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Effect of nutrient management in citronella, lemongrass and Palmarosa intercropping with wheat

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Abstract

The field experiments were carried out during *Rabi* seasons of 2020-21 and 2021-22 at Students' s Instructional Farm (SIF), Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, to study the "Response of nutrient management in Citronella (*Cymbopogon winterianus*), Lemongrass (*Cymbopogon flexuosus*) and Palmarosa (*Cymbopogon martinii*) intercropping with Wheat (*Triticum aestivum* L.)". was carried out on a sandy loam soil at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during 2020-2021 and 2021-22. To study the effect of Wheat on growth, yield and biomass yield of Citronella, Lemongrass and Palmarosa and their economics. The experiment was laid out in Split Plot Design with 9 cropping systems with different combinations [Lemongrass + Wheat (100% RDF), Citronella + Wheat (100% RDF), Palmarosa + Wheat (100% RDF), Lemongrass + Wheat (75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM), Citronella + Wheat (75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM), Palmarosa + Wheat (75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM), Lemongrass + Wheat (50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM), Citronella + Wheat (50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM) and Palmarosa + Wheat (50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM)] each replicated 3 times. The soil of experimental field was slightly alkaline with 8.08 pH and 0.21 EC. The soil is low in organic carbon and low in available nitrogen (260 kg/ha), medium in available phosphorous (17.62 kg/ha) and medium in potash (175.5kg/ha). The Citronella crop (cv.BIO-13), Lemongrass (cv.Pragathi-1) and Palmarosa (cv.PRC-1) was planted in 27th august 2016 at 60X60 cm with different nutrient management as 100% RDF, 75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM 50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM. The Wheat (HD-2967) was sown 29th November 2020-21 and 30th November 2021-22 at 20cm spacing. The intercrop during *Rabi* season was sown along with Citronella, Palmarosa and Lemongrass as per treatment to maintain the different Nutrient management with cropping system. The Lemongrass, Citronella and Palmarosa herbs for harvested during experiment period on 24th Nov 2020, 10th April 2021 and 25th Nov 2021, 10th April 2022 after harvesting of essential oil yielding herbs distillation was done for oil extraction. Highest B:C ratio in was found in Wheat intercrop with Palmarosa (75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM) is 2.6842 followed by followed by Wheat intercrop with Palmarosa (50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM) is 2.6220 and lowest in Citronella + Wheat (100% RDF) is 2.1468.

Keywords: Cropping system, soil health, nutrient management and economics

Introduction

Intercropping of aromatic crops with field crops and is a another technique to increase yield, income of farm and risk management by best utilization of available resources because aromatic crops are perennial type which requires less maintenance and which give more income in terms of herbage, oil and perfumery purpose. Constant use of inorganic chemicals and fertilizers will reduce the soil health and environment. (Dwivedi and Dwivedi, 2007). The availability of FYM with the farmers can be utilized for to reduce the cost of cultivation and to maintain the soil health and crop management technique in order to sustain the productivity of essential oil yield grasses (like citronella, Lemongrass, palmarosa, etc.) with Wheat cropping system. Legume intercropping system can also helps maintains the soil health and yield sustainability. The research work carried out on this aspect has been mainly sole crop based so far, while a few systematic efforts have been made to evaluate the effect of nutrient management and cropping system in intercropping of essential oil yielding Grasses with Wheat on the cropping system.

Hence, a field experiment was conducted to investigate the effect of FYM and inorganic fertilizers at different doses and cropping system as an intercropping with citronella, lemongrass and palmarosa with wheat at CSAUT Kanpur.

