Original Research Article

Effect of integrated nutrient management on yield and quality of summer pearlmillet [*Pennisetum glaucum* (L.) R. Br.] varieties

ABSTRACT

A field experiment on "Effect of integrated nutrient management on yield and quality of summer pearlmillet [*Pennisetum glaucum* (L.) R. Br.] varieties" was carried out during summer 2022 on loamy sand soil of Agronomy Instructional Farm, C. P. College of Agriculture, SardarkrushinagarDantiwada Agricultural University, Sardarkrushinagar. The experiment was laid out in RBD with factorial concept with four replication. The result revealed that significantly higher plant height, effective tillers/plant, girth, length and weight of earhead, grain weight/earhead, grain yield (3366 kg/ha), straw yield (5970 kg/ha) and protein yield were recorded with GHB 1129. It also gave the higher net return (₹53663/ha) and BCR (2.233). Significantly higher plant height, effective tillers/plant, girth, length and weight of earhead, grain weight/earhead, grain yield (3576 kg/ha), straw yield (6271 kg/ha), protein yield and net return (₹57639/ha) with an application of RDF + 30 kg/ha $FeSO4·7H_2O$. An application of RDF (120-60-00 kg/ha N-P_2O_5-K_2O) recorded higher value of BCR (2.277).

Keywords:Pearlmillet, Varieties, Integrated Nutrient management, Earhead, Yield, Quality

1. Introduction

Pearlmillet [*Pennisetum glaucum* (L.) R. Br.] is an important millet crop and grown for both food and fodder purpose. Pearlmillet popularly known as bajra belongs to the family *poaceae*. It grows on poor sandy soils as wall its drought escaping character has made it a popular crop of drought prone areas. The average nutrient composition of the edible portion of the seed is 67% carbohydrates, 12.4% moisture, 11.6% protein, 3.5% fat, 1.5 to 3.0% fibre and 2.7% minerals (Sharma and Burark, 2015).India is the largest producer of pearlmillet having 7.41 million ha area with an annual grain production of 10.3 million tonnes and productivity of 1391 kg/ha (Anonymous, 2021[a]). In Gujarat, area of summer pearlmillet is 2.28 lakh hectares, production is 7.84 lakh tonnes and productivity are 2795 kg/ha (Anonymous, 2021[b]). The major pearlmillet growing states in India are Rajasthan, Maharashtra, Gujarat, Haryana, Uttar Pradesh and Karnataka, where, it is grown both in *kharif* and summer seasons. The major pearlmillet growing district of Gujarat is Banaskantha, Junagadh, Jamnagar, Rajkot, Mehsana, Kheda, Amreli and Kutch.

In the present system of intensive agriculture, most of the farmers are using exhaustive high yielding varieties of the crops that has led to heavy withdrawal of nutrients from the soil during past few years and fertilizer consumption remained much below compared to removal. This gap between nutrient removal and supply cannot be bridged by fertilizers alone. It can only be achieved through integrated nutrient management (INM). Integrated nutrient management involving chemical fertilizers, biofertilizers and organic manures is the key to the sustained productivity as it reduces dependence on chemical fertilizers and not only improves fertilizer use efficiency, but also improves soil productivity by improving physical, chemical and biological properties of soil. Fe deficiency is one of the most frequently encountered micronutrients deficiencies in pearlmillet. Iron plays a role in the formation of plant chlorophyll. Iron containing plant haemoglobin are another promising target for altering Fe content in plant-based foods. Plant haemoglobin is similar to the human haemoglobin, with Fe binding capacity and is most commonly found in nodulating legumes (nitrogen fixing plants) (Kundu *et al*., 2003). Adoption of high yielding short duration varieties which plays important role in the maximization of pearlmillet production per unit area per unit time. Screening of varieties which are appropriate to that particular climatic condition can help in boosting the production of pearlmillet.

Though various breeding efforts in pearlmillet have produced agronomical elite cultivars-both hybrids and varieties with high yielding potential, their adoption has been low in arid areas.

