The Pharma Innovation Journal 2019; 8(6): 1009-1012

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(6): 1009-1012

www.thepharmajournal.com
Received: 09-04-2019
Accepted: 13-05-2019

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Growth, yield and economics of finger millet (*Eleusine coracana* L.) As influenced by varieties and levels of nutrients

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Abstract
A field experiment was conducted during *kharif*, 2018 at Agricultural College Farm, Mahanandi to assess "Response of Finger Millet (*Eleusine coracana* L.) Varieties to Different Levels of Nutrients". The experiment was laid out in randomized block design with factorial concept (FRBD) having twelve treatments and three replications. Among different treatments higher growth parameters, yield attributes such as number of productive tillers per hill and test weight, yield except harvest index and economics were obtained by finger millet variety VR-847 *i.e.,* V_2 over other varieties and regarding fertilizer levels F_3 *i.e.,* application of 120-60-40 N, P_2O_5 and K_2O kg ha^{-1}. However, it was statistically comparable with the treatment F_2 *i.e.,* 90-45-30 N, P_2O_5 and K_2O kg ha^{-1} for some growth parameters. But some yield attributing characters like numbers of fingers per ear head and harvest index was higher in the finger millet variety Vakula *i.e.,* V_3 and total number of grains per finger in the variety PPR-1012 *i.e.,* V_4 gives better results along with the treatment F_3 *i.e.,* application of 120-60-40 N, P_2O_5 and K_2O kg ha^{-1}. Whereas, harvest index and benefit: cost ratio was higher with the application of 60-30-20 N, P_2O_5 and K_2O kg ha^{-1} *i.e.,* F_1 treatment.

Keywords: Finger millet, varieties, nutrient managements, growth, yield, economics.

Introduction
Finger millet (*Eleusine coracana* L.) is important small millet grown in India and has the pride of place with highest productivity among millets. It is also known as Ragi, African millet and Bird's foot millet. In India, it is cultivated in Andhra Pradesh, Karnataka, Tamil Nadu, Orissa, Jharkhand, Uttaranchal, Maharashtra and Gujarat with cultivated area around 1.01 million ha, production of 1385.11 tonnes and productivity is 1363 kg ha^{-1}. In Andhra Pradesh, the total cultivated area is 0.032 million ha, production is 350 tonnes and productivity is 1094 kg ha^{-1} (www.Indiastat.com 2016-2017).

Majority of the finger millet varieties developed in the recent years are with wide adaption, easy cultivation, free from major pests and diseases and drought tolerance which made this crop an indispensable component of dry farming system. Often in the lands where finger millet crop is raised, no other crop worth mentioning can give reasonable harvest. To improve the productive potential, nutrient management is an important practice. Application of nutrients not only influences the economic return of the investment through optimized yield and quality but also cause minimum level of environmental hazards. This calls for adoption of nutrient management practices which aims at efficient and judicious use of the major sources of plant nutrients to get maximum economic yield without any deleterious effect on physico-chemical and biological properties of the soil. In this context, the to find out the "Response of Finger Millet (*Eleusine coracana* L.) Varieties to Different Levels of Nutrients".

Materials and Methods
A field experiment was conducted at Agricultural College Farm, Agricultural College, Mahanandi of Acharya N.G. Ranga Agricultural University during *kharif* season from August to November, 2018 to evaluate the response of finger millet (*Eleusine coracana* L.) varieties to different levels of nutrients. The experiment comprised four finger millet varieties *viz.,* V_1: VR-762, V_2: VR-847, V_3: Vakula and V_4: PPR-1012 and three fertility levels *viz.,* F_1: 60-30-20 N, P_2O_5 and K_2O kg ha^{-1}, F_2: 90-45-30 N, P_2O_5 and K_2O kg ha^{-1} and F_3: 120-60-40 N, P_2O_5 and K_2O kg ha^{-1}. The experiment was laid out in randomized block design with factorial

concept (FRBD) having twelve treatments and three replications. The experimental site was sandy loam and it was slightly alkaline in reaction with a pH of 8.08, EC of 0.21 ds m^{-1}, low in organic carbon (0.35%) and low available nitrogen (137.98 kg N ha^{-1}), low in available phosphorous (39.9 kg P_2O_5 ha^{-1}) and high in available potassium (615.14 kg K_2O ha^{-1}). The fertilizers such as urea, single super phosphate and muriate of potash were supply of NPK and the entire quantity of phosphorous as basal and potassium and nitrogen were applied in three equal splits and other agronomical operations were carried out as per recommendation. The growth, yield attributes and yield were recorded at the time of harvest of crop.

