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Response of nutrient management in citronella, Lemongrass and Palmarosa intercropping with wheat

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Abstract

Essential oil yielding grasses like Citronella, Lemongrass and Palmarosa belongs to family Poaceae. These crops grow well in tropical and subtropical climate. The crop is extensively cultivated in the poor, marginal and waste lands and also along the bunds as live mulch. is a most important staple food crop of the world which grown ancient time in the world and known as 'king of cereal' belong to the family 'Poaceae'. In India, wheat is the second most important cereal crop next only to rice and a key crop of the green revolution in post green revolution era. India stands second among wheat producing countries after China. It is the most important staple food of about two billion people (36% of the world population). Worldwide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally. It is cultivated globally on an area of (223 m ha). With the production of (737 m t) of grains annually to the world food basket, with an average productivity of 3235 kg ha⁻¹ it's the most important *Rabi* cereal crop of India, cultivated on an area of (31mh) with the production of (98.38mt), and productivity of 3216 kg ha⁻¹. 85 percent area of wheat grown under irrigated condition. In Uttar Pradesh, wheat is the cultivated an area of (9.70 m h) with the production of (30.50 m t) and productivity of 3150 kg ha⁻¹(Anonymous, 2022). Intercrop with perennial aromatic grasses it helps to reduce the insecticide usage and gives supplementary income to farmers in terms of oil yield, perfumery & cosmetic and flavouring industries. Therefore, the present investigation was carried out on nutrient management in Citronella, Lemongrass and Palmarosa intercropping with Wheat. To study the effect of Citronella, Lemongrass and Palmarosa on growth and yield attributes of Wheat and on soil health. Observation collected during experimental trail *viz.*, organic carbon, soil pH, EC, available Nitrogen, phosphorous and potassium and yield attributes of wheat are number of tillers (m⁻²) length of ear (cm) weight of ear (g) number of spikelets/ear number of grains/ear test weight (g) biological yield (q/ha) grain yield (q/ha) straw yield (q/ha) and harvest index (%).

Keywords: Cropping system, soil health and nutrient management

Introduction

Growing two or more crops simultaneously on the same piece of land with a definite row pattern. example Intercropping of aromatic crops with field crops at row ratio of 3:3 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. Constant use of inorganic chemicals and fertilizers will reduce the soil health and environment. (Dwivedi and Dwivedi, 2007) [3]. 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. A field experiment was conducted to investigate the effect of Citronella, Lemongrass and Palmarosa on growth and yield attributes of Wheat and on soil health.

Materials and Methods

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)] each replicated 3 times. Soil testing is done before and after the harvesting of wheat crop. Soil sample are collected at 2 different heights at 15 and 30cm with the help of screw auger. The FYM was incorporated thoroughly 2 weeks before the sowing wheat crop.

Results and Discussion

Performance of Wheat on intercropping with essential oil yielding grasses

Experiment during the winter seasons of 1999-2000 and 2000-01 in Uttar Pradesh, India. escape the effect of various row ratios, mustard cultivar and fertilizer rates on the growth, phenological events and yield of component crops in wheat + mustard intercropping. Treatments comprised: 8:1, 5:1 and 2:1 row ratios in Sanjukta, Alesh and Verdan mustard cultivars and 33.33%, 66.67% and 100% recommended dose

of NPK (90:45:45 kg NPK/ha). Association of wheat with mustard under the 8:1 row ratio recorded the maximum values in terms of leaf area index, dry matter accumulation, biological and grain/seed yields of both crops, but the minimum was associated with the 2:1 row ratio, whereas harvest index of wheat decreased significantly from 8:1 to 2:1 row ratio. For association with wheat, Sanjukta Alesh was proved to be more effective than Vardan, with a minimum depression reported by Srivastava and Verma (2014) [2].

In nutrient management significantly highest length of spike (10.39 cm), number of spikelets/spike (18.39) and number of grain per spike (45.86) was recorded significant result in Lemongrass + Wheat + 75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM as compare to Palmarosa + Wheat + 50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM and other intercropping treatments. The weight of grain/plant (2.44 g) was recorded in wheat Lemongrass + Wheat + 75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM at par Palmarosa + Wheat + 50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM respectively it may be due to higher uptake of nutrient in intercropping system. The similar finding also reported by Chaudhary *et al.* (2014) [2].