2. Material and Methods

An experiment was conducted during summer season 2022 at Agronomy Instructional Farm, Department of Agronomy, Chimanbhai Patel College of Agriculture, SardarkrushinagarDantiwada Agricultural University, Sardarkrushinagar, Gujarat. The experimental plot was loamy sand in texture, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium status. The experiment was laid out in Randomized Block Design with factorial concept and replicated four times. There were twelve treatments comprising two varieties (V_1: GHB 1129, V_2: GHB 1231) and six levels of nutrient management [F_1: RDF (120-60-00 kg/ha N-P_2O_5-K_2O), F_2: RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$, F_3: 75% RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$ + *Azotobacter*, F_4: 50% RDF + 30 kg/ha FeSO4$\cdot 7H_2O$ + 5 t/ha FYM + *Azotobacter*, F_5: 75% RDF + 0.5% $FeSO_4 \cdot 7H_2O$ foliar spray at 30 and 45 DAS, F_6: 50% RDF + 0.5% $FeSO_4 \cdot 7H_2O$ foliar spray at 30 and 45 DAS].Fertilizer application was done as per respective treatments. The require quantity of FYM as per treatment were applied at 15 days before sowing. The recommended dose of fertilizers was applied as per treatment. Full dose of phosphorus and 50% nitrogen ware applied as basal dose in form of SSP and urea respectively, while remain 50% nitrogen was applied in one split at 30 DAS in form of urea.Soil application of Fe was applied as basal and foliar spray of $FeSO_4 \cdot 7H_2O$ as per treatment.Before sowing, seeds were treated with *Azotobacter* @ 10 ml/kg seed as per treatment. Crop was sown at 45 cm spacing by using uniform seed rate of 3.75 kg/ha.Gap filling was carried out at 15 DAS keeping 10 cm distance between two plants to maintain equal plant population in all the plots.During the growing season of the crop one hand weeding carried out manually and one interculturing by bullock pair to keep the experiment field weed free and pulverizing the soil for better aeration.The biometric observations were recorded from five randomly selected tagged plants within each net plot for all parameters *viz*., plant height (cm), effective tillers/plant, girthof earhead (cm), lengthof earhead (cm), weight of earhead (g), grain weight/earhead (g), test weight (g),grain yield (kg/ha), straw yield (kg/ha),protein content (%) in grain was determined by Near Infrared Analyzer (Konstantinos G. Kyprianidis and Jan Skvaril, 2017), gross return, net return and BCR.The data recorded for various parameters during the course of investigation were statistically analysed by a producer appropriate to the design of experiment as described by Panse and Sukhatme (1985). The significance of difference was tested by “F” test at 5 per cent level.

3. Result and discussion

3.1 Growth parameters

3.1.1 Plant height (cm)

The results (Table 1) indicated that GHB 1129 variety recorded significantly highest plant height at harvest (196.7 cm). The difference in plant height might be due to genetically make up of plant itself, which is governed by vegetative growth of crop as it played vital role in accelerating all the physiological processes in plants. These findings are in accordance with chaudhari*et al*. (2018), Sutaliya (2020) and Ghuraiya*et al*. 2021.Significantly higher plant height(208.6 cm) at harvest recorded with treatment F_2 in which RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$ applied. However, it was stastically at par with treatment F_1 and F_4 in which RDF (120-60-00 kg/ha N-P_2O_5-K_2O) and 50% RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$ + 5 t/ha FYM + *Azotobacter*,respectively. This might be due to encouraged the formation of new cell, cell division, cell elongation and root development. The vigorous growth of root system ultimately helped in better absorption and utilization of nutrients from soil solution which reflected in overall plant growth and ultimately higher plant height. These findings corroborate with the Sahoo *et al*. 2020 and Kadam *et al.* 2019.

3.2 Yield attributes

3.2.1 Effective tillers/plant

Among two different varieties, significantly highest number of effective tillers/plant (2.69) was recorded with GHB 1129 variety. The fluctuating outcomes of pearlmillet hybrids could be attributed to the genetic makeup of these varieties or their introduction into unfamiliar climatic zones. Varying responses of pearlmillet hybrids have also been reported by Swapanil*et al.* (2014) and Chaudhari *et al*. (2018).It is inferred from the data furnished in Table 1 that the number of effective tillers/plant was significantly influenced due to nutrient management. Significantly higher number of effective tillers/plant (2.88) was observed with treatment F_2 in which application of RDF + 30 kg/ha $FeSO_4{\cdot}7H_2O$ was applied, it was remained at par with treatment F_1 and F_4 [RDF (120-60-00 kg/ha N-P_2O_5-K_2O) and 50% RDF + 30 kg/ha FeSO4·$7H_2O$ + 5 t/ha FYM + *Azotobacter* were applied, respectively].This might be due to the fact that application of fertilizer makes more availability of nutrients, which provide higher availability of nutrient to the plant, while FYM improves the soil-physical properties, hydraulic conductivity of the soil and also the availability of N-P_2O_5-K_2O, which is promoted plant growth and development and resulting in increasing number of effective tillers/plant of pearlmillet. This also reported by Thumar*et al*. (2016) and Patel *et al*. (2014).

