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ROLE OF BIO-FERTILIZERS IN ENHANCING PRODUCTIVITY AND PROFITABILITY OF FODDER MAIZE-BERSEEM (*TRIFOLIUM ALEXANDRINUM*) CROPPING SEQUENCE

Priyanka Suryavanshi[1*], Munish Sharma[2], Yashwant Singh[2], Abdul Mazeed[2] and Nikhil Bhashkar Lothe[2]

[1*]CSIR, Central Institute of Medicinal and Aromatic Plants, Lucknow, Uttar Pradesh, India.
[2]Krishi Vigyan Kendra, S.A.S. Nagar, Mohali (Punjab), India.

Abstract

Availability of quality green fodder is a major concern for increasing milk production in India. In order to meet out green fodder requirements of milch animals, farmers must opt for improved technologies like seed inoculation with beneficial micro organisms (bio-fertilizers). Krishi Vigyan Kendra S.A.S Nagar (Punjab) conducted participatory action research at farmer's field during *kharif* and *rabi* seasons of 2017-18, in order to evaluate the efficacy of these bio-fertilizers in fodder maize-berseem cropping sequence. Thus, a total 16 farmer participatory trials (0.4 hectare each) were conducted. Results revealed that both fodder maize and berseem when inoculated with beneficial microorganisms recorded higher plant growth parameters, green fodder yield and net returns as compared to control (no bio-fertilizer treatment), thereby concluding that biofertlisers are economically viable technology. Adoption of this technology will result in socio-economic security to livestock farmers by increasing productivity and profitability of fodder based crop sequences.

Key words: Bio-fertilizers, Fodder Maize, Berseem, Yield, Economics.

Introduction

Livestock sector in India not only provides food security through supply of milk, meat and self employment to millions of people, but also plays an important role for poverty alleviation of smallholder livestock farmers (Kumar *et al*., 2016). The demand for milk and meat will be around 400 and 14 million tonnes, respectively in the year 2050; whereas the production in 2017 was about 155 million tonnes respectively (Subrahmanya *et al.,* 2017). At present, the country faces a net deficit of 35.6% of green fodder, 10.95% of dry crop residues and 44% of concentrate feed ingredients (Subrahmanya *et al.,* 2017). Forage based economical feeding strategies are required to reduce the cost of quality livestock product as the feed alone constitutes 60-70% of the milk production cost (Kumar *et al*., 2016). Fodder production in the Punjab has to be substantially increased if the present population of 81.2 lakh cattle and buffaloes is to be provided with sufficient fodder of good quality. To meet current requirement of livestock and their annual population growth, strategies are needed to improve availability of energy rich quality fodder all round the year through proper agronomic interventions.

Maize (*Zea mays* L.) is one of the most valued fodder crops as it does not contain any anti nutritional factor coupled with its higher production potential in terms of per unit area and time (Onasanya *et al.,* 2009). Thus, forage maize has become a major constituent of ruminant rations in recent years, as its inclusion as dairy cow diets improves forage intake, increases animal performance and reduces production costs (Cusicanqui and Lauer, 1999). Berseem (*Trifolium alexandrinum* L.) is also one of the most important *rabi* legume fodder crops grown under irrigated conditions occupying about 2 million hectares in India. In Punjab, the area under this crop is more than 65 percent of the total area under fodder crops (Rani *et al.*, 2017). It remains soft and succulent at all stages of crop growth. It provides fodder over a longer period from November to May in 4-5 cuttings. The total fodder yield of this crop is comparatively more as

***Author for correspondence :** E-mail: priyanka@cimap.res.in

compared to any other fodder crop of rabi season (Tiwana *et al*., 2002).

The requirement of fodder crops for nutrients particularly nitrogen is comparatively higher. This is due to the fact that fodder crops are grown to produce luxuriant and succulent vegetative growth in a short period (Agrawal *et al*., 2008). Biofertilizers have an advantage over chemical fertilizers, as they provide nutrients in addition to plant growth promoting substances like hormones, vitamins, amino acids etc. (Shivankar *et al*., 2000). Nitrogen fixing microorganism like Rhizobium supply in addition to nitrogen, considerable amount of organic matter enriching the structure of soil. The living micro organisms involved in consortium biofertilizer are nitrogen fixing, phosphorus solubilizing and plant growth promoting rhizobacteria, which fixes atmospheric nitrogen, solubilizes phosphorus and secretes plant growth promoting substances (IAA, Siderophore, growth hormones). These properties of the consortium biofertilizer are instrumental in improving soil fertility and enhancing the growth and development of plants. Hence, introduction of biofertilizers is necessary for improving the soil fertility and productivity besides reducing the expenditure on chemical fertilizers. Therefore, present study was undertaken to validate the effect of bio-fertilizers on forage yield and economic returns of fodder crops grown in farmers field of district S.A.S Nagar, Mohali, Punjab.

