International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 2, 2020, pp.-9419-9422.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

POTENTIAL ROLE OF CROPPING SYSTEM AND INTEGRATED NUTRIENT MANAGEMENT ON NUTRIENTS UPTAKE AND UTILIZATION BY SWEET SORGHUM AND PHILLIPESARA IN MOLLISOLS

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Received: January 06, 2020; Revised: January 24, 2020; Accepted: January 27, 2020; Published: January 30, 2020

Abstract: Field experiment was conducted during two consecutive Kharif seasons at Instructional Dairy Farm of G.B. Pant University of Agriculture and Technology, Pantnagar to evaluate the effect of intercropping and different sources of nitrogen on nutrient (NPK) content and uptake of sweet sorghum and phillipesara. The experimental results showed that the uptake of all nutrients and content of nitrogen of phillipesara due to intercropping reduced significantly over sole crop while content and uptake of all nutrients reported to be higher due to all the integrated sources of nitrogen compared to 100 percent nitrogen through inorganic fertilizer. In sweet sorghum inter cropping of phillipesara exhibited the superiority over sole sweet sorghum in terms of content and uptake of all nutrients (NPK), but this increase was significant only for the content and uptake of phosphorus. The sources of nitrogen significantly influenced the uptake of nitrogen and potassium. Total uptake of nitrogen, phosphorus and potassium by mixed fodder was significantly higher when 50 percent nitrogen through inorganic fertilizer + 50 percent through vermicompost (F3) was applied to intercropping system. However, application of 100 percent nitrogen through inorganic fertilizer (F1) caused significant reduction in content and uptake of all nutrients during both the years.

Keywords: *Sweet sorghum, Phillipesara (Phaseolus trilobus), Intercropping, INM, Nutrients content, Nutrient uptake*

Citation: Singh S., *et al*., (2020) Potential Role of Cropping System and Integrated Nutrient Management on Nutrients Uptake and Utilization by Sweet Sorghum and Phillipesara in Mollisols. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 2, pp.- 9419-9422.

Academic Editor / Reviewer: Rishikesh Singh, Darusha Witharana, Dr Prashant Shrivastava, Dr Sneh Gautam

Introduction

Sweet Sorghum [*Sorghum bicolor* (L.) Moench.] is a multipurpose sorghum with efficient C4 photosynthetic pathway, tolerance to drought, water logging, salinity and acidic soils which makes it a preferred crop for cultivation on marginal areas [1,2]. Sweet sorghum is becoming the first choice of farmers and ethanol producing industries worldwide because of less cost of cultivation than that of sugarcane [3]. Phillipesara (*Phaseolus trilobus*) is a leguminous cover/fodder crop. Intercropping has been widely used to maximize productivity and efficiency of the resources. It is widely recognized that neither organic manures nor inorganic fertilizers can give higher and sustainable yield. Timsina, (2018) [4] suggested that the integrated and/or site-specific precision nutrient management of inorganic and organic sources is crucial for sustainable soil fertility management and to achieve food security. Therefore, integrated nutrient management is need of the time. It is well documented that conjunctive use of organic and chemical fertilizers helped in reducing the nutrient losses and improved their use efficiency and yield sustainability [5]. Nitrogen plays a crucial role in determining the performance of cereal/legume intercropping. Legume however, have been reported as poor competitors for phosphorous when intercropped with cereals, this suggests that the nutrients utilization by legume in cereal + legume might vary under different agronomic and nitrogen fertilization practices. The improved yield and quality of forage sorghum, legumes and their mixture due to integrated nutrient management have been reported by many workers. However, the information on integrated nutrient management using inorganic fertilizer, FYM and vermicompost in sweet sorghum (sole or intercropped) is meagre. In view of the above, the present study was undertaken to study the effect of cropping system and source of nitrogen on nutrients content and uptake of sweet sorghum and phillipesara.