3.2.2 Girth and length of earhead (cm)

It is apparent from data in Table 1 showed that girth and length of earhead in pearlmillet at harvesting under different varieties was found significant. GHB 1129 variety recorded significantly highest girth(10.16 cm) and length (23.04 cm) of earhead.These results might be due to genetic constitution of these varieties or due to introduction of these hybrids into new climatic zone. This result also supported by Yadav *et al*. (2014), Swapanil*et al*. (2014) and Chaudhari *et al*. (2018).The data outlined in Table 1 clearly indicated that the girthand length of earhead was significantly affected due to different nutrient management. Results showed that treatment F_2,application of RDF + 30 kg/ha $FeSO_4{\cdot}7H_2O$ recorded significantly higher girth(10.53 cm) and length (24.08 cm) of earhead which was statistically at par with treatment F_1 and F_4 [RDF (120-60-00 kg/ha N-P_2O_5-K_2O) and 50% RDF + 30 kg/ha $FeSO_4{\cdot}7H_2O$ + 5 t/ha FYM + *Azotobacter*,respectively].This could be due to higher availability of nutrient to the crop roots which eventually lead to higher shooting of tillers to the base of plant in the form of higher girth and length of earheads. These outcomes are in conformity with the results of Patel *et al*. (2014), Thumar*et al*. (2016), Togas *et al*. (2017) and Samruthi *et al.* (2019), Vaja *et al*. (2020).

3.2.3 Weight of earhead and grain weight/earhead (g)

A perusal of data narrated in Table 1 showed that weight of earhead and grain weight/earhead of pearlmillet was significantly influenced by various varieties. Between two varieties, GHB 1129 produced significantly highest weight of earhead (32.08 g)and grain weight/earhead(14.78 g). Significantly better development of source in form of dry matter accumulation, might have contributed to the more weight per earhead. These results are also supported by Chaudhary *et al*. (2018), Divya *et al*. (2019) Srivastv*et al*. (2020) and Ghuraiya*et al*. (2021). The statistical analysis of earhead weight and grain weight/earheadrevealed that different nutrient management had significant effect on weight of earhead and grain weight/earhead. Results showed that treatment F_2 (RDF + 30 kg/ha $FeSO_4{\cdot}7H_2O$) produced significantly higher weight of earhead(33.48 g) and grain weight/earhead(15.47 g), which found statistically at par with treatment F_1 and F_4[RDF (120-60-00 kg/ha N-P_2O_5-K_2O)and 50% RDF + 30 kg/ha $FeSO_4{\cdot}7H_2O$ + 5 t/ha FYM + *Azotobacter* were applied,respectively].This might be due to adequately fertilized crop benefited from higher rates of nutrition might have resulted into a more vigorous and extensive root system of crop leading to increased vegetative growth responsible for formation of efficient sink and greater sink size, led to more carbohydrate translocation from vegetative plant parts to the reproductive part ultimately produced heavier, longer and thicker earhead. These results are also supported by Divya *et al*. (2019) and Bhargavi *et al*. (2021).

3.2.4 Test weight (g)

The critical examination of data presented in Table 1 clearly indicated that test weight was not significantly influenced due to different varieties.Numerically maximum test weight (9.23 g) was recorded with GHB 1231. These results are also supported by Swapanil *et. al.* (2014), Yadav *et. al.* (2014), Sutaliya (2020) and Ghuraiya *et. al.* (2021). The data clearly inferred that the test weight (g) was not significantly affected by different nutrient management. An application of RDF + 30 kg/ha $FeSO_4{\cdot}7H_2O$ produced maximum test weight of 9.34 g. These results are also supported by Sahoo *et. al.* (2020), Vaja *et. al.* (2020) and Maharana and Singh (2021).

