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Effect of nutrient levels and liquid organic formulations on growth and yield of Sorghum (*Sorghum bicolor* L.)

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Abstract
The field experiment was conducted during *Kharif* season 2023 at experimental field of Crop Research Farm- 2, Department of Agronomy, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH7.3), low in organic carbon (0.48%), available nitrogen (230 kg/ha), available phosphorus (13.60 kg/ha) and available potassium (215.4 kg/ha). The treatments consist of RDF levels (50%, 75%, 100%) and Liquid Organic Formulations (Panchagavya-3%, Vermiwash – 2%, Cow urine – 5%) along with control. The experiment was layout in Randomized Block Design with ten treatments each replicated thrice. Highest Plant height (225.74 cm), maximum plant dry weight (142.55 g/plant) and the yield attributes namely grains/earhead (807.00), Panicle length (14.06 cm), grain yield (3.56 t/ha), stover yield (6.26 t/ha), maximum gross return (89109.71 INR/ha), net return (60209.71 INR/ha) and benefit cost ratio (2.08) were also obtained highest in the 100% RDF + Panchagavya 3%.

Keywords: Sorghum, RDF levels, panchagavya, vermiwash, cow urine, economics

Introduction
Sorghum [*Sorghum bicolor* L.] is the king of millets and third important crop in the country after rice and wheat. Sorghum is grown extensively in almost all the countries in Africa, America, Brazil, China, Russia and Peru and grown substantially by marginal farmers. Sorghum ranks 5th among the world cereal food crops after Rice, Wheat, Maize and Barley. In India, it is most popularly known as “Jowar”. It is widely grown especially in tropical and sub-tropical regions of India. It is grown on an area of about 45 m. ha in the world with a production of about 61m.t, while in India it occupies an area of about 12.8 m ha with a total production of about 12.5 m.t. Average productivity of sorghum in India is only 977 kg per ha which is well below the world average of 1500 kg per ha.

Nitrogen (N) is the most important nutrient for crops, having a dynamic impact on all growth, yield, and grain-quality-determining processes. Thus, increasing nitrogen use efficiency (NUE) in sorghum would provide opportunities to achieve higher yield and better-quality grain was reported by Troy Ostmeyer *et al*. (2022) [12]. Grain yield and biomass, several studies have confirmed that there is an increase in grain-protein content in sorghum with an increase in available N was reported by Bayu *et al*. (2006) [1]. Phosphorus (P) is one of the most important. It plays an important role in many physiological processes such as photosynthesis, storage of energy and its transfer, respiration and cell enlargement, cell division etc. Potassium (K) is an essential nutrient for crop production and fulfills several important roles in plant growth. It helps plants in their physiological processes such as transportation of water, nutrients and carbohydrates, photosynthesis, N utilization, stimulation of early growth, insect and disease resistance for plants was reported by Habetamu Getinet *et al.* (2022) [4].

The use of fermented liquid organic manure or Bio-enhancer like panchagavya and jeevamrut are cheaper eco-friendly preparations made from cow products namely dung, urine, milk, curd and ghee. The panchagavya is an efficient plant growth stimulant that enhances the biological efficiency of crops. It is used to activate soil and to protect the plants from diseases and also increase the nutritional quality of fruits and vegetables.

It is used as a foliar spray, as soil application along with irrigation water, seed or seedling treatment etc. Three per cent panchagavya is an ideal concentration for the foliar spray. Bio-chemical properties of panchagavya revealed that it possesses almost all the major nutrients like N, P, K and micro nutrients essential for plant and growth hormones like IAA and GA required for crop growth (Selvaraj *et al.*, 2003) [10].

Materials and Methods

A field experiment was conducted during *Kharif*-2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), organic carbon (0.36%), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The treatments consisting of three levels of RDF *viz.* 50,75 and 100% and Liquid Organic Formulations *viz*. Panchagavya 3%, Vermiwash 2%, Cow urine 5%. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. The treatment combinations treatment 1 -50% RDF+ Panchagavya 3%, treatment 2 -50% RDF+ Vermiwash 2%, treatment 3 -50% RDF + Cow urine 5%, treatment 4 -75% RDF+ Panchagavya 3%, treatment 5 -75% RDF+ Vermiwash 2%, treatment 6 -75% RDF+ Cow urine 5%, treatment 7 -100% RDF + Panchagavya 3%, treatment 8 -100% RDF + Vermiwash 2%, treatment 9 - 100% RDF+ Cow urine 5%, treatment 10 - Control (RDF-80:40:40 NPK kg/ha). The growth parameters and yield, production was recorded at harvest from randomly selected plants in each plot. The data was computed and analysed by following statistical method of Gomez and Gomez (1984) [3].

