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RESEARCH ARTICLE Agricultural Science Digest

Effect of Nutrient Management on the Land Equivalent Ratio, Yield of Various Quality Parameters, Economics of Oats and Chinese Cabbage in Intercropping

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10.18805/AG.D-5720

ABSTRACT

Background: Proximate analysis of fodder crop helps us to design a balanced ration for the livestock. Oat is major fodder crop in North India during the *Rabi* season. Chinese cabbage can be a potential fodder crop for increasing the quantity as well as nutrient content of the available fodder during the season. The present study was conducted at NDRI research farm for assessing the yield, economics as well as the proximate analysis content advantage in oats and Chinese cabbage intercropping.

Methods: A field trial was conducted during rabi season, 2020 at research farm of NDRI, Karnal. It consisted of seven treatments (Oats sole + RDF, Chinese Cabbage sole + RDF, Oats + Chinese Cabbage (1:1) + RDF, Oats + Chinese Cabbage (2:1) + RDF, Oats + Chinese Cabbage (1:2) + RDF, Oats + Chinese Cabbage (2:1) + 75% RDF+ FYM+ PGPR, Oats + Chinese Cabbage (1:2) + 75% RDF + FYM+ PGPR).

Result: LER of intercropping was observed highest in the "Oats + Chinese Cabbage (2:1) + 75% RDF+ FYM+ PGPR" which was significantly higher than the other treatments. Yield of various quality parameters like crude protein, ether extract, NDF, ADF and hemicellulose for oats and Chinese cabbage solely were obtained in their sole treatment (Sole Oats+ RDF, Sole Chinese cabbage +RDF respectively) but the total yield of CP was recorded highest in the Oats + Chinese Cabbage (1:2) + 75% RDF+ FYM+ PGPR" and the total yield of remaining quality parameters were reported maximum in the "Oats + Chinese Cabbage (2:1) + 75% RDF+ FYM+ PGPR." Gross returns (` 72022/ha), net returns (` 50593/ha) were again reported maximum in the "Oats + Chinese Cabbage (2:1) + 75% RDF+ FYM+ PGPR."

Key words: Chinese cabbage economic, Intercropping, LER, Oats, Proximate analysis,

Abbrevation: PGPR: Plant growth promoting rhizobacteria, RDF: Recommended dose of fertilizers, CC: Chinese cabbage, B:C: Benefit cost ratio, LER: Land equivalent ratio, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, EE: Ether extract.

INTRODUCTION

Agriculture contributes about 16.38 per cent of GDP in the Indian economy. Over explosion of population requires a sharp increase in production of food as well as fodder for enhancing livestock production. Livestock provides an undeniable aspect to the nutritional security of the nation. The quality of feed and fodder to the livestock plays an important role for increasing the production of livestock. Feeding cost accounts for up to 70 per cent of the production cost in the livestock. (Alqauisi *et al.,* 2014). So, it becomes imperative to enhance the quantity as well as quality of fodder production but not at the brink of increasing costs. Presently, India possesses a livestock population of 538.8 million. Country has a cattle count of 192.49 million and buffalo count of 109.85 million. (Anonymous, 2013). A remarkable feature of quality parameter analysis of forage is that it helps us to design a balanced ration for the animal as per requirement, thus enhancing feed efficiency and reducing feeding cost. Intercropping is widely considered to be an important aspect in agronomy to increase the production, improving the health of soil and increasing the profitability of production. Oat (*Avena sativa* L.) is an important annual rabi crop in Northern India which is grown for the fodder as well as porridge purpose. Oats are more palatable than wheat and the amount of the green fodder obtained is more than double compared to wheat. On an average, it contains 8-12 per cent, Crude Protein, 70-75 per cent TDN (Anonymous, 2012). Chinese cabbage as fodder is attracting widespread attention among farmers due to higher production, lesser labour requirement and early sowing. Also, it has smoother nature of leaves than mustard which enhances palatability to livestock. This paper is a preliminary attempt to assess the fodder quality analysis as

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How to cite this article: Glotra, A., Singh, M., Kumar, S., Jat, S.L. and Kumar, S. (2023). Effect of Nutrient Management on the Land Equivalent Ratio, Yield of Various Quality Parameters, Economics of Oats and Chinese Cabbage in Intercropping. Agricultural Science Digest. doi:10.18805/ag.D-5720.