Materials and Methods

Location and site characteristics of study area

The study was conducted during both *Kharif* and *rabi* seasons of 2017-18 at farmer's field in block Majri of District S.A.S. Nagar, Punjab falling under sub mountainous zone (30.69°N latitude, 76.72°E longitude having an average altitude of 316 m from the sea level). The physical analysis indicated that soil of experimental field was loamy sand in texture. The chemical analysis of soil samples taken from 0-15 cm depth revealed that soil of the experimental field was normal in soil reaction (7.6) and electrical conductivity (0.18 dS/m), low in organic carbon (0.32%) and available nitrogen (253.9 kg/ha), medium in available phosphorus (21.1 kg/ha) and high in available potassium (332 kg/ha). The climate of the area is characterized as sub-tropical and semiarid with hot and dry spring-summer from April to June, hot and humid summer from July to September and cold autumn-winter from November to January. The average annual rainfall is about 705 mm, most of which is received during the monsoon period from July to September, while few showers are received during the winter season. Numbers of farmers interested were educated through village level and on-campus training camps organized before the start of crop season. Interested farmers were identified for conducting demonstration on bio-fertilizers for berseem and fodder maize. Thus, a total 16 farmer participatory trials (0.4 hectare each) were conducted during the year 2017-18 (Fodder maize in kharif and Berseem in Rabi) at different locations in district S.A.S Nagar.

Fodder maize variety J-1006 was sown in mid September following dibbling of seed on southern side of eastwest ridges 60 cm apart. Seed rate (75 kg/ha) was used. Seed of one acre was treated with 500gm of consortium biofertilizer made by PAU, Ludhiana. Mode of application was seed treatment in which slurry of the biofertilizer (500gm) is prepared in 500 ml water followed by mixing with the seeds on clean, cemented floor and drying for 2-3 hours in air prior to sowing. The fertilizers urea and DAP were applied at the time of sowing @ 125 kg/ha each. Weeds were controlled by pre-emergence application of Atrazine @ 2 kg/ha one day after sowing and post-emergence application of 2, 4-D @ 1.0 l/ha twenty days after sowing. The green fodder was harvested 60 days after sowing and sold to local dairy farms @ Rs 150/quintal. The data were recorded with respect to number of leaves/ plant, plant height, green fodder yield (q/ ha), dry matter yield (q/ha).

Berseem variety BL-42 was sown in last week of September to first week of October. 20-25 kg seed (free from seeds of chicory (*Kashni*)) was broadcasted in standing water. The technology demonstrated to farmers was inoculation of berseem with the specific *Rhizobium* culture. Seed was moistened with minimum amount of water. Mix thoroughly one packet of *Rhizobium* culture with seed on a clean pucca floor/terpal and dry it in shade. Then broadcast the inoculated seed in standing water on the same day, preferably in the evening because the direct sun light kills the bacteria. 6 tonnes of farmyard manure along with 50 kg phosphorus (313 kg superphosphate) per acre at sowing time. First cutting was done in 50 days after sowing and subsequent cuttings at 40 days intervals during winter and 30 days intervals in spring and summer thus giving 6 cuttings in all. As green fodder, 1st, 2nd, 3rd and 4th, 5th and 6th cuts were taken in 4th week of December, 1st week of February, 2nd week of March and 2nd week of April, 2nd week of May and 2nd week of June. The yield from all cuttings were summed up. The data were recorded with respect to number of leaves/ plant, plant height, green fodder yield (q/ ha), dry matter yield (q/ha) at the time of final harvesting. The selling rate of green fodder was Rs. 165/quintal, respectively.

The expenditure incurred on tractor hours, irrigation,

Table 1: Effect of bio-fertilizers on plant growth parameters and yield of fodder maize and berseem.

Crop	Plant height (cm)		Tillers /plant (Berseem) Leaves/plant (Maize)		Green fodder Yield (q / ha)		Dry Matter Yield (q/ha)		Increase in green fodder yield (%) over control
	Demons-tration	Control	Demons-tration	Control	Demons-tration	Control	Demons-tration	Control	
Maize	230	195.6	18.2	17.6	445	390	110	91.5	14.1
Berseem	55.3	48.5	10.1	9.5	1075	972	982.5	893.6	10.6

sprays, manuring, pesticides and bio-fertilizers were worked out to obtain total cost of cultivation. However, the net profit was obtained after deducting the cost of cultivation from gross returns. In order to find out benefit: cost ratio, the net returns from individual treatment were divided by their respective cost of cultivation which included the cost of treatment also. The economics was calculated considering then prevailing prices of inputs and outputs. Feedback from the farmers was taken so that further research and extension activities were improved.

$$\text{Percent increase in yield} = \frac{\text{Demonstration yield - control yield}}{\text{Farmer's Practice yield}} \times 100$$

