Effect of integrated nutrient management on green forage, dry matter and crude protein yield of oat in oat-Lathyrus intercropping system

Article · October 2020

DOI: 10.22271/09746315.2020.v16.i2.1342

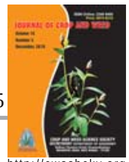
Saikat Biswas
Bidhan Chandra Krishi Viswavidyalaya

Kalyan Jana
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal-741252, IN…

Rajiv KUMAR Agrawal
Indian Grassland and Fodder Research Institute

Journal of Crop and Weed, 16(2): 233-238 (2020)

ISSN- O : 2349 9400 ; P : 0974 6315



http://cwssbckv.org
www.cropandweed.com

Effect of integrated nutrient management on green forage, dry matter and crude protein yield of oat in oat-*Lathyrus* intercropping system

S. BISWAS, K. JANA , [1]R. K. AGRAWAL AND A. M. PUSTE

Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya
Mohanpur-741252, Nadia, West Bengal
[1]ICAR-Indian Grassland and Fodder Research Institute
Division of Crop Production, Jhansi-284003, Uttar Pradesh

Received : 31.05.2019 ; Revised : 15.08.2020 ; Accepted : 20.08.2020

DOI : https/doi.org/10.22271/09746315.2020.v16.i2.1342

ABSTRACT

A field experiment was carried out at Central Research Farm, Gayeshpur, Bidhan Chandra KrishiViswavidyalaya, Nadia, West Bengal during Rabi season of 2015-16 and 2016-17 to find out the effect of integrated nutrient management on green forage, dry matter and crude protein yield of oat under various oat-lathyrus intercropping system. The experiment was laid out in split plot design with three (3) replications comprising 3 levels of cropping system (CS_1- sole oat, CS_2- intercropping of oat with lathyrus in 3:2 row ratio and CS_3- intercropping of oat with lathyrus in 3:3 row ratio) in the main plot and 4 levels of nutrient management (N_1 - Full RDF through inorganic source, N_2 - 75% N through urea + rest N through FYM, N_3 - 75% N through urea + rest N through vermicompost and N_4 -75% N through urea + rest N through mustard oilcake) in the sub plot. Pooled results explored that maximum green forage yield (118.04 q ha^{-1}), dry matter yield (24.69 q ha^{-1}) and crude protein yield (2.67 q ha^{-1}) of oat was obtained when 75% N through urea + rest N through vermicompost was applied. Oat performed best under 3:3 intercropping system due to the benefit of biological nitrogen fixation showing maximum green forage yield (116.09 q ha^{-1}), dry matter yield (25.24 q ha^{-1}) and crude protein yield (2.70 q ha^{-1}). Fodder yield of oat and its quality were found highest in combination of 3:3 intercropping system with 75% N through urea + rest N through vermicompost and thus can be recommended.

Keywords: Crude protein, dry matter, green forage yield, INM, intercropping and Oat

India is blessed with an enormous livestock population and ranks first among all the livestock holding countries with 15% of global livestock population accounting about 512 million (Verma *et al.*, 2016). Livestock productivity, being the backbone of our country, provides energy for agricultural operation, animal protein for the rural communities and generates employment opportunity for them (Raj and Vyakaranahal, 2014). This sector alone or with agriculture can boost up rural economy of the country. However, as compared to our livestock resource, its productivity is very low due to limited fodder production and its supply to meet the demand of our total livestock population. Presently, availability of green fodder is about 400 million tonnes with a deficit of 63.50 per cent and dry fodder supply is around 466 million tonnes as against the demand of 609 million tonnes (Verma *et al.*, 2016). As our population is ever increasing, arable land is mostly devoted for food crops and also due to less attention paid to this sector, production of sufficient quantity of nutritious fodder is limited (Raj and Vyakaranahal, 2014). Another reason for low fodder production is poor fertility status of soil (Iqbal *et al.*, 2009) which is due the consequence of continuous use of inorganic sources of nutrient. Integration of inorganic nutrient sources with organic sources can be the solution here as organic sources like farm yard manure (FYM), poultry manure (PM), green manure and compost *etc*. are environmentally safe and balanced form of nutrients to improvethe soil health (Chang *et al.*, 1991; Brady, 1996; Chung *et al.*, 2000; Keupper and Gegner, 2004).