Result and Discussion

Growth parameters

Plant height (cm) the data revealed that, significantly higher plant height (225.74 cm) was recorded with the application of 100% RDF + Panchagavya 3%, whereas treatment 100% RDF + Vermiwash 2% was found to be statistically at par with it. Plant dry weight (g) the data observed that, significantly the maximum dry matter accumulation (142.55 g) was recorded with treatment 100% RDF + Panchagavya 3%, whereas treatment 100% RDF + Vermiwash 2% was found to be statistically at par with it.

Significant and higher plant height (cm) was with the application of higher level of nutrients which owing to provide sufficient nutrients that are essentially required to various metabolic processes and finally resulting in plant growth. The variation in plant height in sorghum varieties at different levels of fertilizer application was also earlier reported by Mahama *et al*., (2012) [15]. Further, significant and higher plant height was with the application of the IAA and GA present in panchagavya when applied as foliar spray could have created stimuli in the plant system and increased the production of growth regulators in cell system and the action of growth regulators in plant system ultimately stimulated the necessary growth and development. Similar findings were also reported by Patel (2012) [8]. Significant and higher plant dry weight was with the application of fertilizer application might have resulted in better interception and utilization of radiant energy leading towards higher photosynthesis and finally more accumulation of dry matter by individual plant. Fertility level (100% RDF) significantly steppedup grain yield by 19, 36.6 and dry fodder 8.7, 20.7% over 75% and 50% RDF resulted in higher plant dry weight reported by Parasuraman *et al.* (2000) [7] and Singh *et al.* (2012) [11].

Yield and Yield attributes

The data of Grains/earhead revealed that, maximum grains/earhead (807) was significantly influenced by the application of 100% RDF + Panchagavya 3% by the influence of Nutrient levels and liquid organic formulations. Though 100% RDF + Vermiwash 2% was statistically at par with it. The significantly higher potassium uptake in sorghum grain and dry fodder was recorded under higher level of fertility. Increasing levels of fertilizer application increased the N, P and K uptake as reported by Singh *et al.* (2012) [11].

The data of Panicle length (cm) revealed that, significantly highest panicle length (14.06 cm) was recorded with the treatment of application of 100% RDF + Panchagavya 3%. Over all the treatments. However, the treatments 100% RDF + Vermiwash 2% which was found to be statistically at par with it.

The data of Test weight (g) revealed that, maximum test weight (g) (31.14 g) was recorded with the treatment of application of 100% RDF + Panchagavya 3% over all the treatments, minimum was recorded in Control (40.77 g) However, there was no significant difference among the treatments. NPK nutrients play an important role in vegetative growth and development of crop. Nitrogen is one of the major components of chlorophyll and essentially required for several enzyme activities in a plant system and the role of NPK in the plant to maintains cell division, carbohydrate production, stress management, protein synthesis, grain feeling and increasing in yield reported by Varma *et al*. (2017) [13].

The data of Grain yield (t/ha) revealed that, significantly maximum grain yield (3.56 t/ha) was recorded with the treatment of application of 100% RDF + Panchagavya 3% over all the treatments. However, the treatments 100% RDF + Vermiwash 2% were found to be statistically at par with it. The significant improvement in seed yield under the influence of application of fertilizer was largely a function of improved growth and the consequent increase in different yield and yield attributes reported by Jangir *et al*. (2016) [5].

The data of Stover yield (t/ha) the data revealed that, significantly maximum stover yield (6.26 t/ha) was recorded with the treatment of application of 100% RDF + Panchagavya 3% over all the treatments. However, the treatments 100% RDF + Vermiwash 2% was found to be statistically at par with it.

The achievement of present findings might be due to the better growth and development which achieved by better absorption, uptake and translocation and nutrients. The better photosynthesis and chlorophyll formation leads to higher production, translocation and partitioning of photosynthates. The increase of yield attributing characteristics reflects to achieve higher grain yield and biological yield reported by Kapoor *et al.* (2022) [6]. The seed yield increased due to the application of panchagavya and vermicompost might be due to it contains smaller amounts of plant growth regulators like IAA, GA and it also contains many nutrients and the foliar application helped plant to utilize all these nutrients efficiently and helped in increase in yield attributes which eventually helped in increase in seed yield. Crop yield is the complex function of physiological processesand biochemical activities, which modify plant anatomy and morphology of the growing plants. Seed and stover yield of chickpea were significantly influenced by different treatments of panchagavya application reported by Pratik *et al.* (2017) [9] and Chavan *et al.* (2023) [2]. Organic liquid manures which had a positive effect on vegetative and reproductive growth which ultimately led to realization of higher values for

growth attributes leading to higher yield of crop. Moreover, the IAA and GA present in panchagavya when applied as foliar spray could have created stimuli in the plant system and increased the production of growth regulators in cell system and the action of growth regulators in plant system ultimately stimulated the necessary growth and development.