Submitted: 22-12-2022 **Accepted:** 30-06-2023 **Online:** 01-08-2023

well as profitability of oats and Chinese cabbage intercropping.

MATERIALS AND METHODS

The experiment was conducted at Agronomy research farm, National Dairy Research Institute, Karnal located at 29°45′ N, 76°58′ E and at an altitude of 245 m above Mean Sea Level (MSL) in the northern zone of Haryana. Experiment was laid out in the completely randomized block desigh (CRBD) consisting of seven treatments (Oats sole + RDF, Chinese Cabbage sole + RDF, Oats + Chinese Cabbage (1:1) + RDF, Oats + Chinese Cabbage (2:1) + RDF, Oats + Chinese Cabbage (1:2) + RDF, Oats + Chinese Cabbage (2:1) + 75% RDF + FYM+ PGPR, Oats + Chinese Cabbage (1:2) + 75% RDF + FYM+ PGPR) and replicated thrice. Fertilizers were applied according to the Chinese cabbage requirement in intercropping treatment. LER of the intercropping was calculated by the formula given as

$$LER = Lo+Lc = \frac{Y_o}{S_o} + \frac{Y_c}{S_c}$$

Where

Lo= LER of oat crop.

Lc= LER of chinese cabbage.

Yo and Yc= Yield of individual oat and chinese cabbage crops in different treatments.

Sa and Sb= Yield of individual oat and chinese cabbage in pure strands. (T1 and T2).

The quality parameters of the fodder were analysed by the Proximate analysis (Henneberg and Stohmann, 1860) and the Van Soest analysis (Van Soest *et al*., 1991). The proximate analysis included the estimation of the dry matter, crude protein, ether extract, crude fiber, organic matter and the mineral matter while the Van Soest analysis included the estimation of cellulose, hemicellulose and lignin. Yield of the various quality parameters were calculated by multiplying the relative percent of the constituent with the dry fodder yield of the respective crops.

RESULTS AND DISCUSSION

Dry fodder yield (q/ha)

Dry fodder yield of the oats was highest in the treatment (Sole oats + RDF) that was significantly higher than the other treatments. Similar results were observed by Mandal *et al*., (1991) in which he confirmed that the Leaf Area Index (LAI) and dry matter accumulation in sole wheat was significantly higher than the wheat + mustard intercropping in 4:2 ratio. Similarly, the highest dry matter yield of Chinese cabbage crop was reported highest in Sole CC + RDF which was significantly higher than the other treatments. Total highest dry matter yield was obtained in the treatment “Oats + CC (2:1) +75% RDF + FYM + PGPR”. Fig 1 indicates the total dry matter production of oats and Chinese cabbage.

Land equivalent ratio (LER)

LER represented in Table 1 indicates the effect of nutrient management and intercropping on LER and thus the profitability of intercropping. Maximum land equivalent for oats and Chinese cabbage (1.00) were reported in their sole treatment *i.e*., Sole Oats and Sole CC respectively. Treatment T6 (Oats + CC (2:1) +75% RDF + FYM + PGPR) had highest LER (1.17) which was significantly higher than all other treatments. Lowest LER was reported in the Oats + CC (1:1) + RDF with 0.95. An increase in the LER due to intercropping was found in all treatments except in the T3 (Oats + CC (1:1) + RDF) in which the LER was recorded least (0.95).

Yield of fodder quality parameter

Crude protein yield (q/ha)

From the Table 2, it can be concluded that there was significant effect of the treatments on the crude protein yield.