Oat (*Avena sativa* L.) is an important winter growing, high yielding fodder crop, better suited to a variety of soil types, altitude, rainfall and waterlogged conditions compared to most of other cereals (Alemayehu, 1997) and requires bulk of fertilizers N for quality forage production (Singh and Dubey, 2007). Fodder yield of oat in terms of green forage and dry matter as well as the quality is a function of plant height, tiller number, and vegetative growth which are markedly influenced by nutrient application specially nitrogen (Vyas *et al.*, 1988). Intercropping with leguminous crop is always a good option to enhance productivity of cereal crop and also to cure poor soil health. Lathyrus (*Lathyrus sativus* L.) is one such leguminous crop which can fix biological nitrogen in their roots through symbiotic relationship with *Rhizobium leguminosaram* Frank. and thus, helps intercrop as well as succeeding crops to grow through replenishment of N depletion in the soil. Keeping all these facts in mind and for further confirmation, the following research was conducted to evaluate the impact of leguminous crop and integrated nutrient management

Email: kjanarrs@gmail.com

on green forage, dry matter and quality of oat fodder under different oat based cropping system.

MATERIALS AND METHODS

The field experiment was laid out at Central Research Farm, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal (23°N latitude, 89°E longitude and 9.75 m above mean sea level and medium land in topography) during last week of November of 2015-16 and 2016-17in a split plot design with three replications comprising 3 levels of cropping system (CS_1- Sole oat, CS_2 - Intercropping of oat with lathyrus in 3:2 row ratio andCS_3- Intercropping of oat with lathyrus in 3:3 row ratio) in the main plot and 4 levels of nutrient management (N_1 - Full RDF through inorganic source, N_2 - 75% N through urea + rest N through FYM, N_3 - 75% N through urea + rest N through vermicompost and N_4 -75% N through urea + rest N through mustard oilcake) in the sub plot. Recommended doses of fertilizers (RDF) were 80 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1}. The recommended doses of phosphorus and potassium remained same in all four nutrient management options. The soil was sandy loam in texture, neutral in reaction (pH 6.75), low in available N (196.5 kg ha^{-1}), high in available P (47.2 kg ha^{-1}), medium in available K (198.4 kg ha^{-1}) and organic carbon (0.51%).The variety used in the experiment was ‘OS-6’ for oat @ 100 kg ha^{-1}, 70 kg ha^{-1}, 57 kg ha^{-1}for 3 main plot treatments, respectively and ‘Ratan’ (Bio L 212) for lathyrus @15kg ha^{-1}and 20 kg ha^{-1}in 3:2 and 3:3 intercropping systems, respectively. Plot size was 4 ×3 m. Observations included green forage yield (GFY), dry matter yield (DMY) and crude protein yield (CPY) obtained by cutting oat at 60 days after sowing (DAS). The data collected from the field and also estimated after laboratory work were analysed through the analysis of variance method (Goulden, 1952 and Cochran and Cox, 1959) and treatment mean comparison was made according to least significant difference (LSD) at 5% level of significance.

RESULTS AND DISCUSSION

Effect of intercropping systems and INM on green forage yield (GFY) of oat

Pooled results of the experiment revealed that at 60 DAS green forage yield differed significantly with cropping systems. Highest green forage yield (GFY) (116.09 q ha^{-1}) was obtained from intercropping system of oat and lathyrus at 3:3 row ratios (CS_3) followed by 3:2 intercropping system of oat and lathyrus (CS_2) andsole oat (CS_1) (Table 1). This might be due to advantages of biological nitrogen fixation by legume crop (lathyrus) on cereal crop (oat).In intercropping system of oat and lathyrus at 3:3 row ratios (CS_3), oat got additional benefit of more biological nitrogen fixation by lathyrus as compared to sole oat (CS_1) where no biological nitrogen fixation occurred and 3:2 intercropping system (CS_2) where biological nitrogen fixation was comparatively less. The result was in agreement with the research outcomes of Tuna and Orak (2007) and Kokten and Tansi (1999).