Table 1: Effect of treatment combination on soil health during 2020-2021 and 2021-22

Treatment	Organic carbon (%)		Soil pH		E.C. (mmhos/cm at 25 °C)		Available N (kg/ha ⁻¹)		Available P ₂ O ₅ (kg/ha ⁻¹)		Available K ₂ O (kg/ha ⁻¹)	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Wheat + Lemongrass (100% RDF)	0.42	0.43	8.08	8.00	0.21	0.21	254	255	17.50	17.35	178	179
Wheat + Lemongrass (75% RDF + 5 t FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM)	0.48	0.47	8.26	8.25	0.21	0.21	259	259	17.75	17.56	176.5	176
Wheat + Lemongrass (50% RDF + 5 t FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM)	0.46	0.49	8.24	8.25	0.22	0.21	257	260	17.75	17.50	177.5	176.5
Wheat + Citronella (100% RDF)	0.47	0.47	8.26	8.26	0.21	0.22	258.5	258.3	18	18.40	177	178.90
Wheat + Citronella (75% RDF + 5 t FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM)	0.47	0.49	8.21	8.20	0.22	0.21	258.5	259.5	18.10	18.30	178	178
Wheat + Citronella (50% RDF + 5 t FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM)	0.46	0.45	8.28	8.18	0.20	0.20	257	258	17.50	17.40	177.50	177.10
Wheat + Palmarosa (100% RDF)	0.44	0.45	8.15	8.10	0.21	0.21	253	257	17.57	17.55	177.10	176.90
Tomato + Palmarosa (75% RDF + 5 t FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM)	0.46	0.46	8.15	8.10	0.21	0.21	257	257.9	17.45	17.30	176.75	176.00
Wheat + Palmarosa (50% RDF + 5 t FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM)	0.45	0.46	8.18	8.18	0.22	0.21	258	259	17.50	17.20	177.20	176.80

To study the effect of intercropping of Wheat with Citronella, Lemongrass and Palmarosa on soil health

Data recorded regarding soil health, chemical analysis of soil was done treatment wise and presented in Table 1.

In intercropping combination highest organic carbon and available Nitrogen found in Wheat + Lemongrass (75% RDF + 5 t FYM + Azotobactor + PSB + 500 ml in 50 kg FYM) and Wheat + Citronella (75% RDF + 5 t FYM + Azotobactor + PSB + 500 ml in 50 kg FYM) followed by Wheat + Palmarosa (75% RDF + 5 t FYM + Azotobactor + PSB + 500 ml in 50 kg FYM) treatment. The lowest organic carbon and available nitrogen was found in Wheat + Lemongrass (100% RDF).

The available phosphorus (P₂O₅) was highest in Wheat + Citronella (100% RDF) intercropping system followed by

Wheat + Citronella (75% RDF + 5 t FYM + Azotobactor + PSB + 500 ml in 50 kg FYM) fertility level is 18.40 kg/ha and 18.30 kg/ha. The lowest availability was found in Wheat + Palmarosa (50% RDF + 5 t FYM + Azotobactor + PSB + 500 ml in 50 kg FYM) intercropping system.

The highest available potash (179 kg⁻¹) was found in Wheat + Lemongrass (100% RDF) i.e. followed by Wheat + Citronella (100% RDF) (178.90 kg/ha). The lowest availability was found in Wheat + Lemongrass (75% RDF + 5 t FYM + Azotobactor + PSB + 500 ml in 50 kg FYM) intercropping system i.e., 176 kg⁻¹ ha.

The data related to pH value, indicated that the pH value in Wheat + Citronella (100% RDF) intercropping as decreased the pH. The trend of E.C. was constant in most of the treatments.

Table 2: Effect of treatments on length of ear, number of spikelet's/ ear and ear weight in wheat during 2020-21 and 2021-2022

