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CONTENTS

Integrated effect of natural farming concortions, organic farming practices and different fertilizer doses on productivity and profitability of wheat in western Himalayan zones of India

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ABSTRACT: The field experiment was carried out during the *Rabi* seasons of 2021-22 and 2022-23 at experimental block, School of Agricultural Sciences, Shri Guru Ram Rai University (SAS-SGRRU), Pathribagh, Dehradun, Uttarakhand to study the effect of various nutrient management approaches on growth, yield, quality, soil health and net profit of wheat crop. The experiment was laid out split plot design with two factors each at different levels. First factor includes absolute control, organic farming practices (Vermicompost @ 5 t ha^{-1} + seed inoculation with *Azotobacter* and PSB + 2 sprays of Vermiwash at 30 & 45 DAS); and Natural farming practices (Sieved cow dung @ 2.5 t ha^{-1} + seed treatment with *Bijamrit* + *Jeevamrit* @ 200 l ha^{-1}). The second factor comprises 100% RDF, 75% RDF, 50% RDF, 25% RDF and were replicated 3 times. Incorporation of organic farming practices, natural farming practices and different doses of NPK fertilizers significantly influenced all the growth parameters, yield and yield attributes gluten content in wheat grain, soil microbial count in the soil and economics of the cultivation during both years of experimentation. In view of the two years of the experimentation, it can be concluded that organic farming practices + 75% RDF showed 15% and 18% yield advantages during 2021 & 2022, respectively over natural farming + 75% RDF and 29% and 35% over absolute control + 75% RDF. Similarly organic farming practices + 75% RDF showed 13% and 10% monetary benefit during 2022 & 2023, respectively over natural farming + 75% RDF and 40% and 41% over absolute control + 75% RDF. Thus, adoption of organic farming practices + 75% RDF can be suggested for higher grain yield, net income generation of the wheat crop in western Himalayan zones of the Uttarakhand.

Key words: Natural farming, NPK, organic farming, vermicompost, wheat

More than two-thirds of the world's wheat (*Triticum aestivum* L.) is used for staple foods, and one-fifth is utilized for animal feed. Wheat contributes 21% of the food's calories and 20% of its protein. On a worldwide and national level, there are 215.48 and 29.65 million hectares cultivated with wheat, respectively, yielding 731.4 and 99.9 million metric tonnes with average productivity of 3390 and 3371 kg ha^{-1} (Jat *et al*., 2022). Wheat also contains 26.5% crude protein, 8.56% crude fat, and 4.18% ash. (Bilgicli and Ibanoglu, 2007). The world's population is expected to increase from 7.7 billion to 9.7 billion people by the year 2050, therefore wheat will probably continue to play an important role in guaranteeing global food security (Yapa and Pathirana, 2022).

While evaluating different crop production systems based on wheat, low productivity, declining soil fertility and health, low nutrient-use efficiency, and loss of sustainability are the main concerns which are causing hurdles in food security. These factors could have a significant impact on fertilizer, soil, and water management, affecting crop production and reducing nutrient losses (Fixen *et al*., 2014). For the past 50 years, chemical fertilizer has been applied widely without the addition of organic manures, which has led to a significant nutritional shortfall.

However, as integrated nutrient management is essential for improving production potential and yield, and preserving soil health while protecting soil, organic manure application as a sustainable source of plant nutrition is becoming more and more popular. Improvements in soil permeability, soil fertility, enzymatic activity, and soil organic carbon and its reserves are one of the many advantages of organic manures *viz*., farm yard manure, vermicomposts, and vermiwash (Bakht *et al*., 2007; Bali *et al*., 1986).

Wheat production may be increased by using *Azotobacter* alone or in combination with other bio-fertilizers (Marouek *et al*., 2022; Kumar and Ahlawat, 2004). *Bijamrit* and *Jeevamrit*, which are sustainable methods of natural farming for not only giving nutrients but also enhancing the soil's nutritional status, are becoming more popular. To increase wheat productivity and correct nutritional deficiencies, farmers employ chemical fertilizers, although doing so increases cultivation costs and has unfavorable environmental implications, including global warming.

Since organic manures and recycled waste may replace chemical synthetic fertilizers to a greater extent, the scope of integrated nutrient management has greatly expanded. Due to these factors, the current study was carried out at SGRR University, Dehradun to assess how integrated nutrient management might improve wheat production and overall sustainability with the goals of defining the impact on growth, yield characteristics, yield, quality, soil health and economics in Western Himalayan regions of Dehradun.

