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Research Article

GROWTH, YIELD ATTRIBUTES, YIELD AND ECONOMICS OF SUMMER PEARL MILLET (*Pennisetum glaucum* L.) AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT

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Abstract- A field experiment was carried out at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat during summer season of 2015 to study the effect of integrated nutrient management on summer pearl millet (*Pennisetum glaucum* L.) under South Gujarat condition.It can be seen that among the various treatments, the application of (T_9) FYM @ 2.5 t ha^{-1} along with recommended dose of fertilizer (120 kg N + 60 kg P_2O_5 ha^{-1}) and seed inoculation with *Azotobacter* and phosphorus solubilizing bacteria (PSB) isresulted in significantly higher growth characters (plant height at 60 DAS, 158.47 cm and at harvest, 174.28 cm and no. of total tillers plant^{-1} 4.93), yield attributes (number of effective tillers plant^{-1} 4.13, earhead length 24.99 cm, earhead girth 3.20 cm), test weight (9.76 g) and grain yield (3631 kg ha^{-1}) and fodder yield (7492 kg ha^{-1}). The maximum net return of (43435 ₹ ha^{-1}) along with BCR value of (1.94) was recorded by the application of T_9 (T_1 + FYM 2.5 t ha^{-1} + *Azotobacter* + PSB).

Keywords- Biofertilizer, Economics, Growth, INM, Pearl Millet, Yield.

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Introduction

Among various millets, pearl millet is the most important staple food crop of arid and semi-arid regions of the country. Pearl millet is the most important cereal crops and widely grown in India because of its tolerance to drought, high temperatures and low soil fertility. Pearl millet grain is contain high nutritious sources and also used into livestock and poultry farm for feed, while pearl millet stover is a valuable livestock feed. Average composition of the edible portion of seed is 12.4 per cent moisture, 11.6 per cent protein, 3-5 per cent fat, 67 per cent carbohydrates, 1.5 to 3 per cent fiber and 2.7 per cent minerals [14]. In India pearl millet production is 9.25 million tonnes. Gujarat occupies an area (9.20 lakh ha^{-1}) and production (13 lakh tonnes), respectively with productivity of 1208 kg ha^{-1} [1]. Banaskatha, Junagadh, Jamnagar, Rajkot, Mehsana, Kheda, Amreli and Kutch are the major pearl millet growing districts of Gujarat.

At present farmers are using excess and imbalance chemical fertilizer, which leads to nutrient deficiency of other than, applied and declined organic carbon level. An injudicious use of chemical fertilizer spoils the structure and texture of the soil. Therefore, use of chemical fertilizer alone may not keep pace with time in maintenance of soil health for sustaining the productivity. So, adequate and balanced use of manure and fertilizer is essential for better soil health. The concept of Integrated Nutrient Management (INM) is a continuous improvement of soil productivity on long term basis through appropriate use of fertilizers, organic manures along with biofertilizers for optimum growth, yield and quality of different crops and cropping systems in specific agro-ecological situations. This concept also aimed to reduce the non-renewable energy in form of fertilizer use, the resource which is depleting year by year and to maximize the use of organic waste or byproduct waste generated from the prevalent industry in the specific area like, press mud bio-compost from sugar industry and farm yard manure from dairy industry in South Gujarat region. This concept has assumed greater importance in our ecological situation. A judicious combination of chemical fertilizers, organic manures and bio-fertilizers should be formulated for crops and cropping system within the ecological, social and economic possibilities.