Materials and Methods

The experiment was conducted at Instructional Dairy Farm of G.B. Pant University of Agriculture and Technology, Pantnagar, India, during two kharif seasons. Soil of the experimental field was silty clay loam in texture with pH 7.3 and contained high organic carbon (0.77%), low available nitrogen (280 kg/ha) medium available phosphorus (27.3 kg/ha) and potassium (247 kg/ha). The treatment, three cropping system (sole sweet sorghum, sole phillipesara, sweet sorghum + phillipesara intercropping) and six different sources of nutrients (100% of recommended N through inorganic source (F1), 75% of recommended N through inorganic sources + 25% through vermicompost (F2), 50% of recommended N through inorganic source + 50% through vermicompost (F3), 75% of recommended N through inorganic source + 25% through FYM (F4), 50% of recommended N through inorganic source + 59% through FYM (F5) and 50% of recommended N through inorganic source + 25% through vermicompost + 25% through FYM (F6) were tested in a randomized block design with 4 replications. The phillipesara crop was intercropped in between the sweet sorghum rows (1:1) in an additive series.

The recommended dose of NPK applied to sole sweet sorghum was 120-60-40 kg/ha, sole phillipesara was 25-60-0 kg/ha and for intercropping of sweet sorghum + phillipesara was 80-60-40 kg/ha. Nitrogen was applied through different sources as per treatments. Half of the nitrogen and full dose of P and K was applied at the time of sowing as basal application. Rest of the nitrogen was applied in two equal doses each at 30 and 50 days after sowing of sweet sorghum. However, in sole phillipesara, whole amount of N and P was applied as basal. The sowing of both the crops was done on 22 and 25 May during two years. The fodder of both the crops was harvested at 80 days stage.

Table-1 *Effect of intercropping and source of nitrogen on Nutrient content and uptake of sweet sorghum*

Treatment	Nitrogen				Phosphorus				Potassium			
	Content (%)		Uptake (kg/ha)		Content (%)		Uptake (kg/ha)		Content (%)		Uptake (kg/ha)	
	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year
Cropping system												
Sole	1.08	1.04	152.7	113.66	0.272	0.261	38.45	28.52	2.11	2.10	298.33	229.51
Intercropping	1.09	1.07	159.16	119.53	0.302	0.271	44.09	30.27	2.18	2.16	318.32	241.30
S.Em.±	0.01	0.03	2.14	1.45	0.004	0.004	0.69	0.49	0.02	0.019	4.32	2.56
CD at 5%	NS	NS	6.18	4.19	0.013	NS	2.01	1.42	0.05	0.05	12.44	7.39
N source												
F_1	1.06	1.01	144.82	107.48	0.243	0.222	33.19	23.62	2.04	2.09	278.71	222.42
F_2	1.07	1.05	149.66	117.56	0.273	0.257	38.18	28.77	2.21	2.14	309.12	239.59
F_3	1.09	1.10	167.46	125.73	0.316	0.306	48.54	34.97	2.17	2.20	333.39	251.46
F_4	1.10	1.07	155.81	112.50	0.282	0.255	39.94	28.48	2.14	2.14	303.31	234.01
F_5	1.09	1.04	163.19	119.76	0.291	0.265	43.06	28.73	2.15	2.16	318.14	239.19
F_6	1.13	1.08	160.57	119.01	0.316	0.311	45.06	34.27	2.25	2.20	320.56	242.49
S.Em.±	0.02	0.02	3.72	2.52	0.008	0.007	1.21	0.85	0.04	0.03	7.49	4.44
CD at 5%	0.06	0.06	10.7	7.26	0.023	0.022	3.48	2.46	0.13	0.09	21.55	12.8

Table-2 *Nutrients content and uptake of phillipesara as influenced by the treatments*

