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Cultivation of Berseem (*Trifolium alexandrinum*) and Oats (*Avena sativa*) Fodder Crops by Using Biofertilizers and Biopesticide: An Experience from Farmers' Field in Nadia District of West Bengal

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Abstract

Indiscriminate and unscientific application of chemical fertilizers and pesticides, adversely affect the agricultural production system by damaging soil health, contaminating natural water bodies and ground water. As a result of prolonged use of excessive chemical fertilizers and pesticides, the yield of field crops are decreasing due to poor soil health and produced crops also adversely impact human health. For animal husbandry enterprise, fodder production is one of the major activities. Injudicious use of chemicals can reduce fodder production as well as productivity of livestock can also be reduced. Under these circumstances, demonstration of fodder berseem and oats cultivation by using biofertilizers and biopesticides were carried out in farmer's field at three blocks of Nadia district of West Bengal, India. The study was conducted in the winter season of the year 2020-21; the selected farmers were trained and method demonstrations of fodder crop production were carried out. The demonstration results suggested that average yield of berseem fodder crop was 53.33±2.80 t ha^{-1} whereas oats fodder crop was 43.07±2.16 t ha^{-1}. The BC ratio of fodder crop cultivation suggested that, by the cultivation of both fodder crops farmers got substantial economic return. Fodder produced by the using biofertilizers and biopesticide contain good amount of dry matter as well as crude protein. From the study it can be concluded that both the fodder crops can be grown in the farmers' field of the study area by using the biofertilizers and biopesticide without deteriorating the fodder yield and fodder quality.

Keywords: Biofertilizers, biopesticides, berseem, oats, fodder crop, method demonstration

1. Introduction

For successful animal husbandry practices, fodder production plays a very important role. Cost of feeding livestock is the major cost component involved in the animal husbandry enterprise (Ghule et al., 2012; Angadi et al., 2016) and it constitutes more than 70 percent of cost for animal husbandry. Under intensive dairy farming, milk yield and revenue are high, but the input costs are also high as farmers have to grow green fodder (Kumar and Singh, 2017). Green fodder crops not only provide required nutrition to livestock but also contribute significantly in the overall return on investment in animal husbandry farms; thus, for profitable animal husbandry venture fodder production by following

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scientific practices should be given proper emphasis. On the other hand, world is facing problem of degradation in soil and water quality due to extensive use of chemical fertilizers as well as chemical pesticides. These chemical fertilizer and pesticides contaminates water bodies and as a result of that, human health problem has been reported (Roychowdhury et al., 2014; Kumar, 2015). Human health problems arising due to contamination of soil and water is not the sole bad effect of chemical fertilizers and pesticides, these chemicals also reduce production potential of crops in the long run. Modern agriculture lost its sustainability owing to excess use of chemical fertilizers and harmful pesticides further leading to higher cost of cultivation, declined food security and safety, and finally the reduction in soil fertility (Saritha and Tollamadugu, 2019). Indiscriminate use of chemical fertilizers can also reduce the production as well as quality of fodder crops.In this circumstance, it is very much essential to introduce biofertilizer and biopesticide based fodder production system. The adverse effects such as environmental toxicity and long residual action resulting from excessive use of these chemicals have prompted the search for nontoxic eco-friendly biological agents (Dhir, 2017). Recently, biofertilizer technology is gaining attention amongst the agronomists and soil scientists because of its considerable benefits, especially in sustainable agriculture (Suyal et al., 2016). Biofertilizers and biopesticides are environmental friendly products and can be used in integrated nutrient management (INM) and integrated pest management (IPM) techniques (Kumar, 2018). The use of bio-fertilizers and bio-pesticides offers a better option to augment the 'Fertilizer Use Efficiency' and maintain soil health (Rao and Mishra, 2012). Apart from these biofertilizers can reduce the biotic and abiotic stress(Ribeiro et al., 2018; Rocha et al., 2019). Biofertilizers are comprised of variety of free-living microorganisms that can turn inaccessible nutrients into usable forms by biological processes, resulting in improved plant root growth and seed germination (Chaichi et al., 2015). The major types of biofertilizers are nitrogen fixing, phosphorus solubilization, potassium solubilization, zinc solubilization, and iron sequestration biofertilizers (Abbey et al., 2019). Biopesticide is a formulation made from naturally occurring substances that controls pests by non toxic mechanisms and in ecofriendly manner (Kumar, 2012). Berseem and oats are the two major fodder crops fed to livestock especially to the dairy animals. Berseem or Egyptian clover (*Trifolium alexandrinum*), a potential winter forage legume, is one of the most popular crops in north, north-west and central parts of India (Pathan et al., 2013). Application of biofertilisers in berseem can ensure effective nodulation, fixing more nitrogen and producing plant growth hormones (Garg et al., 2015). On the other hand oats fodder crop is widely accepted by the farmers of West Bengal. With these backgrounds, the study has been conducted to know the efficacy of cultivation practices of fodder oats and berseem by using biofertilizers and biopesticides.