Results and Discussion

Effect of bio-fertilizer on growth and yield of fodder maize

The effect of microbial inoculants on plant height of fodder maize is shown in table 1. The application of the inoculums to the maize showed an increase in height (230 cm) while control plots having no consortium recorded 195.6 cm. Similarly, number of leaves per plant also recorded an increase and the value was 18.2 as compared to control (17.6). Yield is an expression of various morphological, physiological and growth parameters in crop. Results also revealed that demonstration plots having microbial inoculants recorded higher green fodder yield (14 percent) over control. Dry fodder yield also recorded similar trend. This might be due to more availability of nutrients from synergistic effect of bio-fertilizers with chemical fertilizers and beneficial effects of Azotobacter and phosphate solubilizing bacteria (PSB) inoculation might have increased availability and uptake of nitrogen and phosphorus for plant growth. These introduced beneficial microorganisms might have produced amino acids, vitamins and growth promoting substances like indole acetic acid and gibberellic acid which might have resulted in enhanced nutrient uptake, translocation and synthesis of photosynthate assimilates causing an increase in plant growth characters and economically profitable yield. Soil micro-organisms that colonize the rhizosphere might have assisted plants in the uptake of phosphorus, potassium and nitrogen from the soil. These results are in accordance with the work of (Shaharoona *et al*., 2006) who reported such increase in yield attributes of maize due to *Pseudomona*s inoculation. Wu *et al*., 2005 from China also reported that application of biofertilizers (containing *Glomus mosseae* or *Glomus intraradices* + *Azotobacter chroococcum*, *Bacillus megaterium* and *Bacillus mucilaginous*) resulted in significantly higher growth of maize. Beyranvand *et al*., (2013) also recorded significantly higher maize yield and yield components due to application of biofertilizers in maize.

Effect of bio-fertilizer on growth and yield of berseem

Result on berseem seed inoculation with rhizobium (Table 1) revealed that better growth parameters such as plant height (55.3 cm) and number of tillers per plant (10.1) in demonstration plots as compared to control having no rhizobium treatment. Production of greater forage and dry matter yield per hectare is very important for the producers. Data manifested in table 1 shows that seed inoculation with beneficial microorganisms had positive effect on green fodder yield (GFY) and dry matter yield (DMY) during various cuts. Noticeable increase in green fodder was obtained in all six cuts in demonstration plots of berseem which recorded higher value by 10.6% over control plots. The inoculation of berseem seedling with biofertilizers might have led to stimulation of root development, increased nodulation and nitrogen fixation by enhanced biological activities in the soil and supply of nitrogen to plants. Also, these microorganisms might have

Table 2: Effect of bio-fertilizers on economic profitability of fodder maize and berseem.

Crop	Control Plots (without bio-fertilizer)				Demonstration Plots (with bio-fertilizer inoculation)				Net returns increase (%) over control
	Gross Cost (Rs./ ha)	Gross Return (Rs./ ha)	Net Return (Rs./ ha)	B:C Ratio	Gross Cost (Rs./ ha)	Gross Return (Rs./ ha)	Net Return (Rs./ ha)	B:C Ratio	
Maize	22750	58500	35,750	1.57	23150	66750	43600	1.88	21.95
Berseem	43180	156880	113700	2.63	43480	177375	133895	3.07	17.76

produced vitamins and plant growth promoting substances for the betterment of plant growth and yield. Singh, (2008) and Rani *et al*., 2017 also recorded the similar trend in green fodder yield, dry matter yield, plant height and shoots/m2 in berseem crop at 50 days after sowing and the subsequent cuttings at 30-35 days intervals.

Economic evaluation of demonstrations on bio-fertilizers

Economic analysis of a crop decides the economic viability of the applied treatment and it also provides the benefit : cost ratio of the applied treatments. The data presented in table 2 reveals that seed inoculation with beneficial microorganisms recorded significantly higher gross returns, net returns and benefit : cost ratio over control (no biofertiliser) in both the crops. In maize crop, demonstration plots recorded Rs. 35750 per ha net returns and benefit : cost ratio of 1.88, where as in control plots B:C ratio was 1.57. This might be due to higher fodder yield of maize obtained with biofertiliser inoculation and the cost of its application was much lower as compared to increase in yield. The higher net returns (Rs. 113700 per ha) and benefit : cost ratio (3.07) from berseem was also recorded from demonstration plots, while it was 2.63, in control plots. Percent increase in net returns over control plot was recorded 21.95% in maize and 17.76 % in berseem in demonstration plots, respectively over control. Similar results were also reported by Rani *et al*., (2017) and Singh, (2008) in case of fodder maize and berseem.

Conclusions

Based on the above mentioned findings, it may be concluded that the seed inoculation with bio-fertilizers was found to be effective in increasing the growth and green fodder yield in both fodder maize and berseem and was also economically viable technology. The potential bio-fertilizers plays an important role in maintaining the productivity and sustainability of soil systems and in turn helps in increasing the production potential of crops. It serves as a farmer friendly, eco friendly and cost effective input that can be easily used in the farms in a wide range of crops. There is utmost need to organize method / result demonstrations and organizing field days showing the monetary gain and benefits of use of bio-fertilizers in fodder crops.

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