Materials and Methods

The trial was conducted in the field No. 03 at Student's Instructional Farm, Department of agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.) during Rabi season 2020-2021 and 2021-22. Geographically, Kanpur is situated in subtropical region. It is situated at an elevation of 125.9 meter above mean sea level, 26°20' 35" North latitude and 80°18'35" East longitude. It is situated in the alluvial belt of Indo-Gangetic plain in the Central Part of Uttar Pradesh, which comes into Agro-climatic zone-V. The soil of the experimental field was sandy loam in texture, low in organic carbon and low in available nitrogen, medium in available phosphorus and medium in available potassium respectively. Value of pH showed that the experimental field was slightly alkaline in nature. The experiment was laid out in Split Plot Design with 9 cropping systems and nutrient management with different combinations [Lemongrass + Wheat (100% RDF), Citronella + Wheat (100% RDF), Palmarosa + Wheat (100% RDF), Lemongrass + Wheat (75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM), Citronella + Wheat (75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM), Palmarosa + Wheat (75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM), Lemongrass + Wheat (50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM), Citronella + Wheat (50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM) and Palmarosa + Wheat (50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM)) and Palmarosa + Tomato (75% RDF+10 t FYM)] each replicated 3 times. The FYM was incorporated thoroughly 2 weeks before the sowing of wheat crop. The economics of the cropping system under different treatments was calculated in terms of net returns and B: C ratio using Sale price of Wheat MSP Rs.1975/q and Citronella & lemongrass oil as per India in perfumer Rs. 1000/kg and palmarosa Rs. 2000/kg.

Results and Discussion

Performance of essential oil yielding grasses intercropped with wheat

Performance of Citronella

The data recorded in relation to plant height (cm), tillers per plant, herbage yield and oil yield after the harvesting Citronella crop which shows non-significance in plant height and significant in tillers per plant, herbage yield and oil yield and in intercropping of Wheat which were not affected by space and intercrop. Similar results reported by Srivastava *et al.* (2016) [13], Ansari *et al.* (2015) [1], Mani ram *et al.* (2015) [6], Ansari *et al.* (2014) [2] and Verma *et al.* (2014) [16]

Nutrient management shows significant results to Citronella crop in terms of plant height (cm), tillers per plant, herbage yield and oil yield. Similar results reported by Singh *et al.* (2008) [11], Tanu *et al.* (2004) [15] and Ram *et al.* (2000) [9].

Performance of Lemongrass

The data recorded in relation to plant height (cm), tillers per plant, herbage yield and oil yield after the harvesting Lemongrass which shows non-significance in plant height and significant in tillers per plant, herbage yield and oil yield and in intercropping of Wheat which were not affected by space and intercrop. Similar results reported by Gajbhiye *et al.* (2013) [5], Pratibha *et al.* (2011) [8] and Prasad and Mukherjee (1980) [7].

Nutrient management shows significant results to Lemongrass crop in terms of plant height (cm), tillers per plant, herbage yield and oil yield. Similar results reported by S. Rashmi and S.B. Singh (2013) [10], Gajbhiye *et al.* (2013) [5], Pratibha *et al.* (2011) [8], Singh (2003) [12] and Prasad and Mukherjee (1980) [7].

Performance of Palmarosa

The data recorded in relation to plant height (cm), tillers per plant, herbage yield and oil yield after the harvesting Palmarosa crop which shows non-significance in plant height and significant in tillers per plant, herbage yield and oil yield and in intercropping of Wheat which were not affected by space and intercrop. Similar results reported by Wankhade *et al.* (2010a) [17] and Srivastava *et al.* (1998) [14].

Nutrient management showed significant results to Palmarosa crop in terms of plant height (cm), tillers per plant, herbage yield and oil yield Pratibha *et al.* (2011) [8], Wankhade *et al.* (2010a) [17], Chauhan *et al.* (2000) [3].

Table1: Herbage yield of Citronella, Lemongrass and Palmarosa grasses (t/ha) during 2020-21 and 2021-22.