Materials and Methods

A field experiment was carried out at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat during summer season of 2015 to study the effect of integrated nutrient management on summer pearl millet (*Pennisetum glaucum* L.) under South Gujarat condition. There were total 14 treatments comprised of various source of organic manures, bio-fertilizers and fertilizer *viz.*, RDF (120-60-00 NPK kg ha^{-1}) (T_1), T_1 + FYM 5 t ha^{-1} (T_2), T_1 + Bio-compost 5 t ha^{-1} (T_3), T_1 + FYM 2.5 t ha^{-1}(T_4), T_1 + Biocompost 2.5 t ha^{-1}(T_5), 75 % RDF + FYM 5 t ha^{-1}(T_6), 75 % RDF + Biocompost 5 t ha^{-1}(T_7), T_1 + Biocompost 2.5 t ha^{-1} + *Azotobacter*+ PSB (T_8), T_1 + FYM 2.5 t ha^{-1} + *Azotobacter* + PSB (T_9), 75 % RDF + Biocompost 5 t ha^{-1} + *Azotobacter* + PSB (T_{10}), 75 % RDF + FYM 5 t ha^{-1} + *Azotobacter*+ PSB (T_{11}), Biocompost 5 t ha^{-1} + *Azotobacter* + PSB (T_{12}), FYM 5 t ha^{-1} + *Azotobacter* + PSB (T_{13}), 50 % RDF + Biocompost 2.5 t ha^{-1} + FYM 2.5 t ha^{-1} + *Azotobacter* + PSB (T_{14}) were evaluated in randomized block design (RBD) with three replications. The soil of South Gujarat is locally known as heavy black soil. The soil of the experimental field was clayey in texture and showed low rating for available nitrogen (190 kg ha^{-1}), while medium rating for phosphorus (41 kg ha^{-1}) and high rating for available potash (360 kg ha^{-1}). The soil was found slightly alkaline (pH 7.60) with normal electrical conductivity (0.38 dS m^{-1}). All agronomical practices were followed during investigation period and meteorological week wise weather parameters were also observed. Pearl millet cultivar ''GHB-744" used as experimental materials and sowing at 60×10 spacing in field. Application of

fertilizer, organic manure and biofertilizers were applied as per treatment. Five tagged plants from each plot were selected randomly for recording different observations.The collected data for various parameters were statistically analysed using Fisher's analysis of variance (ANOVA) technique and the treatments were compared at 5% level of significance.

Results and Discussion

Growth parameters

The results revealed that different INM treatments exerted their significant influence on plant height at 60 DAS and at harvest as well as number of total tillers plant^{-1} at harvest. But at 30 DAS it had not influence any significant effect on plant height. Significantly the higher plant height of 158.47 cm at 60 DAS and 174.28 cm at harvest, while highest number of tillers plant^{-1} (4.93) [Table-1] were recorded under the treatment T_9 (T_1 + FYM 2.5 t ha^{-1} + *Azotobacter* + PSB). This treatment proved superior because FYM application improves the soil-physical properties, hydraulic conductivity of the soil and also the availability of NPK which increased the plant growth. The superiority of this treatment over the rest of the combinations of fertilizers might also be due to higher availability of NO_3-N and production of growth-promoting substances. These results are in close conformity with those of Jain and Poonia, 2003 [5], Rathore and Singh, 2006 [13] and Choudhary and Gautam, 2007 [3].

Yield attributes

Perusal of data presented in [Table-1] indicates that treatment T_9 (T_1 + FYM 2.5 t ha^{-1} + *Azotobacter* + PSB) recorded significantly the higher number of effective tillers plant^{-1} (4.13), earhead length (24.99 cm), earhead girth (3.20 cm) and test weight (9.76 g) as compare to other treatments. This might be due to the fact that application of fertilizer make more availability of nutrients which is provide to a higher availability of nutrient to the plant, while FYM improves the soil-physical properties, hydraulic conductivity of the soil and also the availability of NPK, which is promoted plant growth and development and resulting in increasing yield attributes of pearl millet. Use of bio-fertilizer (*Azotobacter* + PSB) led to higher availability of N and P as well as promoted the root growth, which is promoted yield attributes characters. The probable reason for increase in test weight due to higher availability of nitrogen might be attributed to the better filling of grains resulting into bold sized seeds and consequently highest test weight. These results are already in agreement with those reported by Khan *et al.,* 2000 [7], Apoorva *et al.,* 2010 [2], Hoda *et al.,* 2015 [4].