3.2.5 Grain yield (kg/ha) and straw yield (kg/ha)

The results showed in Table2indicated that different varieties exert significant effect on grain yield and straw. Among two different varieties, significantly highest grain yield (3366 kg/ha) and straw yield (5970 kg/ha) was recorded with GHB 1129.The percent increase in grain yield and straw yield under V_1 to the tune of 7.01 % and 5.66 % respectively over F_1.The grain yield is sum of all growth contributing factors by both agronomical and genetic manipulation. Higher grain in GHB 1129 seems on account of overall improvement in growth as well as yield attributes. This might be due to the increased vegetative growth in terms of plant height and number of tillers/plants which resulted in higher straw yield produced by the crop. This result also submitted by Chaudhary *et al.*(2018), Sahoo *et al.* (2020), Srivastav *et al.* (2020) and Malakar *et al.* (2021).A critical analysis of data revealed that treatment F_2 in whichapplication of RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$recorded significantly higher grain yield (3576 kg/ha) and straw yield (6271 kg/ha), it was at par with treatment F_1 and F_4 in which RDF (120-60-00 kg/ha N-P_2O_5-K_2O)and 50% RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$ + 5 t/ha FYM + *Azotobacter*,respectively was applied.The percent increase in grain yield and straw yield under F_2 to the tune of 7.27 % and 4.00 % respectively over F_1.This increase in yield might be due to effective utilization of applied nutrients. Iron plays a major role in biosynthesis of IAA and especially due to its role in initiation of primordial reproductive part and portioning of photosynthetic towards them which promotes the yield. The increased supply of fertilizers and their higher uptake by plants might have stimulated the rate of various physiological processes in crop. The results of present study with the combined application of fertilizers are in line with those of Vaja *et al*. (2020), Maharana and Singh (2021), Waikar*et al*. (2021), Malakar *et al*. (2022).

3.3 Quality parameters

3.3.1 Protein content (%)

Protein content in grain (%) was not significantly influenced due to different varieties. However, GHB 1129 estimated marginally the highest protein content (9.33%). This result also submitted by Patel *et. al*. (2018). It is inferred from the data furnished in Table 2 that the protein content in grain (%) was not significantly influenced due to nutrient management. Numerically maximum protein content in grain (9.71%) was observed with application of RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$. The results of present study with the combined application of fertilizers are in line with those of Togas *et al*. (2017).

3.4 Economics

Data presented in Table 2, it could be seen that the maximum net realizations and benefit: cost ratio of ₹53663/ha and 2.233, respectively obtained with GHB 1129. The minimum net realizations and benefit: cost ratio was noted under variety GHB 1231. The increase in profitability is mainly due to increase in grain as well as straw yield with GHB 1129 as discussed earlier. Result revealed that the maximum net realizations ₹57639/ha recoded with treatment F_2 (RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$), while maximum benefit: cost ratio of 2.277 recorded with F_1 [RDF (120-60-00 kg/ha N-P_2O_5-K_2O)]. Remarkable effect of fertilizer application on grain and straw yield of pearlmillet was recorded which might be increased net profit with application of RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$.

4. Conclusion

On the basis of the results obtained from the present investigation, it can be concluded that pearlmillet variety GHB 1129 should be fertilized with RDF (120-60-00 kg/ha N-P_2O_5-K_2O) or RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$ or 50% RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$ + 5 t/ha FYM + *Azotobacter* for getting higher yield and net return.