MATERIALS AND METHODS

The field experiment was conducted during the *Rabi* season of 2021-22 and 2022-23 in the Experiment block of the School of Agricultural Sciences of the Shri Guru Ram Rai University (SAS-SGRRU), Pathribagh Dehradun, Uttarakhand which is located in the north western region of Uttarakhand at an altitude of 450 m above mean sea level (MSL) and in between 29^0 58' and 31^0 2'30'' North latitude and 77^0 34'45'' and 78^0 18'30'' east longitudes. The experimental year's summer temperatures were between 31°C and 17°C and 32°C and 18°C, respectively, whereas the experimental year's winter temperatures ranged between 23°C and 6°C and 24°C and 70°C.

The soil of the experimental field was sandy loam with neutral pH of 7.4 and 7.5, during 2021-22 and 2022-23, respectively. The experiment was laid out split plot design with two factors with different levels. First factor Organics include Absolute control; Organic Farming practices (Vermicompost @ 5 t ha^{-1} + seed inoculation with *Azotobacter* and PSB + 2 sprays of Vermiwash at 30 & 45 DAS); and Natural farming practices (Sieved cow dung @ 2.5 t ha^{-1} + seed treatment with *Bijamrit* + *Jeevamrit* @ 200 l ha^{-1}). Second factor comprises 100% RDF; (75% RDF; 50% RDF; 25% RDF and were replicated 3 times.

The land of the experimental site was prepared properly with the aid of a tractor-drawn leveller after being ploughed fully followed by two cross-wise harrowing with a tractor-drawn harrow at the ideal soil moisture condition. On the 14^{th} and 16^{th} of November 2021 and 2022, respectively, the wheat variety DBW 173 was seeded using the line sowing method with a row-to-row distance of 22.5 cm and a seed rate of 100 kg ha^{-1}.

Vermicompost, sieved cow dung, *Jeevamrit*, and various dosages of RDF (120: 60: 40 kg NPK ha^{-1}) were incorporated and mixed well in the field's soil at the time of field preparation in accordance with the treatments specified in the various blocks. The seeds were treated with *Azotobacter*, PSB, and *Bijamrit* 24 hours before sowing, and vermiwash was sprayed at 30-40 DAS. During both years, the first irrigation was applied at the crown root initiation (CRI) stage, which is typically 21–25 days after sowing. Subsequent irrigations were applied according to the soil moisture content. When the grain hardened and had a moisture level of 18–20%, the crop was harvested manually with a sickle, and after being left to sundry for three to four days, the harvested produced was threshed to separate the grain from the straw.

The observation of growth- crop growth rate, dry matter accumulation was taken on the basis of randomly selected 5 plants from each plot to record dry weight at 30, 60, 90 DAS and harvest.

In order to estimate the amount of gluten, 25 g of wheat flour from the harvested grains from each treatment was placed in a plastic bowl, 15 ml of water was added to produce dough, and the bowl was then submerged in water for an hour. Gently kneading the mixture over a fine strainer removed the starch. To create a cohesive mass or so-called wet gluten, washed water was pressed into clean water. The content was squeezed dry and then placed in a petri dish with a tiny piece of aluminum foil. The wet gluten that resulted from this process was then dried in a hot air oven at 100° C for 24 hours (Imran *et al*., 2013). Dry gluten is the term used to describe the dried gluten produced via this method. The following formulas were used to calculate the wet and dry per cent gluten as described under:

$$\text{Wet gluten } (\%) = \frac{w_2 - w_1}{25} \times (100 - A)$$

$$\text{Dry gluten } (\%) = \frac{w_3 - w_1}{25} \times (100 - B)$$

Where, Weight of flour taken = 25 g, Weight of empty petri dish wash = $w_{1,}$ Weight of petri dish + wet gluten (before drying) = w_2 Weight of petri dish + dry gluten (After drying) = $w_{3,}$ Wet gluten content = A; Dry gluten content = B

Total bacterial, fungal, and actinomycetes populations were enumerated using serial dilution technique and pour plate method. After the appropriate incubation period, the colonies of microorganisms appearing on plates were counted following the standard method (Pramer and Schmidt, 1964). Nutrient agar medium (Johnson and Curl, 1972) was used for total bacterial count, Martin's dextrose rose agar medium and starch ammonium agar medium were used for fungi and actinomycetes, respectively.

Net return was calculated by subtracting respective values of cost of cultivation from gross return. The benefit-cost ratio was calculated by dividing net return by the cost of cultivation.