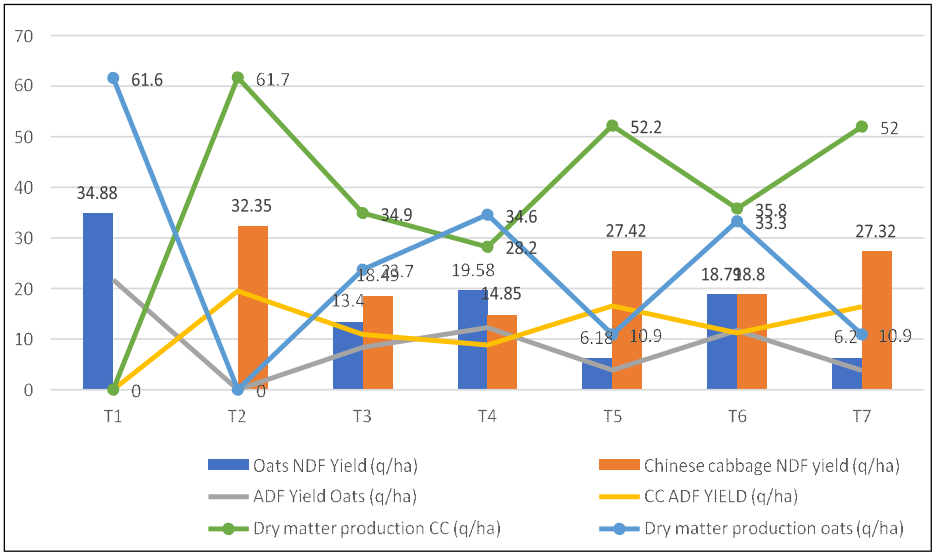

Fig 1: Dry matter and yield of quality parameters of oats and chinese cabbage in intercropping.

Highest crude protein yield (5.04 q/ha) was found in the Sole oats + RDF for oats crop which was significantly higher than any other treatment. Highest crude protein yield of Chinese cabbage was reported in its sole treatment *i.e.*, Sole CC +RDF and was equal to the 7.48 q/ha and was significantly higher than all other treatments. Total highest crude protein yield (7.17 q/ha) was recorded in the "Oats + CC (1:2) +75% RDF+ FYM + PGPR".

Ether extract yield (q/ha)

Ether extract yield of both the crops in different treatments are represented in Table 2. It illustrates that there was significant effect on the ether extract yield of oats and Chinese cabbage due to the intercropping as well as nutrient management. Highest ether extract yield in oats was obtained in "Sole oats + RDF" which was equal to 1.52 q/ha, significantly higher than the other treatments. Highest ether extract yield of chinese cabbage was reported in the "Sole CC + RDF (1.55 q/ha)", which was significantly higher than the other treatments. Highest total ether extract of both the crops was obtained in intercropping ratio of 2:1 with the use of PGPR *i.e.*, in "Oats +CC (2:1) + 75%RDF + FYM + PGPR."

Neutral detergent fiber yield (q/ha)

Neutral Detergent Fiber yield of both the crops in different treatments are represented in Table 2. It is interesting to note that the highest NDF yield of oats was reported in its sole treatment *i.e.*, Sole oats + RDF (34.88 q/ha) and the highest yield of NDF for Chinese cabbage was obtained in the Sole CC treatment due to higher population of these two crops in these two treatments respectively. Highest total NDF of both the crops combined together was reported in intercropping ratio of 2:1 with the use of PGPR *i.e.*, "Oats +CC (2:1) + 75% RDF + FYM + PGPR." And was equal to37.59 q/ha. Similarly, Fig 1 indicates the total Neutral detergent fiber yield (q/ha) of oats and Chinese cabbage.

Acid detergent fiber yield (q/ha)

Acid detergent fiber yield of both the crops in different treatments are represented in Table 2. It is apparent from

Table 1: Effect of nutrient management on the land equivalent ratio of oats and Chinese cabbage in Intercropping.

Treatment	Land equivalent of oat (L_o)	Land equivalent of chinese cabbage (L_c)	LER
T_1 (Sole Oats + RDF)	1.00		1.00
T_2 (Sole CC + RDF)		1.00	1.00
T_3 (Oats + CC (1:1) + RDF)	0.38	0.57	0.95
T_4 (Oats + CC (2:1) + RDF)	0.55	0.45	1.00
T_5 (Oats + CC (1:2) + RDF)	0.18	0.95	1.13
T_6 (Oats + CC (2:1) +75% RDF + FYM + PGPR)	0.54	0.63	1.17
T_7 (Oats + CC (1:2) +75% RDF + FYM + PGPR)	0.17	0.85	1.02
SE_m	0.003	0.009	0.01
CD(P=0.05)	0.01	0.03	0.03

Table 2: Effect of nutrient management on the yield of crude protein, ether extract, NDF and ADF of the oats and Chinese cabbage in intercroppoing.

