India, New Delhi pp.* 15.
[3] Banik P. and Sharma R.C. (2009) *Journal of Sustainable Agriculture* 33: 379-395.
[4] Hauggaard N., Ambus H. P. and Jensen E.S. (2001) *Plant Soil* 236: 63–74.
[5] Mbah C.N. and Onweremadu E.U. (2009) *Journal of Agronomy* 2(1): 7-12.
[6] Prasanthi K. and Venkateswaralu B. (2014) *Journal of Tropical Agriculture* 52(1): 86-89.
[7] Thavaprakaash N., Velayudham K and Muthukumar V.B. (2005) *Research Journal of Agricultural and Biological Sciences* 1(4): 295-302.
[8] Uwah D.F., Undie U.L. and John N.M. (2014) *Journal of Agriculture and Environmental Sciences* 3(2): 315-331.
[9] Abraham T. and Lal R.B. (2004) *Indian Journal of Dryland Agriculture, Research and Development* 19(1): 81-87.
[10] Latati M., Pansu M.B., Drevon J.J. and Ounane S.M. (2013) *International Journal of Research in Applied Sciences* 01: 1-7.
[11] Kumar K.T. and Venkateswarlu B. (2013) *Range Management and Agroforestry* 34(1): 137-141.
[12] Dhakal S. (2014) *International Journal of Novel Research in Life Sciences* 1(1): 1-7.
[13] Ogunbanjo O. R., Omueti J. A., Jajeoba I. O. J., Omolaiye J. A., Abiola I. O. and Uzokwe N. E. (2007) *International Journal of Agricultural Sciences, Sciences, Environment and Technology Series 'A'* 7(1): 87-98.
[14] Yadav A.K., Chand S. and Thenua O.V.S. (2016) *Global Journal of Bio-Science and Biotechnology* 5(1): 115-118.
[15] Saleem R., Ahmad Z.I., Anees M.A., Majeed A., Ali A. and Shah H. (2016) *Academia Journal of Biotechnology* 4(4):153-163.
[16] Bhathal S. and Kumar R. (2016) *International Journal in Management and Social Science* 4(5): 42-47.