Treatments	Characteristics of spike								
	Length of ear (cm)			Number of spikelet			Ear weight (g)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Cropping system									
Wheat + Citronella	9.96	10.00	9.98	17.10	17.51	17.30	3.07	3.10	3.08
Wheat + Lemongrass	10.01	10.04	10.02	17.30	17.81	17.55	3.09	3.13	3.11
Wheat + Palmarosa	9.97	10.01	9.99	17.17	17.61	17.39	3.08	3.11	3.09
S.E(d)±	0.055	0.07	0.04	0.10	0.17	0.10	0.05	0.06	0.04
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nutrient management									
100% RDF	9.43	9.47	9.45	15.81	16.20	16.01	2.87	2.90	2.89
75% RDF 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM	10.37	10.39	10.38	18.41	18.90	18.65	3.29	3.32	3.31
50% RDF 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM	10.15	10.18	10.17	17.36	17.83	17.49	3.09	3.12	3.11
S.E(d)±	0.51	0.06	0.039	0.10	0.10	0.07	0.06	0.07	0.05
C D at (5%)	0.11	0.13	0.081	0.22	0.23	0.15	0.14	0.15	0.10
Interaction									
Nutrient management x Cropping system									
S.E(d)	0.08	0.10	0.06	0.17	0.18	0.12	0.10	0.12	0.08
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cropping system x Nutrient management									
S.E(d)	0.09	0.11	0.07	0.18	0.25	0.15	0.11	0.12	0.09
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Effect of treatments on number of grains per ear, grain weight/ear and test weight of wheat during 2020-21 and 2021-2022

Treatments	Grains characteristics								
	Number of grains per ear			Grains weight per ear (g)			Test weight (g)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Cropping system									
Wheat + Citronella	39.75	40.90	40.32	2.16	2.19	2.17	36.04	36.08	36.06
Wheat + Lemongrass	40.39	41.75	41.07	2.21	2.25	2.23	36.24	36.28	36.26
Wheat + Palmarosa	40.12	41.64	40.88	2.19	2.22	2.20	36.18	36.22	36.20
S.E(d)±	0.56	0.63	0.59	0.04	0.05	0.04	0.24	0.25	0.24
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nutrient management									
100% RDF	39.88	40.67	40.27	2.15	2.18	2.16	36.12	36.16	36.14
75% RDF 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM	44.17	45.86	45.01	2.40	2.44	2.42	37.63	37.68	37.65
50% RDF 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM	42.25	43.34	42.79	2.25	2.28	2.26	36.79	36.83	36.81
S.E(d)±	0.69	0.82	0.74	0.06	0.07	0.06	0.27	0.29	0.28
C D at (5%)	1.23	1.56	1.39	0.05	0.06	0.05	0.48	0.50	0.49
Intrraction									
Nutrient management x Cropping system									
S.E(d)	0.46	0.52	0.49	0.09	0.10	0.09	0.27	0.28	0.27
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cropping system x Nutrient management									
S.E(d)	0.57	0.60	0.58	0.12	0.13	0.12	0.31	0.32	0.31
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Growth and Yield Attributes of Wheat

Yield attributes of wheat *viz.*, number of grains per ear and ear weight (g) of wheat observed and highest number was recorded in Wheat + Lemongrass cropping system (41.07) followed by Wheat + Palmarosa cropping system (40.88) and the minimum in Wheat + Citronella (40.32) cropping system. grain weight per ear (g) of wheat recorded highest in Wheat + Lemongrass cropping system (2.25 g) followed by Wheat + Palmarosa cropping system (2.22 g) while the minimum was in Wheat + Citronella (2.19 g) cropping system. The test weight (g) of wheat was recorded highest in Wheat + Lemongrass cropping system (36.28 g) followed by Wheat + Palmarosa cropping system (36.18 g) and the minimum was in Wheat + Citronella (36.04 g) cropping system.

Under nutrient management practices highest length of spike (10.39cm), number of spikelets/spike (18.39) and number of grain per spike (45.86) was recorded significant result in Lemongrass + Wheat + 75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM as compare to Palmarosa + Wheat + 50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM and other intercropping treatments. The weight of grain/plant (2.44 g) was recorded in wheat Lemongrass + Wheat + 75% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM at par Palmarosa + Wheat + 50% RDF + 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50 kg FYM and lowest was recorded 100% RDF respectively it may be due to higher uptake of nutrient in intercropping system

Table 4: Effect of treatments on biological yield, grain yield, straw yield and harvest index of wheat during 2020-21 and 2021-2022