	Dry fodder yield (q/ha)		Crude protein yield (q/ha)		Ether extract yield (q/ha)		NDF yield (q/ha)		ADF yield (q/ha)	
	Oats	Chinese cabbage	Oats	Chinese cabbage	Oats	Chinese cabbage	Oats	Chinese cabbage	Oat	Chinese cabbage
Sole Oats + RDF	61.6		5.04		1.52		34.88		21.73	
Sole CC + RDF		61.7		7.48		1.55		32.35		19.50
Oats + CC (1:1) + RDF	23.7	34.9	1.92	4.22	0.57	0.86	13.40	18.49	8.37	10.93
Oats + CC (2:1) + RDF	34.6	28.2	2.81	3.38	0.93	0.70	19.58	14.85	12.26	8.84
Oats + CC (1:2) + RDF	10.9	52.2	0.90	6.32	0.27	1.36	6.18	27.42	3.85	16.57
Oats + CC (2:1) +75% RDF + FYM + PGPR	33.3	35.8	2.68	4.26	0.80	0.90	18.79	18.80	11.70	11.20
Oats + CC (1:2) +75% RDF + FYM + PGPR	10.9	52.0	0.87	6.30	0.27	1.28	6.20	27.32	3.81	16.41
SEm±	0.29	0.81	0.02	0.09	0.02	0.04	0.23	0.39	0.12	0.29
CD (P=0.05)	0.9	0.3	0.06	0.30	0.06	0.11	0.73	1.22	0.36	0.92

Table 3: Effect of nutrient management on hemicellulose and ash yield of the oats and chinese cabbage in intercropping.

Treatment	Hemicellulose yield (q/ha)		Ash yield (q/ha)	
	Oat	Chinese cabbage	Oats	Chinese cabbage
Sole Oats + RDF	13.15		6.29	
Sole CC + RDF		12.85		4.99
Oats + CC (1:1) + RDF	5.02	7.55	2.41	2.82
Oats + CC (2:1) + RDF	7.32	5.93	3.54	2.28
Oats + CC (1:2) + RDF	2.35	10.85	1.11	4.24
Oats + CC (2:1) + 75% RDF + FYM + PGPR	7.09	7.60	3.38	2.90
Oats + CC (1:2) + 75% RDF + FYM + PGPR	2.36	10.91	1.11	4.22
SEm±	0.15	0.25	0.036	0.06
CD(P=0.05)	0.46	0.77	0.11	0.19

Table 4. Economics of different treatments.

Treatments	Cost of cultivation (`/ha)	Gross returns (`/ha)	Net returns (`/ha)	B:C ratio
Sole Oats + RDF	22166.47	56050.17	33880.53	1.53
Sole CC + RDF	19158.87	68526.57	49363.27	2.57
Oats + CC (1:1) + RDF	21312.00	60534.33	39221.33	1.84
Oats + CC (2:1) + RDF	21663.80	70843.33	49179.90	2.27
Oats + CC (1:2) + RDF	20928.00	69094.00	48165.9	2.30
Oats + CC (2:1) +75% RDF + FYM + PGPR	21428.18	72022.00	50593.81	2.36
Oats + CC (1:2) +75% RDF + FYM + PGPR	20778.61	68665.2	42130.8	2.01

the table that the highest ADF yield in the case of oat crop was obtained in the case of sole oats treatment *i.e*., Sole Oats + RDF (21.73 q/ha) followed by the treatment of intercropping in a ratio of 2:1 applied with RDF (12.26 q/ha). Chinese cabbage recorded the highest ADF yield in "Sole CC + RDF" (19.50 q/ha) which was significantly higher than all other treatments. Maximum combined ADF of both the crops was obtained in the intercropping ratio of 2:1 with the use of PGPR *i.e*., "Oats +CC (2:1) + 75%RDF + FYM + PGPR." and was equal to 22.90 q/ha. Similarly, Fig 1 indicates the total acid detergent fiber yield of oats and Chinese cabbage.