On the other hand, at 60 DAS green forage yield also differed significantly with different levels of nutrient management. Highest green forage yield (118.04 q ha^{-1}) was obtained from 75% N through urea + rest N through vermicompost (N_3) followed by 75% N through urea + rest N through mustard oilcake (N_4), 75% N through urea + rest N through FYM (N_2) and full RDF through inorganic source (N_1) (Table 1). This might be because of integration of organic manure in the form of vermicompost with inorganic fertilizer which gave quick responses over other organic nutrient sources. Since vermicompost is an excellent base for establishment of beneficial free living and symbiotic microbes and improves nutrient availability specially nitrogen, green forage yield of oat was superior when vermicompost was applied in conjunction with inorganic fertilizers. Almost similar result was noticed by Godara *et al.* (2012) where they reported that instead of using organic or inorganic nutrient source alone, combined use of both specially using vermicompost better improved green forage yield of oat variety ‘Kent’.

Effect of intercropping systems and INM on dry matter yield (DMY) of oat

Experimental results (pooled of 2 years) showed that dry matter yield (DMY) at 60 DAS differed significantly with cropping systems. Highest dry matter yield (25.24 q ha^{-1}) was obtained from intercropping system of oat and lathyrus at 3:3 row ratios (CS_3) followed by 3:2 intercropping system of oat and lathyrus (CS_2) and sole oat (CS_1) (Table 1). More biological nitrogen fixation from more lathyrus plant population in 3: 3 intercropping system (CS_3) might be the reason behind this superior result as compared to 3:2 intercropping system (CS_2) where too biological nitrogen fixation occurred but at lower extent due to less plant population of lathyrus. Lowest dry matter yield was obtained from sole oat (CS_1) as there was no advantage of biological nitrogen fixation due to absence of legume crop lathyrus. Rahetlah *et al.* (2010) also found similar type of result in oat-vetch intercropping system.

Different levels of nutrient management also significantly influenced dry matter yield of oat. Pooled results stated that highest dry matter yield (24.69 q ha^{-1}) was recorded from75% N through urea + rest N through

Table 1: Effect of oat-lathyrus intercropping systems and integrated nutrient management on green forage yield (GFY), dry matter yield (DMY) and crude protein yield (CPY) of oat (Pooled)

Treatment	Green forage yield (q ha^{-1})	Dry matter yield (q ha^{-1})	Crude protein yield (q ha^{-1})
Levels of cropping system (CS)			
CS_1	104.6	20.9	2.07
CS_2	107.4	22.4	2.24
CS_3	116.1	25.2	2.70
SEm (±)	0.22	0.3	0.02
LSD (0.05)	0.88	1.15	0.07
Levels of nutrient management (N)			
N_1	102.8	21.5	2.08
N_2	107.4	22.4	2.15
N_3	118.1	24.7	2.67
N_4	109.2	22.8	2.45
SEm (±)	**0.28**	**0.36**	**0.03**
LSD (0.05)	**0.85**	**1.09**	**0.10**

Table 2: Interaction effect of oat based intercropping systems and integrated nutrient management on dry matter yield (DMY) of oat (q ha^{-1}) (Pooled)

Cropping systems	Levels of nutrient management (N)				Mean
	N_1	N_2	N_3	N_4	
CS_1	19.21	20.95	21.95	21.61	**20.93**
CS_2	21.28	22.24	23.36	22.55	**22.36**
CS_3	23.94	24.06	28.76	24.19	**25.24**
Mean	**21.48**	**22.42**	**24.69**	**22.78**	
	CS × N	**N × CS**			
SEm (±)		**0.64**		**0.62**	
LSD (0.05)		**1.89**		**1.98**	

Table 3: Interaction effect of oat based intercropping systems and integrated nutrient management on crude protein yield (CPY) of oat (q ha^{-1}) (Pooled)

Cropping systems	Levels of nutrient management (N)				Mean
	N_1	N_2	N_3	N_4	
CS_1	1.75	1.89	2.35	2.29	**2.07**
CS_2	1.98	2.09	2.69	2.21	**2.24**
CS_3	2.51	2.48	2.97	2.85	**2.70**
Mean	**2.08**	**2.15**	**2.67**	**2.45**	
		CS × N		**N × CS**	
SEm (±)		**0.06**		**0.06**	
LSD (0.05)		**0.18**		**0.17**	

vermicompost (N_3) followed by 75% N through urea + rest N through mustard oilcake (N_4), 75% N through urea + rest N through FYM (N_2) and full RDF through inorganic source (N_1). Dry matter yieldof oat under full RDF through inorganic source (N_1) was statistically at par with dry matter yield of oat under 75% N through urea + rest N through FYM (N_2) whereas dry matter yield of oat under 75% N through urea + rest N through FYM (N_2) was statistically at par with dry matter yield of oat under 75% N through urea + rest N through mustard oilcake (N_4) (Table 1). Benefits of incorporation of organic sources of nitrogen especially vermicompost