Results and Discussion

The results obtained from the present experiment as well as relevant discussion have been summarized under following heads:

Growth parameters

The growth parameters (Table 1) such as Plant height, number of tillers per hill and drymatter production was higher with finger millet variety of VR-847 V_2 which was statistically superior to VR-762, Vakula and PPR-1012 *i.e.,* V_1, V_3 and V_4. The increase in growth parameters might be due to its genetical potential and drought tolerant capability of these varieties as they maintained higher physiological activity in terms of higher growth parameters. These results are in collaboration with the findings of Aparna *et al.* (2017) [1] and Triveni *et al.* (2018) [7].

Among different nutrient levels, application of 120-60-40 N, P_2O_5 and K_2O kg ha^{-1} *i.e.,* F_3 more plant height, number of tillers per hill and drymatter production which was comparable with F_2 and F_1 *i.e.,* 90-45-30 N, P_2O_5 and K_2O kg ha^{-1} and 60-30-20 N, P_2O_5 and K_2O kg ha^{-1} at all the stages of crop growth. Finger millet variety VR-847 with the application of 120-60-40 kg N, P_2O_5, K_2O ha^{-1} significantly enhanced the plant height, number of tillers per hill and drymatter production which might be due to increase in the availability of nutrients that enhanced the uptake of nutrients resulted in cell development, triggering young tissues and involved in plant mersitematic growth than other levels of nutrients, which is responsible for higher plant height, profused tillering, hence higher drymatter accumulated. There results were in conformity with the findings of Thimmaiah *et al.* (2016) [6], Prakasha *et al.* (2018) [4] and Triveni *et al.* (2018) [7].

Table 1: Growth parameters as influenced by Finger millet varieties and different levels of nutrients.

Treatment	Plant height (cm)	No. of tillers $hill^{-1}$	Drymatter production (kg ha^{-1})
Varieties			
V_1: VR-762	103.71	5.25	14673.7
V_2: VR-847	104.78	5.47	15572.4
V_3: Vakula	84.01	4.93	12694.1
V_4: PPR-1012	97.18	4.64	13366.0
SEm ±	0.79	0.07	99.79
CD (P=0.05)	2.32	0.21	292.65
Fertilizer Levels			
F_1: 60-30-20 N, P_2O_5 and K_2O kg ha^{-1}	93.03	4.91	12906.8
F_2: 90-45-30 N, P_2O_5 and K_2O kg ha^{-1}	97.84	5.08	14128.1
F_3: 120-60-40 N, P_2O_5 and K_2O kg ha^{-1}	101.40	5.24	15194.7
SEm ±	0.68	0.06	86.42
CD (P=0.05)	2.01	0.18	253.44
V X F			
SEm ±	1.37	0.12	172.84
CD (P=0.05)	NS	NS	506.89

Yield attributes

The yield attributing characters (Table 2) such as number of productive tillers per hill and test weight was statistically higher in the finger millet variety VR-847 *i.e.,* V_2. Whereas, higher ear head length and total number of grains per finger were observed in variety PPR-1012 i.e., V_4. However, number of fingers per ear head was higher in variety Vakula i.e., V_3. With the application of 120-60-40 N, P_2O_5 and K_2O kg ha^{-1} *i.e.,* F_3 treatment obtained higher yield attributing characters when compared with treatments F_2 and F_1 *i.e.,* 90-45-30 N, P_2O_5 and K_2O kg ha^{-1} and 60-30-20 N, P_2O_5 and K_2O kg ha^{-1}, respectively. With increase in the fertilizer levels there is an increase in yield attributing characters. It might be due to timely availability of nutrients to the plant which helps to improve physiological function of plants. Similar results were also reported by Nigade *et al*. (2013) [3], Wafula *et al.* (2016) [10], Triveni *et al*. (2017) [8] and Triveni *et al*. (2018) [7].

Table 2: Yield attributes as influenced by Finger millet varieties and different levels of nutrients.

Treatment	Number of productive tillers $hill^{-1}$	Ear head length (cm)	Number of fingers per ear head	Total number of grains per finger	Test weight (g)
Varieties					
V_1: VR-762	4.02	6.29	6.00	127.21	3.16
V_2: VR-847	4.18	6.28	6.10	128.26	3.32
V_3: Vakula	3.45	6.73	8.87	99.94	2.84
V_4: PPR-1012	3.66	8.56	6.81	178.70	2.63
SEm ±	0.22	0.07	0.05	2.65	0.04
CD (P=0.05)	0.14	0.21	0.15	7.79	0.12

Fertilizer Levels					
F_1: 60-30-20 N, P_2O_5 and K_2O kg ha^{-1}	3.63	6.71	6.40	118.12	2.85
F_2: 90-45-30 N, P_2O_5 and K_2O kg ha^{-1}	3.83	6.92	6.85	128.41	3.00
F_3: 120-60-40 N, P_2O_5 and K_2O kg ha^{-1}	4.05	7.29	7.61	154.06	3.12
SEm ±	0.19	0.06	0.04	2.30	0.03
CD (P=0.05)	0.12	0.18	0.13	6.75	0.10
V X F					
SEm ±	0.08	0.12	0.08	4.60	0.07
CD (P=0.05)	NS	NS	0.26	13.50	NS