Treatments	Herbage yield (t/ha)											
	(t/ha)			(t/ha)			(t/ha)			(t/ha)		
	2020-21	2020-21	Pooled	2020-21	2020-21	Pooled	2021-22	2021-22	Pooled	2021-22	2021-22	Pooled
Cropping system												
Wheat + Citronella	12.99	13.20	13.09	13.01	13.26	13.11	13.67	13.96	13.81	13.72	13.99	13.85
Wheat + Lemongrass	13.95	14.17	14.06	13.99	14.21	14.10	14.77	15.06	14.91	14.83	15.12	14.97
Wheat + Palmarosa	12.02	12.51	12.27	12.12	12.56	12.31	13.51	13.71	13.61	13.55	13.76	13.65
S.E(d)±	0.33	0.11	0.20	0.35	0.13	0.23	0.23	0.17	0.20	0.21	0.16	0.21
C D at (5%)	0.49	0.31	0.59	0.51	0.34	0.51	0.66	0.49	0.59	0.67	0.47	0.61
Nutrient management												
100% RDF	12.48	13.03	12.75	12.53	13.21	12.87	13.51	13.73	13.62	13.56	13.78	13.67
75% RDF 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50kg FYM	13.50	13.83	13.67	13.54	13.91	13.72	14.62	14.95	14.78	14.72	14.99	14.85
50% RDF 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50kg FYM	12.98	13.21	13.11	12.99	13.26	13.12	13.82	14.04	13.93	13.91	14.11	14.01

S.E(d)±	0.22	0.29	0.25	0.24	0.31	0.23	0.29	0.31	0.30	0.31	0.29	0.26
C D at (5%)	0.49	0.65	0.66	0.51	0.67	0.52	0.65	0.69	0.66	0.66	0.68	0.64
Interaction												
Nutrient management x Cropping system												
S.E(d)	0.46	0.43	0.47	0.45	0.31	0.43	0.48	0.47	0.47	0.43	0.45	0.44
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cropping system x Nutrient management												
S.E (d)±	0.38	0.51	0.52	0.35	0.48	0.47	0.51	0.54	0.51	0.53	0.55	0.54
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Herbage yield of essential oil yielding grasses (kg/ha) during 2020-21 and 2021-22.

Treatments	Oil yield (kg/ha)											
	(kg/ha)			(kg/ha)			(kg/ha)			(kg/ha)		
	2020-21	2020-21	Pooled	2020-21	2020-21	Pooled	2021-22	2021-22	Pooled	2021-22	2021-22	Pooled
Cropping system												
Wheat + Citronella	48.53	49.43	48.98	48.57	49.76	49.16	50.32	50.96	50.64	50.67	51.12	50.89
Wheat + Lemongrass	50.32	51.43	50.87	50.39	51.67	51.03	53.27	53.86	53.56	53.63	54.56	54.09
Wheat + Palmarosa	44.56	45.62	45.09	44.61	45.89	45.25	46.54	46.71	46.62	46.84	46.98	46.91
S.E(d)±	0.78	0.28	0.51	0.61	0.31	0.53	1.39	0.66	0.46	1.12	0.56	0.39
C D at (5%)	2.22	0.81	1.45	1.98	0.92	1.51	3.96	1.88	1.32	2.98	1.71	1.21
Nutrient management												
100% RDF	45.67	46.11	45.89	45.77	46.34	46.05	47.51	47.98	47.74	47.62	48.21	47.91
75% RDF 5 t/ha FYM + Azotobacter + PSB @ 500 ml in 50kg FYM	53.43	54.99	54.21	53.98	55.45	54.71	56.65	57.32	56.98	56.99	58.32	57.65
50% RDF 5 t/ha FYM + Azotobacter + PSB @ 500 ml in 50kg FYM	48.56	49.13	48.84	48.81	49.41	49.11	50.32	50.85	50.58	50.79	51.37	51.08
S.E(d)±	0.92	0.91	0.89	0.88	0.93	0.83	0.76	1.03	1.12	0.69	1.01	1.03
C D at (5%)	2.03	2.02	1.97	2.12	2.14	1.99	1.68	2.27	2.47	1.57	2.19	2.31
Intracross												
Nutrient management x Cropping system												
S.E(d)	1.52	1.32	1.36	1.53	1.31	1.34	1.76	1.60	1.65	1.71	1.56	1.43
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cropping system x Nutrient management												
S.E(d)±	1.59	1.58	1.55	1.62	1.57	1.52	1.32	1.79	1.94	1.43	1.69	1.67
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Cost of cultivation