Economics analysis

Gross return, Net return and benefit cost ratio of different treatments are depicted in (Table 3).

Gross return (89109.71 INR/ha) was found to be highest in 100% RDF + Panchagavya 3% and minimum gross return (77416.76 INR/ha) was found to be in control. Net return (60209.71 INR/ha) was found to be highest in 100% RDF + Panchagavya 3% and minimum net return (49216.76 INR/ha) was found to be in control. Benefit cost ratio (B:C) Benefit cost ratio (2.08) was found to be highest in 100% RDF + Panchagavya 3%, which was 33% higher than control.

Table 1: Effect of Nutrient levels and liquid organic formulations on Growth Attributes in Sorghum.

S.no	Treatments	Plant Height (cm) (At harvest)	Dry Weight (g/plant) (At harvest)	CGR (g/m2/day) (80-100 DAS)	RGR (g/g/day) (80-100 DAS)
1.	50% RDF+ Panchagavya 3%	201.90	133.31	11.01	0.003
2.	50% RDF+ Vermiwash 2%	200.99	136.48	13.09	0.003
3.	50% RDF + Cow urine 5%	200.75	130.63	5.60	0.001
4.	75% RDF+ Panchagavya 3%	206.79	137.52	10.71	0.002
5.	75% RDF+ Vermiwash 2%	205.01	133.66	7.05	0.002
6.	75% RDF+ Cow urine 5%	203.79	133.83	9.01	0.002
7.	100% RDF + Panchagavya 3%	225.74	142.55	4.30	0.001
8.	100% RDF + Vermiwash 2%	220.75	141.56	6.30	0.001
9.	100% RDF + Cow urine 5%	215.69	138.14	5.48	0.001
10.	Control (80-40-40 NPK kg/ha)	198.07	131.13	10.27	0.003
	F-test	S	S	NS	NS
	S.Em (±)	8.51	2.29	2.96	0.0007
	CD (p = 0.05)	17.87	6.81	-	-

Table 2: Influence of Nutrient levels and liquid organic formulations on yield attributes and yield of Sorghum.

S.no	Treatments	Number of Grains/ear head	Panicle length (cm)	Grain Yield (t/ha)	Stover Yield (t/ha)
1.	50% RDF+ Panchagavya 3%	715.73	12.48	3.22	5.87
2.	50% RDF+ Vermiwash 2%	721.47	11.99	3.17	5.91
3.	50% RDF + Cow urine 5%	719.53	11.83	3.18	5.82
4.	75% RDF+ Panchagavya 3%	731.53	12.87	3.13	5.95
5.	75% RDF+ Vermiwash 2%	717.07	12.49	3.23	5.95
6.	75% RDF+ Cow urine 5%	714.27	11.89	3.26	5.97
7.	100% RDF + Panchagavya 3%	807.00	14.06	3.56	6.26
8.	100% RDF + Vermiwash 2%	784.07	13.22	3.49	6.19
9.	100% RDF + Cow urine 5%	747.40	12.50	3.41	6.12
10.	Control (80-40-40 NPK kg/ha)	705.73	11.41	3.10	5.82
	F-test	S	S	S	S
	S.Em (±)	21.37	0.38	0.09	0.07
	CD (p = 0.05)	63.51	1.12	0.29	0.21

Table 3: Influence of Nutrient levels and liquid organic formulations on economics of Sorghum.

S. No	Treatments	Gross returns (INR/ha)	Net returns (INR/ha)	B: C ratio
1.	50% RDF+ Panchagavya 3%	80611.04	53711.04	2.00
2.	50% RDF+ Vermiwash 2%	79352.67	52552.67	1.96
3.	50% RDF + Cow urine 5%	79490.76	52740.76	1.97
4.	75% RDF+ Panchagavya 3%	78231.00	50331.00	1.80
5.	75% RDF+ Vermiwash 2%	80708.07	52908.07	1.90
6.	75% RDF+ Cow urine 5%	81566.74	53816.74	1.94
7.	100% RDF + Panchagavya 3%	89109.71	60209.71	2.08
8.	100% RDF + Vermiwash 2%	87185.66	58385.66	2.03
9.	100% RDF + Cow urine 5%	85150.05	56400.05	1.96
10.	Control (80-40-40 NPK kg/ha)	77416.76	49216.76	1.75

Conclusion

It is concluded that, among different combinations 100% RDF with Panchagavya 3% has performed better in growth parameters and yield of sorghum, which was also proven economically profitable.

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