2. Materials and Methods

The study has been conducted in the Nadia district (Situated between 22°53" and 24°11" North latitude and 88°09" and 88°48" East longitude) of West Bengal as both berseem and oats are well accepted by the livestock farmers of the area for feeding their animals. For demonstration of berseem crop, 15 farmers' field has been selected. Out of the selected 15 farmers; 5 farmers belonged to Chakdah block, 4 farmers belonged to Ranaghat-I block and 6 farmers were from Shantipur block. The demonstrations were carried out in the winter season of 2020-21. The pH ranges in the soil of selected block did not varied much and the level of soil pH was 7.51, 7.35 and 7.22 in the three blocks namely Chakdaha, Ranaghat-1 and Shantipur, respectively. The level of organic carbon percentage in soil was .60, .40 and .36 in Chakdaha, Ranaghat-1 and Shantipur blocks, respectively. Available N (kg ha^{-1}) level in Chakdaha, Ranaghat-1 and Shantipur blocks was found to be 516.48, 514.60 and 471.33, respectively whereas available phosphorus (kg ha^{-1}) in soil was 19.98, 13.17 and 30.85 in Chakdaha, Ranaghat-1 and Shantipur blocks, respectively. Available K (kg ha^{-1}) level in Chakdaha, Ranaghat-1 and Shantipur blocks was found to be 159.02, 107.30 and 117.70, respectively. Demonstration of oats fodder crop was carried out in the field of 17 farmers and out of those 17 farmers; 5 farmers were from Chakdah block, 4 farmers were from Ranaghat-1 block and 8 farmers were from Shantipur block. Farmers were thoroughly trained about the method of using biofertilizers and biopesticides as well as the cultivation practices of both fodder crops. For the study 'BL 42'variety of berseem fodder crop and 'Kent' variety of oats fodder crop was used. Farmers were provided the seed and required biofertilizers and biopesticides. In case of berseem, *Rhizobium trifolii* (CFU count 5×10^7 g^{-1}) and Phosphate Solubilizing Bacteria (*Bacillus polymyxa*- CFU count 5×10^7 g^{-1}) was used as biofertilizers and *Trichoderma viride* (1.50% WP- CFU count 2×10^6 g^{-1}) was used as biopesticide. For oats fodder crop *Azotobacter* (*Azotobacter chroococcum*- CFU count 5×10^7 g^{-1}), Phosphate Solubilizing Bacteria (*Bacillus polymyxa*- CFU count 5×10^7 g^{-1}) was used as biofertilizers and *Trichoderma viride* (1.50% WP- CFU count 2×10^6 g^{-1}) was used as biopesticides. For berseem fodder crop cultivation, variety of 'BL 42' was used @ 27 kg ha^{-1}, whereas for oats fodder crop cultivation 'Kent' variety was used @ 90 kg ha^{-1}. For both the cases of berseem and oats fodder crop, *Trichoderma viride* was used 10 gram for per kg of fodder seed. In case of berseem fodder crop, 50 g of *Rhizobium trifolii* was used for treating per kg of seed. In oats crop, per three kg of seed was treated with 50 grams of *Azotobacter* and 50 g of Phosphate Solubilizing Bacteria. Land for fodder berseem and fodder oats was prepared by using cowdung manure @ 2 t ha^{-1}. Farmers were recommended to apply irrigation to have proper moisture level before sowing oats seeds. For berseem crop, seeds were recommended to be sown by broadcasting method in standing water of 5 cm in the field. No chemical

fertilizer or pesticide was used for those demonstrations. The data has been collected by developing one schedule. Different statistical tests like ANOVA, Duncan's Multiple Range Test and other descriptive statistics were used for analyzing the data. The data for the study were analyzed by utilizing SPSS 20 software package.