Treatments	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Wheat + Lemongrass (100%RDF)	34184.86	73791.10	39606.24	2.1586
Wheat + Lemongrass (75%RDF+5 t FYM + Azotobacter + PSB @ 500 ml in 50 kg FYM)	38831.47	87467.50	48636.03	2.2524
Wheat + Lemongrass (50%RDF+5 t FYM + Azotobacter + PSB @ 500 ml in 50 kg FYM)	36649.62	80421.72	43772.10	2.1943
Wheat + Citronella(100%RDF)	34595.54	73391.45	38795.91	2.1468
Wheat + Citronella (75%RDF+5 t FYM + Azotobacter + PSB @ 500 ml in 50 kg FYM)	39246.49	86781.34	47534.85	2.2112
Wheat + Citronella (50%RDF+5 t FYM + Azotobacter + PSB @ 500 ml in 50 kg FYM)	37063.48	79956.57	42893.09	2.1573
Wheat + Palmarosa (100%RDF)	35003.67	90805.92	55802.25	2.5941
Wheat + Palmarosa (75%RDF+5 t FYM + Azotobacter + PSB @ 500 ml in 50 kg FYM)	39654.32	106443.07	66788.75	2.6842
Wheat + Palmarosa (75%RDF+5 t FYM + Azotobacter + PSB +500 ml in 50 kg FYM)	37470.94	98250.15	60779.21	2.6220

Economic analysis

Treatment wise costs of cultivation were calculated and highest in wheat intercrop with palmarosa (75% RDF + 5 t/ha FYM + Azotobacter + PSB @ 500 ml in 50 kg FYM) (Rs.39654.32/ha) followed by other treatments. The lowest cost of cultivation is recorded in tomato intercrop with citronella (100% RDF) (Rs.34184.86/ha).

The data computed regarding gross income showed that the highest gross income in wheat intercrop with palmarosa (75% RDF + 5 t/ha FYM + Azotobacter + PSB @ 500 ml in 50 kg FYM) Rs.73391.45/ha and lowest gross income in wheat

intercrop with citronella (100% RDF) is Rs.133806.7/ha.

The data pertaining to net income rupees per hectare received under different treatments. Highest net income was obtained in wheat intercrop with palmarosa (75% RDF + 5 t/ha FYM + Azotobacter + PSB @ 500 ml in 50 kg FYM) is Rs.66788.75/ha followed by wheat intercrop with palmarosa (50% RDF + 5 t/ha FYM + Azotobacter + PSB @ 500 ml in 50 kg FYM) is Rs.158037.07/ha and wheat intercrop with palmarosa (50% RDF + 5 t/ha FYM + Azotobacter + PSB @ 500 ml in 50 kg FYM) is Rs.60779.21/ha.

Highest B: C ratio in was found in wheat intercrop with

palmarosa (75% RDF + 5 t/ha FYM + Azotobactor + PSB@500 ml in 50 kg FYM) is 2.6842 followed by followed by wheat intercrop with palmarosa (50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM) is 2.6220 and lowest in citronella + wheat (100% RDF) is 2.1468.

Conclusion

- In cropping system, herbage yield and oil yield highest in Lemongrass+ Wheat followed by Citronella + Wheat and Palmarosa + Wheat. In nutrient management herbage yield and oil yield highest in 75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM, followed by 75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM and 100% RDF.
- Highest B: C ratio in was found in Wheat intercrop with Palmarosa (75% RDF + 5 t/ha FYM + Azotobactor + PSB@500 ml in 50 kg FYM) is 2.6842 followed by followed by Wheat intercrop with Palmarosa (50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM) is 2.6220 and lowest in Lemongrass + Wheat (100%RDF) is 2.1468.
- Highest Net income rupees per hectare was obtained in wheat intercrop with palmarosa (75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM) is Rs.66788.75/ha followed by wheat intercrop with palmarosa (50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM) is Rs.158037.07/ha and wheat intercrop with palmarosa (50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM) is Rs.60779.21/ha.
- Thus for obtaining maximum profit Palmarosa + Wheat should be grown and fertilized 75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM (120kg N, 60kg P₂O₅ and 40kg K₂O/ha).
- It is a another practice to boost the yield, income of farm and risk management by best utilization of available resources because aromatic crops are perennial type which requires less maintenance and which give more income in terms of oil yield and perfumery use.

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