Hemicellulose yield (q/ha)

Hemicellulose yield of both crops in different Intercropping ratios in different treatments has been represented in the Table 3.

Table 3 represents the hemicellulose and ash yield of oats and Chinese cabbage in intercropping. It can be seen that highest hemicellulose yield in oats was_noted in the "Sole Oats + RDF", which was equal to the 13.15 q/ha followed by "Oats + CC (2:1) + RDF (7.32 q/ha)". Chinese cabbage recorded highest hemicellulose yield in the "Sole CC + RDF (12.85 q/ha). Total highest yield of the hemicellulose was obtained in "Oats +CC (2:1) + 75%RDF + FYM + PGPR" that is equal to 13.69 q/ha.

Ash yield (q/ha)

Ash yields of the both crops in different treatments have been reported in Table 3. Intercropping ratios had significant effect on the ash yield content of both the crops *i.e*., oats and Chinese cabbage. The highest ash yield in the case of the oat was obtained in the treatment Sole oats + RDF i.e.,6.29 q/ha which was significantly higher than other treatments and Chinese cabbage reported highest ash yield in its sole treatment.

Economics

Economics of both the crops in different ratios of intercropping has been presented in the Table 4. Highest cost of cultivation was incurred in the "Sole oats + RDF" and that is ` 22166.47/ha followed by Oats + CC (2:1) + RDF which was equal to ` 21663.80/ha. Lowest cost of cultivation was obtained in the sole Chinese cabbage cropping (` 19158.87/ha). Highest gross returns were obtained in "Oats + CC (2:1) + 75% RDF + FYM + PGPR" followed by "Oats + CC (2:1) + RDF)". The lowest gross returns were obtained in the sole oats cropping and that is ` 56050.17/ha. Highest net returns were reported in "Oats + CC (2:1) + 75% RDF +FYM + PGPR" (` 50593.81/ha) followed by the "Oats + CC (2:1) + RDF" (` 49179.90/ha) and the lowest net returns were obtained in the sole Oats cropping. The cost benefit ratio indicates the net returns obtained per rupee invested in the business. Data showed that the highest cost-benefit ratio obtained in the T2 (Sole CC treatment), a value of 2.57 followed by the "Oats + CC(2:1) + 75%RDF +FYM +PGPR", which had a value of 2.36.

CONCLUSION

Intercropping ratios as well as the nutrient management significantly affected the yield and quality parameters of fodder, the productivity of crops and the economics. Higher land equivalent ratios were obtained in the intercropping treatments except for the "Oats + CC (1:1) + RDF" suggesting that the better land utilization can be done with the intercropping. Better returns and benefit -cost ratio were also reported from the intercropping treatment having the PGPR treatment i.e., "Oats +CC (2:1) + 75%RDF + FYM + PGPR."

Conflict of interest: None.

REFERENCES

Alqaisi, O., Hemme, T., Latacz-Lohmann, U. and Susenbeth, A. (2014). Evaluation of food industry by-products as feed in semi-arid dairy farming systems: the case of Jordan. Sustainability Science. 9(3): 361-377.

Anonymous, (2012). Nutritive value of Commonly Available Feeds and Fodders in India. Animal Nutrition Booklet. National Dairy Development Board, Anand. pp: 41-42.

Anonymous, (2013). Vision 2050. IGFRI booket., pp: 1-2.

Henneberg, W. and Stohmann (1860). Versuche über das Erhaltungsfutter volljährige Rindviehes. Im: Henneberg W und Stohmann F Beiträge zur Begründung einer rationellen Fütterung der Wiederkäuer. C.A. Schwctschke und Sohn, Braunschweig. Kapitel. II: 17-188.

Mandal, B.K., Dasgupta, S., and Ray, P.K. (1991). Effect of intercropping on yield components of wheat, chick pea and mustard under different moisture regimes. Zeitschrift für Acker- und Pflanzenbau. 155(4): 261- 270.

Van Soest, P.V., Robertson, J.B. and Lewis, B. (1991). Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. Journal of Dairy Science 74(10): 3583-3597.