Treatments	Yield											
	Biological yield (q/ha)			Grain yield (q/ha)			Biological yield (q/ha)			Harvest index (%)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Cropping system												
Wheat + Citronella	94.89	96.77	95.83	37.43	38.30	37.66	57.56	58.47	58.02	39.44	39.57	39.50
Wheat + Lemongrass	95.96	96.82	96.39	37.93	38.43	38.18	58.44	58.96	58.70	39.53	39.69	39.61
Wheat + Palmarosa	95.03	96.89	95.96	37.51	38.37	37.94	57.65	58.52	58.08	39.47	39.60	39.53
S.E(d)±	0.62	0.88	0.54	0.64	0.72	0.48	0.73	0.37	0.41	0.14	0.05	0.09
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nutrient management												
100% RDF	91.96	93.20	92.58	34.57	35.28	34.92	56.49	56.92	56.95	37.59	37.85	37.72
75% RDF 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50kg FYM	98.12	100.34	99.23	39.53	40.60	40.06	58.55	59.74	59.14	40.28	40.46	40.37
50% RDF 5 t/ha FYM + Azotobactor + PSB @ 500 ml in 50kg FYM	94.92	96.97	95.94	37.38	38.53	37.95	57.54	58.45	57.99	39.38	39.54	39.46
S.E(d)±	0.70	0.82	0.54	0.61	0.76	0.49	0.73	0.50	0.44	0.12	0.06	0.06
C D at (5%)	1.53	1.79	1.11	1.33	1.66	1.01	1.59	1.09	0.91	0.27	0.14	0.09
Interaction												
Nutrient management x Cropping system												
S.E(d)	1.21	1.42	0.93	1.06	1.32	0.84	1.26	0.86	0.76	0.21	0.11	0.11
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cropping System x Nutrient management												
S.E(d)±	1.15	1.48	0.93	1.08	1.29	0.84	1.26	0.76	0.23	0.10	0.14	1.15
C D at (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Yield

Under cropping system practices yield (q ha⁻¹) of wheat was observed as biological yield (q ha⁻¹), grain yield (q ha⁻¹), straw yield (q ha⁻¹) and harvest index (%) of wheat (table 4) was also calculated highest biological yield under Wheat + Lemongrass cropping system (96.39 q ha⁻¹) followed by Wheat + Palmarosa cropping system (96.30 q ha⁻¹) and while the minimum yield was in Wheat + Citronella (96.26 q ha⁻¹) cropping system. Grain yield of wheat was also highest under Wheat + Lemongrass cropping system (38.39 q ha⁻¹) followed by Wheat + Palmarosa cropping system (38.36 q ha⁻¹) while the minimum in Wheat + Citronella (38.31 q ha⁻¹) cropping system. Straw yield was obtained highest in Wheat + Lemongrass cropping system (58.47 q ha⁻¹) followed by Wheat + Palmarosa cropping system (58.54 q ha⁻¹) and minimum in Wheat + Citronella (58.53 q ha⁻¹) cropping system. Harvest index was calculated highest in Wheat + Lemongrass cropping system (39.98%) followed by Wheat + Palmarosa cropping system (39.62%) while the minimum was obtained in Wheat + Citronella (39.56%) cropping system.

Under nutrient management practices yield (q ha⁻¹) of wheat was observed as biological yield (q ha⁻¹), grain yield (q ha⁻¹), straw yield (q ha⁻¹) and harvest index (%) of wheat (table 4.10) was also calculated in highest (99.38 q ha⁻¹, 39.53 q ha⁻¹, 59.55 q ha⁻¹ and 40.41%) value respectively was recorded under 75% RDF +5 tons FYM ha⁻¹ + Azotobactor + PSB @ 500 ml in 50 kg FYM respectively followed by 50% RDF +5 tons FYM ha⁻¹ + Azotobactor + PSB @ 500 ml in 50 kg FYM (95.96 q ha⁻¹, 38.53 q ha⁻¹, 57.56 q ha⁻¹ and 39.59%) and the lowest in 100% RDF (92.20 q ha⁻¹, 36.28 q ha⁻¹, 57.48 q ha⁻¹ and 38.65%) alone respectively.

Conclusion

1. In cropping system, Cultivation of Wheat with Lemongrass shows significantly higher yield than other cropping system and in nutrient management 75% RDF

+5 tons FYM ha⁻¹ + Azotobactor + PSB @ 500 ml in 50 kg FYM gives significantly higher yield than other nutrient management.

2. Intercropping effect with plant growth and soil health. Combination of Wheat + Lemongrass (75% RDF +5 tons FYM ha⁻¹ + Azotobactor + PSB @ 500 ml in 50 kg FYM) fertility level increase soil organic matter and increase in nitrogen level and decrease the soil pH. In combination with Wheat + Lemongrass (75% RDF +5 tons FYM ha⁻¹ + Azotobactor + PSB @ 500 ml in 50 kg FYM) intercropping system with different fertility level is better than all other suitable combination of Wheat with grasses intercropping system, respectively.

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