Table 4: Interaction effect of oat based intercropping systems and integrated nutrient management on green forage yield (GFY) of oat (q ha^{-1}) (Pooled)

Cropping systems	Levels of nutrient management (N)				Mean
	N_1	N_2	N_3	N_4	
CS_1	98.06	102.23	113.37	104.73	104.60
CS_2	101.47	104.07	117.07	106.90	107.37
CS_3	108.84	115.77	123.87	116.10	116.14
Mean	**102.79**	**107.36**	**118.10**	**109.24**	
		CS × N		**N × CS**	
SEm (±)		**0.44**		**0.48**	
LSD (0.05)		**1.58**		**1.54**	

with inorganic sources in oat was confirmed by Jayanthi *et al*. (2002). Devi *et al.* (2011) also observed the beneficial effect of integrating vermicompost in nutrient management option on dry matter of wheat. Kumar and Shivadhar (2006) from Jhansi got almost similar type of result in single cut oat under irrigated condition where they found that 50% RDF + 5t ha^{-1} vermicompost was statistically at par with 100% RDF in terms of dry matter yield and use of 50% RDF + 5t ha^{-1} vermicompost + 5t ha^{-1}FYM gave superior result over full inorganic nutrient sources.

Effect of intercropping systems and INM on crude protein yield (CPY) of oat

At 60 DAS crude protein yield (CPY) differed significantly with cropping systems. Highest crude protein yield (2.70q ha^{-1}) was observed in intercropping system of oat and lathyrus at 3:3 row ratios (CS_3) followed by 3:2 intercropping system of oat and lathyrus (CS_2) and sole oat (CS_1) (Table 1). CPY of oat was lowest in sole oat cropping system (CS_1) due to absence of legume crop lathyrus to undergo biological nitrogen fixation. Haq *et al.* (2018) similarly reported that crude protein yield was influenced positively by various cereal-legume intercropping system due to effect of biological nitrogen fixation.

Among different levels of nutrient management, crude protein yield also differed significantly. Pooled results showed that highest crude protein yield (2.67 q ha^{-1}) was obtainedfrom75% N through urea + rest N through vermicompost (N_3) followed by 75% N through urea + rest N through mustard oilcake (N_4), 75% N through urea + rest N through FYM (N_2) and full RDF through inorganic source (N_1) (Table 1). Crude protein yield of oat under full RDF through inorganic source (N_1) was statistically at par with crude protein yield of oat under 75% N through urea + rest N through FYM (N_2). Though Crude protein percentage is always higher in general when full inorganic nutrition is done, in this experiment crude protein yield was found highest when vermicompost was applied with inorganic fertilizers and it might be because of the fact that dry matter yield of oat was improved significantly due to beneficial effect of vermicompost. The results were in conformity with research findings of Khan *et al.* (2013) in oat crop.

Interaction effect on dry matter yield of oat

Interaction between cropping systems and different levels of nutrient management had significant influence on dry matter yield of oat at 60 DAS. It was found that when 75% N through urea + rest N through vermicompost (N_3) was applied in the intercropping system of oat and lathyrus at 3:3 row ratios (CS_3), maximum dry matter yield (28.76q ha^{-1}) was recorded (Table 2). It might be due to beneficial influence of vermicompost on supplying adequate nutrients to the crop throughout the growth period (Arya and Niranjan, 1994; Dass*et al*., 2008) and also its role in improving soil biological activity and thus enhancing the biological nitrogen fixation (BNF) capacity of legume crop lathyrus. Besides, greater sown proportion of lathyrus in that system fixed more quantity nitrogen biologically. On the other hand, use of full RDF through inorganic source (N_1) in sole oat (CS_1) exhibited lowest dry matter yield (19.21 q ha^{-1}) among all the combinations due to not getting any benefit of vermicompost and biological nitrogen fixation. Similar result was also reported by Singh *et al.* (2014) in sorghum-phillipesara intercropping system.