3. Results and Discussion

From the Table 1, it can be said that the farmers were growing fodder oats and fodder berseem without following any scientific package of practice. In case of oats, they were using around four numbers of tillage where as in case of berseem they were using around two number of tillage. They were using around one hundred kg of nitrogen in case of fodder oats cultivation and round 9 kg of nitrogen in case of beseem fodder crop cultivation. On the other hand they were using 35 to 40 kg of phosphorus per hectare of land for cultivation of oats fodder and around 23 kg of phosphorus in case of berseem fodder crop. For cultivation of berseem farmers were using 25 kg potash per hectare. Farmers were giving first irrigation after 23 days of sowing in case of oats and around after 4 days of sowing in case of berseem fodder crop. The average yield of oats was reported as 37.77±3.44 t ha^{-1} and 44.18±8.99 t ha^{-1} in berseem fodder.

Table 1: Current practices followed by the farmers

Name of crop	No. of tillage	Nitrogen (Kg ha^{-1})	Phosphorus (Kg ha^{-1})	Potash (Kg ha^{-1})	1st irrigation (Days after sowing)	Yield (t)
Oats	3.94±.18	103.91±10.79	35.86±5.33	29.11±6.44	22.71±1.63	37.77 ± 3.44
Berseem	1.94±.53	9.62±3.66	23.72±7.19	25.94±9.63	3.94±1.34	44.18 ± 8.99

Yield and economic parameter of berseem fodder crop demonstration has been shown in the Table 2. From the table it can be found that, there was no significant difference in terms of yield among the three blocks where the demonstration was conducted. The average yield from the three blocks was 53.33±2.80 t ha^{-1}, which was higher than the yield as received by the farmers earlier, without applying biofertilzers and biopesticides. Mia et al. (2012) in their study also found that, inoculation with biofertlizers significantly increased the seedling emergence, seedling vigor, root growth namely root length, root surface area and volume. It was observed from the demonstration that, economic cost of cultivation has not been varied significantly in different blocks and average cost of cultivation for berseem crop production was observed as ₹ 35687.00±385.97 ha^{-1}. The amount of benefit per hectare of land was calculated and it was found that the total benefit accrued due to cultivation of berseem fodder crop was ₹ 106653.33±5589.43. The analysis also suggested that, if the benefit and cost ratio were compared, then on an average cultivation of berseem fodder crop grave 2.99 times benefit than the cost involved or investing rupees one can fetch around 3 rupees by cultivating the crop by using biofertilizers and biopesticides. Thus application of biofertilizers and biopesticides can be a viable option to achieve economic sustainability in the long run. Barragan-Ocana and del -Valle-Rivera (2016) has also opined in the similar line.

Table 2: Berseem (Var-BL 42) demonstration result

		Mean	Std. Error	F-value
Yield (t ha^{-1})	Chakdah	49.94	7.41	0.33
	Ranaghat-1	54.73	3.06	
	Shantipur	55.22	3.38	
	Total	53.33	2.80	
Economic cost in ha (₹)	Chakdah	36617.00	833.82	2.74
	Ranaghat-1	34517.00	557.89	
	Shantipur	35692.00	357.95	
	Total	35687.00	385.97	
Benefit ha^{-1} (₹)	Chakdah	99880.00	14824.79	0.34
	Ranaghat-1	109450.00	6129.37	
	Shantipur	110433.33	6752.86	
	Total	106653.33	5589.43	
B:C ratio	Chakdah	2.74	0.41	0.62
	Ranaghat-1	3.17	0.15	
	Shantipur	3.10	0.20	
	Total	2.99	0.16	

The dry matter content of berseem fodder crop was analysed and it was found that (Table 3) there was no significant variation among different blocks in terms of dry matter content of berseem fodder crop grown by using biofertilizer and biopesticides. The average dry matter content of berseem fodder crop was analysed and it was 14.36±0.87. The crude

Table 3: Nutritional quality of Berseem (Var BL 42) grown by using biofertilizer and biopesticide

		Mean	Std. Error	F-value
DM (%)	Chakdah	14.38	1.52	3.67
	Ranaghat-1	11.34	1.67	
	Shantipur	16.34	0.79	
	Total	14.36	0.87	
Crude protein content	Chakdah	13.81	0.24	57.35* (p<.01)
	Ranaghat-1	13.21	0.10	
	Shantipur	11.20	0.16	
	Total	12.74	0.40	

protein content of the berseem crop was analysed and it was found that the crude protein content varied significantly and the average crude protein content was 12.74±0.40. Thus the study showed that the fodder crop grown without any chemical fertilizer or pesticide can give good quality of fodder with good nutritional quality.