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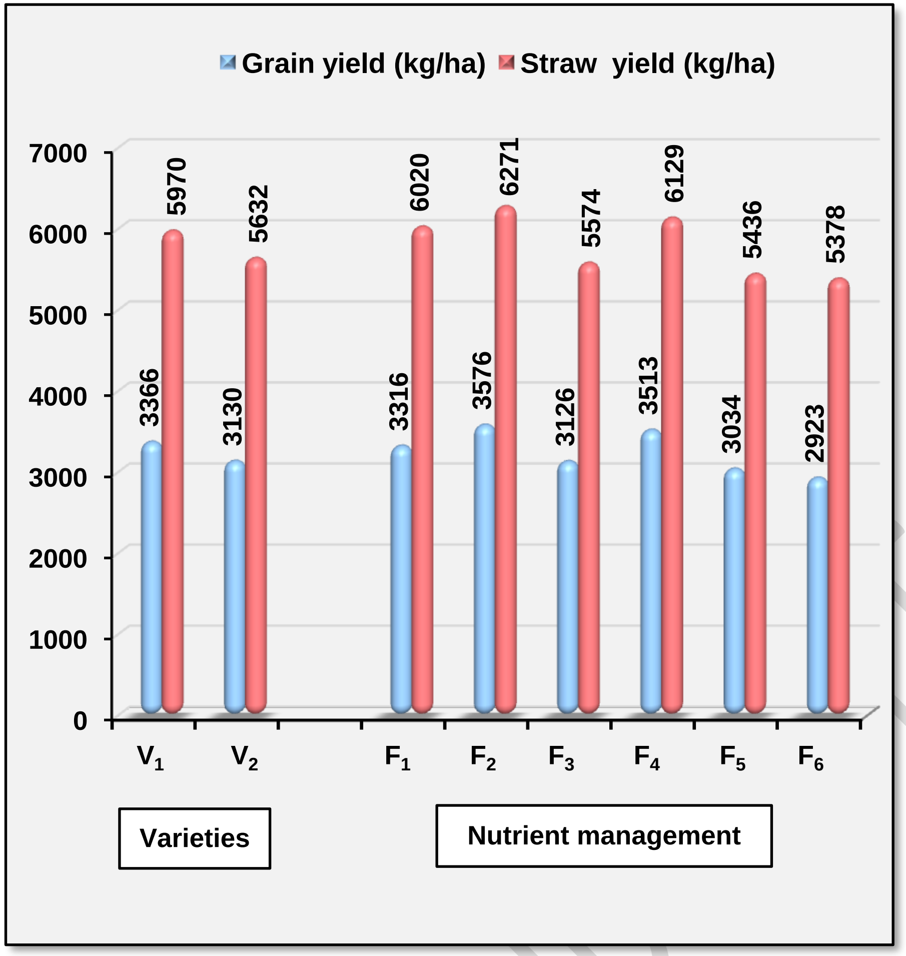
Table 1: Effect of varieties and nutrient management on growth and yield attributes of pearlmillet

Treatment	Plant height (cm)	Effective tillers/plant	Girth of earhead (cm)	Length of earhead (cm)	Weight of earhead (g)	Grain weight/earhead (g)	Test weight (g)
Variety (V)							
V_1 : GHB 1129	196.7	2.69	10.16	23.04	32.08	14.78	9.11
V_2 : GHB 1231	185.7	2.49	9.37	21.41	29.81	13.67	9.23
S.Em.±	3.82	0.06	0.21	0.46	0.67	0.33	0.11
C.D. (P=0.05)	10.98	0.18	0.60	1.33	1.94	0.95	NS
Nutrient management (F)							
F_1 : RDF (120-60-00 kg/ha N-P_2O_5-K_2O)	198.0	2.63	10.12	22.84	30.89	14.78	9.31
F_2 : RDF + 30 kg/ha $FeSO_4·7H_2O$	208.6	2.88	10.53	24.08	33.48	15.47	9.34
F_3 : 75% RDF + 30 kg/ha $FeSO_4·7H_2O$ + *Azotobacter*	186.8	2.55	9.48	21.65	30.09	13.70	9.25
F_4 : 50% RDF + 30 kg/ha $FeSO_4·7H_2O$ + 5 t/ha FYM + *Azotobacter*	191.5	2.72	10.34	23.39	33.02	15.07	9.28
F_5 : 75% RDF + 0.5% $FeSO_4·7H_2O$ foliar spray at 30 and 45 DAS	182.6	2.41	9.37	21.37	29.11	13.76	8.96
F_6 : 50% RDF + 0.5% $FeSO_4·7H_2O$ foliar spray at 30 and 45 DAS	179.7	2.36	8.76	20.02	29.08	12.59	8.88
S.Em.±	6.61	0.11	0.36	0.80	1.17	0.57	0.20
C.D. (P=0.05)	19.02	0.31	1.04	2.31	3.36	1.65	NS
Interaction (V × F)							
S.Em.±	9.35	0.15	0.51	1.13	1.65	0.81	0.28
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS
C.V. %	9.78	11.65	10.42	10.20	10.67	11.41	6.12

Table 2:Effect of varieties and nutrient management on yield, quality and economics of pearlmillet