Interaction effect on crude protein yield of oat

Interaction effect between cropping systems and different levels of nutrient management on crude protein yield of oat at 60 DAS was found statistically significant. Table 3 revealed that intercropping system of oat and lathyrus at 3:3 row ratios (CS_3) when applied with 75% N through urea + rest N through vermicompost (N_3) recorded highest crude protein yield (2.97 q ha^{-1}). Since crude protein yield was the function of dry matter and crude protein content, increased crude protein yield might be due to biological nitrogen fixation capacity of more lathyrus population and also release of nitrogen from integrated source of nutrients specially using vermicompost which helped in better uptake of nitrogen from soil resulting in its deposition in plant as crude protein. This result was closely in agreement with findings of Gill *et al.* (1988) and Pereira *et al.* (1989). Among different combinations, sole oat (CS_1) under the use of full RDF through inorganic source (N_1) was the weakest in recording crude protein yield of oat (1.75 q ha^{-1}).

Interaction effect on green forage yield of oat

Pooled results of two years as represented in the table 4 depicted significant effect of interaction between cropping systems and different levels of nutrient management on green forage yield of oat obtained through cutting at 60 DAS. Application of 75% N through urea + rest N through vermicompost (N_3) in intercropping system of oat and lathyrus at 3:3 row ratios (CS_3) ensured highest green forage yield of oat (123.87 q ha^{-1}). Combined application of inorganic and organic sources of nitrogen specially use of vermicompost in INM option positively influenced the crop nutrient uptake which reflected in attaining green biomass of oat. Further, biological nitrogen fixation through leguminous inter crop lathyrus particularly in CS_3 helped oat to flourish and attain vigorous growth. Amin (2011) reported influence of nitrogen from various sources on yield and quality of forage maize. Sole oat (CS_1), on the other hand, under application of full RDF through inorganic source (N_1) exhibited lowest green forage yield (98.06 q ha^{-1}) at 60 DAS.

Oat as fodder crop during *rabi* season in new alluvial zone of West Bengal even in India is gaining importance day by day due to its high green forage potential. Since green forage is one of the most appreciated livestock feed and its quality is a very vital factor for attaining high livestock productivity, nutritious green forage production of oat is the focus of the time. From this experiment based on the pooled results of two years it may be concluded that 75% inorganic N and 25% N from organic source *i.e.*vermicompost can be recommended for application under 3:3 intercropping system of oat-lathyrus with the benefit of biological nitrogen fixation in order to achieve maximum green forage yield, dry matter yield of oat along with its nutritive value in terms of crude protein yield.

REFERENCES

Alemayehu, M. 1997. Conservation waste forage development for Ethiopia. Institute for Sustainable Development. Addis Ababa Ethiopia, pp. 57-60.

Amin, M.E.H. 2011. Effect of different nitrogen sources on growth, yield and quality of fodder maize (*Zea mays* L.). *J. Saudi Soc. Agril. Sci.*, **10**:17-23.

Arya, R.L. and Niranjan, K.P. 1994. Effect of organic and inorganic sources of nitrogen in intercropping systems. *Indian J. Dryland Agril Res. Dev.*, **9**: 17-22.

Brady, N.C. 1996. *Nature and Properties of Soil*, 10th Ed. Printice Hall India Pvt. Ltd., New Delhi, pp. 291.

Chang, C., Sommerfeldt, T.G. and Entz, T.1991. Soil Chemistry after eleven annual application of cattle feed lot manure. *J. Environ. Quality*, **20**: 475-480.

Chung, R., Wang, C. H., Wang, Y., Wang, R.S., Wang, C.W. and Wang, Y.T. 2000. Influence of organic matterand inorganic fertilizer on the growthand nitrogen accumulation of cornplants. *Taiwan J. Plant Nutr.*, **23**(3):297-311.

Cochran, W.G. and Cox, G. M. 1959. Experimental Designs. Asia Publishing House, Bombay.

Dass, A., Lenka, N. K., Sudhishri, S. and Patnaik, U.S. 2008. Integrated nutrient management for production, economics and soil improvement in winter vegetables. *Int. J. Veg. Sci.*,**14**:104-120.

Devi, K.N., Singh, M.S., Singh, N.G. and Athokpam, H.S. 2011.Effect of integrated nutrient management on growth and yield of wheat (*Triticum aestivum* L.). *J. Crop and Weed*, **7(2)**:23-27.

Gill, A.S., Abichandani, C.T., Maurya, P. K. and Mannikan, N.D. 1988. Nitrogen fertilization in fodder sorghum. *Indian J. Agril. Res.*, **22**:171.