Yield

The higher grain and straw yield (Table 3) were recorded in the finger millet variety VR-847 *i.e.,* V_2 and statistically it is on par with the variety VR-762 *i.e.,* V_1 when comparable with other varieties. The higher grain and straw yield was recorded at the treatment F_3 *i.e.,* application of 120-60-40 N, P_2O_5 and K_2O kg ha^{-1} over rest of fertilizer levels. Regarding the interaction effect higher yields were observed in the variety VR-847 *i.e.,* V_2 with the application of 120-60-40 N, P_2O_5 and K_2O kg ha^{-1} *i.e.,* F_3 treatment during crop growth period, it might be due to the fact that the crop has not experienced nutrient stress at any growth stage of crop because of higher nutrition, improved vegetative growth and yield attributing characters such as number of productive tillers, no. of fingers per ear head, total no. of grains per finger and test weight of crop resulted higher grain and straw yield. Similar results were also reported by Thimmaiah *et al*. (2016) [6], Aparna *et al*. (2017) [1], Vajantha *et al*. (2017) [9] and Prakasha *et al*. (2018) [4]

The higher harvest index was recorded with the finger millet variety of Vakula (V_3) followed by the other varieties PPR-1012 (V_4), VR-762 (V_1) and VR-847 (V_2). However, all these treatments were comparable with each other. The maximum harvest index was obtained at the treatment F_1 *i.e.,* application of 60-30-20 N, P_2O_5 and K_2O kg ha^{-1} which is statistically at par with the treatments F_2 and F_3 *i.e.,* 90-45-30 N, P_2O_5 and K_2O kg ha^{-1} and 120-60-40 N, P_2O_5 and K_2O kg ha^{-1}, respectively. These results were in conformity with the findings of Aparna *et al.* (2017) [1] Chandrakala *et al.* (2017) [2] and Triveni *et al.* (2017) [8]

Table 3: Yield and economics as influenced by Finger millet varieties and different levels of nutrients.

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
Varieties						
V_1: VR-762	2825.9	5630.7	33.66	42388	24291	2.35
V_2: VR-847	2863.5	5808.5	33.34	42952	24855	2.38
V_3: Vakula	2699.2	5310.5	34.06	40487	22390	2.24
V_4: PPR-1012	2567.5	5106.4	33.72	38512	20415	2.13
SEm ±	12.98	79.11	0.30	194.72	194.72	0.01
CD (P=0.05)	38.07	232.02	NS	571.05	571.05	0.03
FERTILIZER LEVELS						
F_1: 60-30-20 N, P_2O_5 and K_2O kg ha^{-1}	2616.8	4459.1	37.04	39251	22838	2.39
F_2: 90-45-30 N, P_2O_5 and K_2O kg ha^{-1}	2730.3	5531.4	33.07	40954	22852	2.26
F_3: 120-60-40 N, P_2O_5 and K_2O kg ha^{-1}	2870.0	6401.6	30.99	43050	23273	2.18
SEm ±	11.24	68.51	0.26	168.63	168.63	0.009
CD (P=0.05)	32.97	200.94	0.77	494.55	NS	0.02
V X F						
SEm ±	22.48	137.03	0.52	337.27	337.27	0.01
CD (P=0.05)	65.94	NS	NS	989.10	989.10	0.05

Economics

The higher gross returns, net returns and benefit: cost ratio was obtained in the finger millet variety V_2 *i.e.,* VR-847 while lower gross returns, net returns and benefit: cost ratio was obtained in the variety V_4 *i.e.,* PPR-1012 variety. Regarding the fertilizer levels, higher gross returns and net returns were obtained with application of F_3 *i.e.,* 120-60-40 N, P_2O_5 and K_2O kg ha^{-1}, The higher gross returns was due to the fact that crop has not experienced nutrient stress at any growth stages and application of higher doses of fertilizers improved vegetative growth and increased the yield attributes and yield which resulted in higher gross returns and net returns. Whereas higher benefit: cost ratio was observed with the application of F_1 *i.e.,* application of 60-30-20 N, P_2O_5 and K_2O kg ha^{-1} which was followed by F_2 and F_3 *i.e.,* application of 90-45-30 N, P_2O_5 and K_2O kg ha^{-1} and 120-60-40 N, P_2O_5 and K_2O kg ha^{-1}, respectively. The higher benefit: cost ratio might be due to less cost of cultivation and optimum grain and straw yield. These results were in conformity with the findings of Sundaresh *et al*. (2017) and Triveni *et al*. (2018) [7].

Conclusion

Overall, it can be concluded that the finger millet variety VR-847 performed better under the fertilizer level F_3 *i.e.,* application of 120-60-40 N, P_2O_5 and K_2O kg ha^{-1}. However, higher benefit: cost ratio was obtained with the application of 60-30-20 N, P_2O_5 and K_2O kg ha^{-1}.

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