Table-1 *Growth parameters and yield attributes of pearl millet as influenced by INM treatments*

Treatments	Plant height			Number of total tillers plant^{-1}	Yield attributes			
	At 30 DAS	At 60 DAS	At harvest		Number of effective tillers plant^{-1}	Earhead length (cm)	Earhead girth (cm)	Test weight (g)
T_1	47.64	133.55	158.03	3.77	3.20	22.42	2.85	8.91
T_2	50.89	149.58	170.70	4.73	4.00	24.69	3.07	9.50
T_3	50.72	147.79	168.01	4.47	3.93	24.59	3.02	9.46
T_4	50.51	143.25	164.97	4.53	3.80	23.55	2.99	9.39
T_5	49.27	145.35	166.70	3.87	3.53	23.85	2.94	9.24
T_6	47.18	130.46	155.06	3.27	2.93	22.94	2.78	8.84
T_7	47.07	124.03	146.08	3.47	2.77	21.69	2.74	8.80
T_8	51.61	153.32	172.16	4.80	4.07	24.75	3.13	9.68
T_9	52.08	158.47	174.28	4.93	4.13	24.99	3.20	9.76
T_{10}	48.41	137.04	159.41	3.80	3.27	23.45	2.88	8.95
T_{11}	48.49	139.91	162.06	4.00	3.43	23.39	2.91	8.99
T_{12}	44.24	119.69	144.79	3.17	2.37	20.49	2.63	8.30
T_{13}	44.89	114.14	144.15	3.03	2.43	21.19	2.66	8.69
T_{14}	46.11	127.46	147.36	3.20	2.60	21.99	2.70	8.77
S.Em.±	1.51	4.60	4.34	0.14	0.18	0.76	0.10	0.21
C.D. at 5%	NS	14.06	13.24	0.42	0.54	2.31	0.30	0.65
C.V. %	6.23	6.70	5.43	7.00	10.70	6.54	6.80	4.69

Yield

Grain and stover yields increased significantly due to various combinations of chemical fertilizer, organic manure and biofertilizers during experiment. Significantly the higher grain yield of 3631 kg ha^{-1} was recorded under the treatment T_9 (T_1 + FYM 2.5 t ha^{-1} + *Azotobacter* + PSB) over the treatments T_8, T_2, T_3 and T_4.

The supply of nitrogen is related with carbohydrate utilization. When nitrogen supply is sufficient, fewer carbohydrates are deposited in vegetative parts, and the source-sink relationship becomes proper. The increased grain yield by FYM application with chemical fertilizer might be due to effect of FYM on improvement of physical properties of soil and availability of nutrients to the plants. Organic manure provided favourable environment for microorganism i.e. *Azotobacter* which fixes atmospheric nitrogen available to plants. Likewise, PSB is one of the most important nutrient solubilizing microorganisms, which convert insoluble phosphate into soluble forms by secreting several organic acids. These findings support those of Meena and Gautam, 2005 [10], Kanzaria *et al.,* 2010 [6] and Priyadarshani *et al.,* 2012 [12].

A perusal of data presented in [Table-2] showed that treatment T_9 (T_1 + FYM 2.5 t ha^{-1} + *Azotobacter* + PSB) found significantly the higher fodder yield (7492 kg ha^{-1}), which was statistically at par with the treatments T_8, T_2, T_3 and T_4. The increase in fodder yield might be due to increase availability of the nutrients like nitrogen and phosphorus, causing accelerator of the photosynthetic rate and thus leading to more production of carbohydrate resulted in more dry matter production. While organic manure and bio-fertilizers increase the formation of the root hairs and lateral root which helps in higher nutrients uptake and resulted in higher biomass production. Similar conclusion was also drawn by Kumar *et al.*, 2014 [8] and Patil *et al.,* 2014 [11].