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Protein content (%)	Cost of cultivation (₹/ha)	Net returns (₹/ha)	B: C ratio
Variety (V)						
V_1 : GHB 1129	3366	5970	9.33	43503	53663	2.233
V_2 : GHB 1231	3130	5632	9.29	43503	47260	2.088
S.Em.±	80.08	116.79	0.11	-	-	-
C.D. (P=0.05)	230	336	NS	-	-	-
Nutrient management (F)						
F_1 : RDF (120-60-00 kg/ha N-P_2O_5-K_2O)	3316	6020	9.48	42338	54070	2.277
F_2 : RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$	3576	6271	9.71	45236	57639	2.274
F_3 : 75% RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$ + *Azotobacter*	3126	5574	9.34	43406	46994	2.083
F_4 : 50% RDF + 30 kg/ha $FeSO_4 \cdot 7H_2O$ + 5 t/ha FYM + *Azotobacter*	3513	6129	9.23	48417	52476	2.084
F_5 : 75% RDF + 0.5% $FeSO_4 \cdot 7H_2O$ foliar spray at 30 and 45 DAS	3034	5436	9.15	41721	46139	2.106
F_6 : 50% RDF + 0.5% $FeSO_4 \cdot 7H_2O$ foliar spray at 30 and 45 DAS	2923	5378	8.94	39900	45452	2.139
S.Em.±	138.70	202.29	0.20	-	-	-
C.D. (P=0.05)	399	582	NS	-	-	-
Interaction (V × F)						
S.Em.±	196.16	286.08	0.28	-	-	-
C.D. (P=0.05)	NS	NS	NS	-	-	-
C.V. %	12.08	9.86	5.95	-	-	-



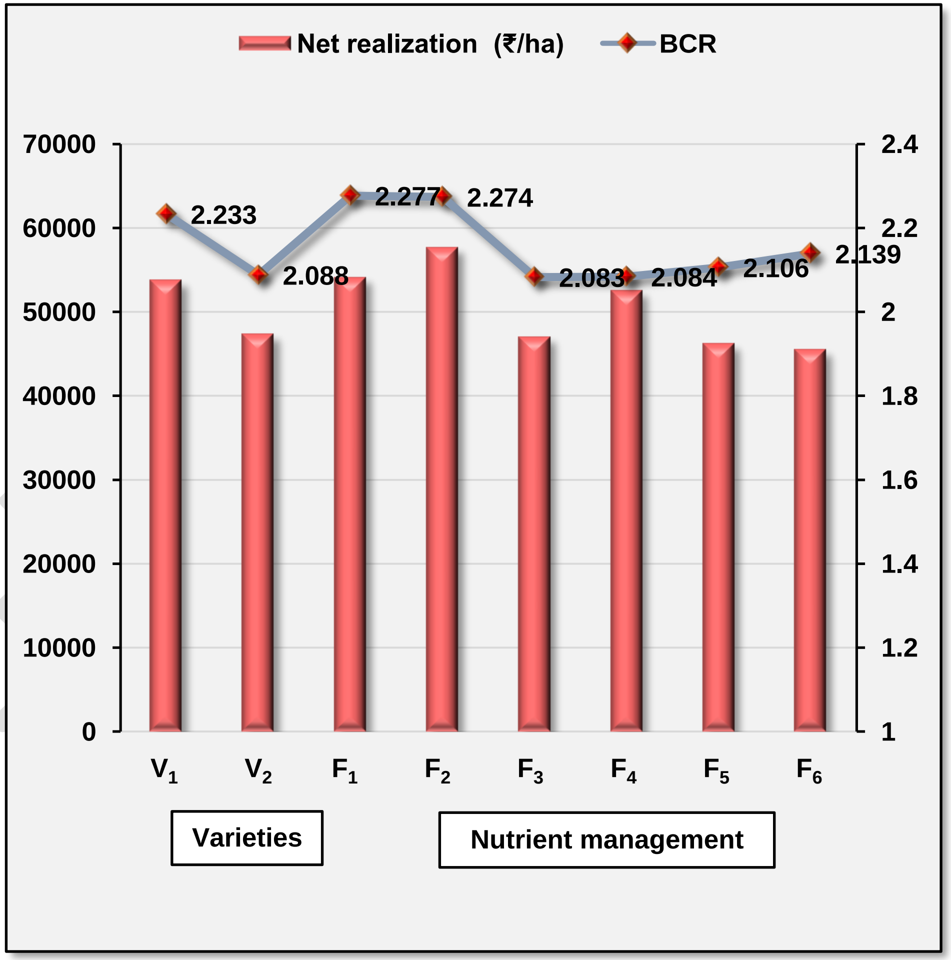


Figure 1: Effect of varieties and nutrient management on grain and straw yield (kg/ha) of summer pearlmillet

Figure 2: Effect of varieties and nutrient management on economics of summer pearlmillet