Treatment	Nitrogen				Phosphorus				Potassium			
	Content (%)		Uptake (kg/ha)		Content (%)		Uptake (kg/ha)		Content (%)		Uptake (kg/ha)	
	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year
Cropping system												
Sole	2.27	2.27	72.72	54.48	0.326	0.322	10.46	7.72	1.08	1.08	34.68	25.74
Intercropping	2.04	2.04	24.69	18.88	0.322	0.317	3.92	2.96	1.05	1.07	12.79	9.87
S.Em.±	0.01	0.01	0.71	0.55	0.006	0.007	0.22	0.15	0.02	0.02	0.80	2.00
CD at 5%	0.05	0.04	2.04	1.60	NS	NS	0.64	0.42	NS	NS	2.30	5.76
N source												
F_1	2.10	2.12	40.22	28.66	0.295	0.288	5.67	3.88	0.97	0.97	18.66	13.12
F_2	2.16	2.12	45.81	34.6	0.302	0.303	6.43	4.97	1.01	1.05	21.46	17.18
F_3	2.20	2.20	58.75	47.88	0.325	0.313	8.65	6.76	1.10	1.12	29.32	24.36
F_4	2.13	2.15	53.27	39.54	0.34	0.335	8.40	6.17	1.09	1.09	27.22	20.07
F_5	2.12	2.16	41.74	31.45	0.33	0.325	6.56	4.87	1.08	1.07	21.32	15.66
F_6	2.24	2.20	46.83	32.44	0.355	0.355	7.35	5.27	1.15	1.13	24.03	16.75
S.Em.±	0.03	0.02	1.23	0.96	0.011	0.012	0.39	0.25	0.03	0.03	1.38	1.34
CD at 5%	0.08	0.07	3.55	2.77	0.032	0.034	1.12	0.74	0.11	0.09	3.98	3.81

Table-3 *Total nitrogen uptake (kg/ha) by mixed fodder as influenced by the treatments*

N source	Ist Year				IInd Year			
	Sole phillipesara	Sole sweet sorghum	Intercropping system	Mean	Sole phillipesara	Sole sweet sorghum	Intercropping system	Mean
F_1	61.69	85.32	107.85	85.3	44.07	68.97	82.96	65.34
F_2	69.96	91.82	114.29	92.02	52.15	75.62	93.32	73.69
F_3	90.48	98.75	131.03	106.75	74.32	86.60	105.60	88.84
F_4	80.63	89.86	119.66	96.71	61.45	74.07	92.98	76.16
F_5	62.73	88.55	114.06	88.10	46.12	73.32	102.75	74.06
F_6	73.14	92.00	115.70	93.61	48.79	82.37	97.62	76.26
Mean	73.11	91.05	117.09		54.48	76.82	95.87	

	Cropping system	N- source	Interaction	Cropping system	N- source	Interaction
S.Em.±	2.96	4.19	7.26	1.27	1.79	3.11
CD at 5%	8.42	11.91	20.63	3.60	5.10	8.83

Table-4 *Total phosphorus uptake (kg/ha) by mixed fodder at 80 days stage as influenced by the treatments*

N source	Ist Year				IInd Year			
	Sole phillipesara	Sole sweet sorghum	Intercropping system	Mean	Sole phillipesara	Sole sweet sorghum	Intercropping system	Mean
F_1	8.43	18.82	24.57	17.27	5.91	14.37	17.12	12.47
F_2	9.43	23.5	29.09	20.67	7.12	18.72	22.03	15.96
F_3	12.74	27.45	35.39	25.19	10.15	23.37	26.97	20.03
F_4	11.35	21.22	30.98	21.18	9.16	17.42	21.28	15.95
F_5	9.42	23.47	29.55	20.81	6.52	18.5	23.36	16.13
F_6	10.84	26.62	31.51	22.99	7.48	22.92	26.55	19.12
Mean	10.34	23.51	30.18		7.72	19.22	22.88	

	Cropping system	N- source	Interaction	Cropping system	N- source	Interaction
S.Em.±	0.44	0.62	1.08	0.33	0.47	0.82
CD at 5%	1.25	1.78	3.07	0.95	1.35	2.33

The N content of forage on dry weight basis was determined by microkjeldhal method. Phosphorus content was determined in both sweet sorghum and phillipesara plant in the harvested samples after tri-acid digestion, following molybdovanado-phosphoric acid method. Potassium content in sweet sorghum and phillipesara plant samples was determined using flame photometer after tri-acid digestion. On the basis of N, P and K content of plants total N, P and K uptake was also determined using following formula:

Nutrient uptake (kg/ha) = Total dry fodder yield (q/ha) × percentage nutrient in dry fodder

Table-5 *Total potassium uptake (kg/ha) by mixed fodder at 80 days stage as influenced by the treatments*

N source	I[st]Year				II[nd]Year			
	Sole phillipesara	Sole sweet sorghum	Intercropping system	Mean	Sole phillipesara	Sole sweet sorghum	Intercropping system	Mean
F_1	27.6	177.4	195.6	133.6	19.4	140.1	149.1	102.4
F_2	31.8	202	212.5	148.8	25.1	159.3	170.2	118.2
F_3	42.9	206.7	221.3	156.9	35.6	169.2	181.7	128.8
F_4	39.7	183.7	205.9	143.1	29.3	148.6	160.4	112.8
F_5	30.9	185.4	197.2	137.8	22.1	148.6	181.2	117.3
F_6	36.4	195.5	213	148.3	23.7	172.2	172.3	122.7
Mean	34.9	191.8	207.6		25.8	156.3	169.2	

	Cropping system	N- source	Interaction	Cropping system	N- source	Interaction
S.Em.±	2.3	3.2	5.6	1.8	2.6	4.5
CD at 5%	6.5	9.1	15.8	5.2	7.3	12.7

Results and Discussion

Nutrient content and uptake of Sweet sorghum

Intercropping of phillipesara with sweet sorghum exhibited the superiority over sole sweet sorghum in terms of content and uptake of all nutrients (NPK) during both the years, but this increase was significant only for the content and uptake of phosphorus during both the years [Table-1]. Application of 50 percent nitrogen through inorganic fertilizer and 50 percent through vermicompost (F3), being at par with F2, F6 (first year), F2, F5 and F6 (Second year), significantly increased the nitrogen uptake compared to all other nitrogen sources during both the years. Nitrogen through inorganic fertilizer (F1) caused significantly lower nitrogen uptake compared to all other nitrogen sources, except F4 (both years), F2, F5 and F6 during 2007 which remained at par with F1. Application of nitrogen 50 percent through inorganic + 50 percent through vermicompost (F3), being at par with F4, F5 and F6, during first year and, with F6 during second year caused significant increase in phosphorus content and uptake compared to all other nitrogen sources. However, F1caused significant reduction in phosphorous content and uptake compared to all other nitrogen sources during both the years except F2 which was at par during first year with respect to content. Application of F3 caused significant enhancement in potassium uptake compared to all other sources during both the years, except F2 and F6 (both years) and F5 (Second year). Significant reduction in potassium uptake compared to all other nitrogen sources was noticed due to F1 during both the years, except that F1 remained at par with F4 (both years) and F5 (first year). The enhancement in growth parameters of sweet sorghum due to intercropping system might have increased the nutrient content and uptake as there existed a positive correlation between growth parameters of sweet sorghum and NPK content and uptake. Similar was the reason of having higher value of NPK content under application of nitrogen 50 percent through inorganic fertilizer and 50 percent through vermicompost (F3) compared to other nutrient sources [6] and Aariff Khan, *et al.* (2010) [7] suggested that integration of organic and inorganic fertilizer of nutrients increased the K uptake primarily because the organic sources have their residual effect, responsible for improving soil carbon and other properties. Vermicompost improve soil health, nutrient retention and their availability in soil which intern leads to vigorous plant growth and enhances uptake of soil N and P by crops [8]. Results of Mostafa Mohamed Selim (2018) [9] also confirmed who found that maize/legumes intercropped resulted in superior nutrients uptake.