Economics

The economics of different treatments in [Table-2] indicated that treatment T_9 (T_1 + FYM 2.5 t ha^{-1} + *Azotobacter* + PSB) secured maximum net return of 43435 ₹ ha^{-1} with BCR of 1.94, followed by the treatments T_8 (T_1 + Biocompost 2.5 t ha^{-1} + *Azotobacter* + PSB), T_4 (T_1 + FYM 2.5 t ha^{-1}) and T_1 (RDF 120-60-00 NPK kg ha^{-1}) with corresponding net realization values of 40301, 38531 and 37047 ₹ ha^{-1} respectively, with BCR of 1.87 (T_1), 1.73 (T_4) and 1.71 (T_8) ₹ ha^{-1}. The highest net realization was mainly because of higher productivity and better market prices. The differences in the B: C ratio is attributed to yield differences and varying costs when different organic manures were added. It is evident that organic manures such as FYM and biocompost can be used in combination for more profitable income. Similar results are also reported by Lakum *et al.,* 2011 [9] and Sipai *et al.*, 2014 [15]

CONCLUSION

On the basis of one year field experimentation, it seems quite logical to indicate that different treatments have deviation in ability to produce the crop yield of summer pearl millet (cv. GHB-744). It can be seen that among the various treatments, the application of FYM @ 2.5 t ha^{-1} along with recommended dose of fertilizer (120 kg N + 60 kg P_2O_5 ha^{-1}) and seed inoculation with *Azotobacter* and

phosphorus solubilizing bacteria (PSB) is identified as the best integrated nutrient management treatment for pearl millet crop to secure higher production, maximum net return and BCR.

Table-2 *Yield and economics of pearl millet as influenced by INM treatments*

Treatments	Grain yield (kg ha^{-1})	Fodder yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	BCR
T_1	3118	6579	56810	37047	1.87
T_2	3456	7160	62704	37941	1.53
T_3	3398	7078	61728	34465	1.26
T_4	3353	6926	60794	38531	1.73
T_5	3297	6844	59846	36333	1.55
T_6	3080	6537	56194	32575	1.38
T_7	3038	6417	55366	29247	1.12
T_8	3523	7306	63934	40301	1.71
T_9	3631	7492	65818	43435	1.94
T_{10}	3198	6682	58136	31897	1.22
T_{11}	3264	6707	59110	35371	1.49
T_{12}	2842	6014	51816	29008	1.27
T_{13}	2884	6153	52682	32374	1.59
T_{14}	2995	6310	54550	30705	1.29
S.Em.±	120.67	257.75	-	-	-
C.D. at 5%	369	788	-	-	-
C.V. %	7.49	7.66	-	-	-

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Abbreviations:

+	Plus
-	Minus
%	Per cent
&	And
₹	Rupees
;	Semi colon
@	At the rate
Anon.	Anonymous
ANOVA	Analysis of variance
B.C.R	Benefit: cost ratio
C.D.	Critical Difference
cm	Centi meter
C:N	Carbon: Nitrogen Ratio
C.V.	Coefficient of Variance
DAS	Days after sowing
dS m^{-1}	Desi Simen per meter
Ec	Electrical conductivity
et al.	Et allii, and others
etc.	ET cetera(and the rest)
FYM	Farm Yard Manure
g	Gram
GHB 744	Gujarat Hybrid Bajara – 744
ha	Hectare
INM	Integrated nutrient management
kg ha^{-1}	Kilogram per hactor
N	Nitrogen
No.	Number
P_2O_5	Phosphorus
pH	Potential of Hydrogen
PSB	Phosphorus solubilizing bacteria
RBD	Randomized Block Design
RDF	Recommended dose of fertilizer
S.Em.	Standard Error of Mean
t ha^{-1}	Tonnes per hectare
Viz.	Namely

Ethical approval

I **(**Thumar Chiragkumar M.**)** declare that this article does not contain any studies with human participants or animals performed by any of the authors during research work

Conflict of Interest: None declared

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