The demonstration result of cultivation of oats (Var-Kent) by using biofertilizers and biopesticides has been shown in the Table 4 and from the table it can be said that, there was no significant variation among different blocks in terms of yield of oats fodder crop. The average yield of oats fodder was 43.07±2.16 t ha^{-1}. Total economic cost involved in cultivation of fodder oats was calculated and from the table it can be said that it did not varied significantly within different blocks and the average cost of cultivation of oats fodder crop was ₹ 31920.24±554.14. Benefit received through the cultivation of oats under the demonstration was calculated and it was found that the amount of benefit received was ₹ 64605.88±3232.83.

Table 4: Oats demonstration (Var-Kent) result

		Mean	Std. Error	F-value
Yield (t ha^{-1})	Chakdah	43.12	3.81	0.06
	Ranaghat-1	41.75	4.81	
	Shantipur	43.70	3.49	
	Total	43.07	2.16	
Economic cost in ha (₹)	Chakdah	32552.00	1108.78	0.57
	Ranaghat-1	30894.50	1012.50	
	Shantipur	32038.25	848.49	
	Total	31920.24	554.14	
Benefit ha^{-1} (₹)	Chakdah	64680.00	5728.82	0.06
	Ranaghat-1	62625.00	7220.15	
	Shantipur	65550.00	5240.50	
	Total	64605.88	3232.83	
B:C ratio	Chakdah	1.97	0.13	0.04
	Ranaghat-1	2.03	0.22	
	Shantipur	2.02	0.12	
	Total	2.01	0.08	

Benefit to cost ratio achieved by cultivation of oats fodder crop by using biofertilizers and biopesticides was analyzed and it suggested that the by investing Rs. 1 for cultivation of oats farmers can get return of around rupees 2.01.

The dry matter content of oats fodder crop grown by using biofertilizers and biopesticides was analyzed and found that the contents has not significantly varied block wise (Table 5). The average dry matter content of oats was 17.04±.94. It suggested that, by growing oat fodder crop by using biofertilizer and biopesticides can give good quality of fodder which contain high amount of dry matter. Several other researchers like Verma et al. (2013),Malusà et al. (2016), Mahanty (2017) also established positive effect of biofertilizers on yield and quality of different crops. The Crude protein content of oats fodder crop did not varied significantly among the block and the average crude protein content of oats fodder crop grown by using biofertilizer and biopesticide was 9.47±.70. Thus from the study it can be said that cultivation of oats fodder crop can give good economic return with high quality of fodder which is having rich nutritive value.

Table 5: Nutritional quality of oats (Var-Kent) grown by using biofertilizer and biopesticide

		Mean	Std. Error	F-value
DM (%)	Chakdah	19.06	1.36	2.25
	Ranaghat-1	13.65	2.76	
	Shantipur	17.06	1.16	
	Total	17.04	0.94	
CP	Chakdah	9.33	0.25	.07
	Ranaghat-1	9.90	2.19	
	Shantipur	9.20	0.92	
	Total	9.47	0.70	

4. Conclusion

Good yield of fodder oats (43.07±2.16 t ha^{-1}) and berseem (53.33±2.80 t ha^{-1}) was obtained by using biofertilizers and biopesticide. In case of oats fodder crop, Crude protein content was as high as 9.47±.70 and dry matter content was 17.04±.94. Moreover, benefit cost analysis from the study suggested that, farmers could get good economic returns by cultivating fodder berseem and fodder oats by using biofertilizers and biopesticide. By using biofertilizers and biopesticide for cultivation of berseem fodder crop farmer could earn three times of the investment and incase of oats, farmer could get two times of their investment.

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