Nutrient content and uptake of Phillipesara

Under intercropping, content of nitrogen and uptake of all nutrients reduced significantly over sole crop during both the years [Table-2]. These decreased values of NPK content and uptake by phillipesara can be explained in light of the fact that sorghum being a fast growing and heavy utilizer of nutrient might have extracted more available nutrients from the soil compared to sole phillipesara. The higher values of nitrogen, phosphorus and potassium under sole phillipesara compared to its intercropping system may be because of reduced nodulation and lower N_2 fixation by phillipesara under intercropping system, as it has also been suggested by Reddy and Willey(1981) [10] that groundnut had lower nodules and much lower N_2 fixation per plant in millet + groundnut mixture than when grown alone. All the integrated sources of nitrogen caused higher content and uptake of all nutrients compared to F1 during both the years. The 50% of recommended N through inorganic source + 25% through vermicompost + 25% through FYM (F6) significantly enhanced the content of all nutrients compared to all other sources during both the years. However, this increment was not significant in treatments F2, F3 (first year), F3, F4, F5 (second year) for nitrogen, F3, F4 (both years), F5 (first year) for phosphorus and F3, F4, F5 (both years), F2 (second year) for potassium. While (F1), being at par with F2, F4, F5 (nitrogen), F2, F3 (phosphorus) and F2 (potassium) during both the years, reduced the content of all nutrients significantly as compared to all other sources of nitrogen during both the years. The uptake of all nutrients due to (F3) was significantly higher compared to all other nitrogen sources during both the years, except uptake of phosphorus due to F4 (both years) and potassium due to F4 during first year where uptake of these nutrients remained at par with F3. Higher values of content and uptake of all nutrients under integrated sources of nitrogen might be due to beneficial effect of combinations of inorganic nitrogen with different organic sources as earlier reported by Duraisamy and Mani (2001) [11] working on sorghum and sorghum + cowpea-maize cropping sequences. The findings corroborate the report of Kumawat *et al.* (2013) [12]. Duraisamy *et al.* (2001) [13] also suggested that the increasing levels of nitrogen and super imposing of coir pith either alone or with bio-fertilizer increase the N uptake under sole as well as intercropping systems.

Uptake of nutrients by mixed fodder of the cropping system

The significant interaction existed between cropping system and nutrient source with respect to N, P and K uptake by crops [Table-3,4 & 5]. Nitrogen and phosphorus uptake were significantly higher in the combined fodder obtained by application of 50 percent nitrogen through inorganic fertilizer + 50 percent nitrogen through vermicompost applied to intercropping system. The study made on NPK uptake of mixed fodder of phillipesara and sweet sorghum revealed that the combined fodder uptake more NPK over all other systems under F3, removed significantly higher NPK compared to remaining treatment combinations. The additive effect of both crops under intercropping system might have caused higher NPK uptake by combined fodder, the higher dry matter yield and percentage of nutrients under F3 applied to intercropping system was responsible for such effect. Dahiya, *et al.*, (1987) suggested that integration of organic and inorganic fertilizer of nutrients increased the K uptake primarily because the organic sources have their residual effect, responsible for improving soil carbon and other properties. Vermicompost improve soil health, nutrient retention and their availability in soil which intern leads to vigorous plant growth and enhances uptake of soil N and P by crops. The findings corroborate the report of Swain et. al. (2019) [14] who reported more nutrient uptake in sweet corn+horse gram inter-cropping with integrated nutrient management [15-19].

Conclusion

On the basis of results obtained it can be concluded that inter cropping of legume in sweet sorghum resulted in Higher values of content and uptake of all nutrients under integrated sources of nitrogen due to beneficial effect of combinations of inorganic nitrogen with different organic sources.

Application of research: Phillipesara should be intercropped with sweet sorghum and application of nitrogen 50 percent through inorganic source and 50 percent through vermi-compost should be applied to this intercropping system.

Research Category: Cropping System

Acknowledgement / Funding: Authors are thankful to Director of Experiment Station, G.B. Pant University of Agriculture and Technology, Pantnagar, 263145, Uttarakhand, India. Authors are also thankful to ICAR-Krishi Vigyan Kendra, Banda, Mirzamurad, 221 307, Banda University of Agriculture and Technology, Banda, 210001, Uttar Pradesh, India

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Research project name or number: Research station trials

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: ICAR-Krishi Vigyan Kendra, Banda, 221 307

Cultivar / Variety / Breed name: Sweet Sorghum

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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