Godara, A.S., Gupta, U.S. and Singh, R., 2012. Effect of integrated nutrient management on herbage, dry fodder yield and quality of oat (*Avena sativa* L.). *Forage Res.*, **38**(1): 59-61.

Goulden, C.H. 1952. Methods of Statistical Analysis. John Wiley and sons Inc., New York.

Haq, S.A., Korieng, J. Shiekh, T.A., Bahar, F.A., Dar, K.A., Raja, W., Wani, R.A. and Khuroo, N.S. 2018. Yield and quality of winter cereal-legume fodder mixtures and their pure stand under temperate conditions of Kashmir valley, India. *International J. Curr. Microbiol. Appl. Sci.*,**7**(2): 3626-3631.

Iqbal, M.F., Sufyan, M.A., Aziz, M.M., Zahid, I.A., Qamir-ul-Ghani and Aslam, S. 2009.Efficacy of nitrogen on green fodder yield and quality of oat (*Avena sativa* L.). *J. Animal Plant Sci.*,**19**(2): 82-84.

Jayanthi, C., Malarvizhi, P., Fazullah Khan, A.K. and Chinnusamy, C. 2002. Integrated nutrient management in forage oat (*Avena sativa*). *Indian J. Agron.*, **47**:130-133.

Khan, S., Khan, B. D., Rehman, A. and Ilyas, 2013. Enhancing nutritive value and green fodder production of fodder oat through integrated use of organic and inorganic fertilizers. *Asian J. Agri. Biol.*,**1**(4):175-178.

Kokten, K. and Tansi, V. 1999. Possibilities of growing chickling mixtures with different cereals species under Cukurova conditions.3rd Field Crops Congress, Adana, Turkey.15-18 November. pp. 75-79.

Kuepper, G. and Gegner, L. 2004. Organic crop production overview. ATTRA of National Centre for Appropriate Technology. Arkansa. www. attra. ncat.org.

Kumar, S. and Shivadhar 2006. Influence of organic and inorganic sources of nutrients on forage productivity and economics of oat (*Avena sativa* L.). *Ann. Agril. Res.*, **27**:205-209.

Raj, M.S.P. and Vyakaranahal, B.S. 2014. Effect of integrated nutrient and micronutrients treatment onplant growth parameters in oat cultivar (*Avena sativa* L.). *Int. J. Plant Sci.,* **9**(2): 397-400.

Pereira, J.C., Obeid, J.A. and Barbosa, P. D. 1989. Effect of spacing and nitrogen fertilizer on yield and crude protein content of forage sorghum. *Ravistada Sociedade Brasileria Zootecina*,**18**:468-472.

Rahetlah, V.B., Randrianaivoarivony, J.M., Razafimpamoa, L.H. and Ramalanjaona, V.L. 2010. Effects of sedling rates on forage yield and quality of oat (*Avena sativa* L.) vetch (*Vicia sativa* L.) mixtures under irrigated conditions of Madagascar. *African J. Food Agric. Nutr. Dev.*,**10**(10) : 4254-4267.

Singh, S. D. and Dubey, S. N.2007.Soil properties and yield of fodder oat (*Avena sativa* L.) as influenced by sources of nutrient and cutting management. *Forage Res.*,**33**(2):101-103.

Singh, S., Kewalanand, Chandra, R. and Dass, A. 2014. Effect of integrated nutrient sources on fodder yield and quality of sweet sorghum [*Sorghum bicolor* (L.) Moench.] and phillipesara (*Phaseolus trilobus*) intercropping system. *Ann. Agric. Res.*, **35**(2): 193-199.

Tuna, C. and Orak, A. 2007. The role of intercropping on yield potential of common vetch (*Vicia sativa* L.) /oat (*Avena sativa* L.) cultivated in pure stand and mixtures. *J. Agril. Biol. Sci.*,**2**(2):14-19.

Verma, C., Thanki, J.D., Singh, D. and Chaudhari, S.N. 2016. Effect of nitrogen, bio-fertilizer and farm yard manure on yield and nutrient uptake in oat (*Avena sativa* L.). *Bioscan*,**11**(1):499-501.

Vyas, M. N., Ahlawat, J. S., Patel, Dadha N.M. and Malavia, D.D. 1988. Response of forage oats to varying levels of nitrogen and phosphorus. *Indian J. Agron*., **33**(2): 204-205.