RESULTS AND DISCUSSION

The present investigation confirmed that significantly lowest values of growth rates, yield attributes were recorded in absolute control plots where neither neigher organic farming nor natural farming practices were incorporated. Organic farming and natural farming practices had a significant effect on crop growth rate, dry matter accumulation, yield, gluten content, microbial count and net income during both the years. Significantly higher growth attributes, grain yield, harvest index, wet & dry gluten content, microbial mass and net income of wheat crop were recorded under the incorporation of organic farming practices followed by natural farming practices. Highest growth and yield (Table 1, 3) under organic farming practices might be due to the fact that balanced application of vermicompost, vermiwash and bio-fertilizers like *Azotobacter* and PSB supplies the all-essential elements to plant to get good vegetative growth and maximum number of grains per spikes owing to enhanced grain yield and harvest index thus securing higher net returns. Similar observations were also reported by Kumar *et al*., 2015. Significant increase in per cent wet and dry gluten content (Table 2) under Organic farming practices may be explained by the fact that, vermicompost and vermiwash promote plant development and the absorption of many essential elements, such phosphorus and nitrogen, which in turn infer all the metabolic processes required to provide noticeable gluten content (Sharma and Garg, 2018; Suthar and Singh, 2008). Application of different doses of NPK fertilizers also had led to the significant changes in growth and yield of the crop being maximum with 75% RDF followed by 100%, 50% and 25%. Right amount of nitrogen, phosphorus and potassium is effective in the enhancement of vegetative parameters and dry matter accumulation (Maryada *et al*., 2001) which might have complementary interaction with grain yield. Similar results have also been found by Chauhan *et al.* (2002) who reported that growth rate, yield attributing characters increased with NPK as N being essential constituent of chlorophyll, P for energy transfer and enhanced root growth which helps in capturing the solar energy and production of more photosynthates, thereby

Table 1: Effect of natural farming, organic farming practices and different fertilizer doses on growth rate and dry matter accumulation in wheat crop during *rabi* 2021 & 22

Treatment	CGR (g m^{-2} day^{-1})				Dry matter accumulation (g m^{-2})					
	30-60 DAS		60-90 DAS		30 DAS		60 DAS		90 DAS	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Organic/natural farming practices										
Absolute control	0.35	0.40	1.04	1.55	10.53	12.00	41.80	58.49	131.0	157.8
Organic Farming practices	0.39	0.44	1.11	1.62	11.24	13.14	44.56	61.74	134.3	167.5
Natural farming practices	0.38	0.41	1.07	1.55	11.23	12.27	43.20	58.83	132.8	166.5
CD (5%)	0.010	0.020	0.040	0.050	0.01	0.45	1.03	1.44	1.150	6.64
Fertilizer doses										
100 % RDF	0.37	0.42	1.09	1.55	11.01	12.09	43.74	58.50	132.28	161.05
75 % RDF	0.37	0.44	1.09	1.61	12.20	13.14	46.98	64.51	132.84	168.17
50 % RDF	0.37	0.40	1.07	1.56	10.81	11.99	43.39	60.41	134.01	165.16
25 % RDF	0.36	0.40	1.06	1.57	10.98	12.65	42.63	60.34	131.75	161.31
CD (5%)	0.001	0.020	0.001	0.002	0.54	0.60	1.25	1.23	2.010	4.32

Table 2: Effect of natural farming, organic farming practices and different fertilizer doses on yield attributes and gluten content of wheat crop during *rabi* 2021 & 22

Treatment	Number of tillers per meter row length		Number of grains per ear		Test weight (g)		% wet Gluten content		% dry gluten content	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Organic/natural farming practices										
Absolute control	100.5	109.0	39.9	41.3	41.4	41.2	26.8	30.9	7.99	9.74
Organic Farming practices	107.4	120.9	42.7	42.9	45.1	46.0	33.5	37.2	9.81	11.3
Natural farming practices	103.9	115.6	40.5	41.7	42.6	41.4	28.6	34.2	8.46	10.2
CD (5%)	1.254	3.641	0.64	0.50	0.33	0.52	0.56	0.42	0.15	0.61
Fertilizer doses										
100 % RDF	105.5	113.8	40.3	41.9	42.1	41.2	30.0	34.2	8.29	10.7
75 % RDF	106.2	119.5	42.3	43.2	46.2	45.4	32.5	35.7	9.88	12.4
50 % RDF	102.9	116.5	40.8	41.7	43.2	42.0	29.6	33.1	8.50	10.7
25 % RDF	101.2	116.6	40.4	41.2	41.2	41.2	28.9	32.7	8.33	9.91
CD (5%)	3.110	2.119	0.57	0.54	0.57	0.54	0.43	0.79	0.31	0.61

more yield (Dhanush *et al.*, 2018). Remarkable impact of K on both grain yield and test weight derives from boosting either the photosynthetic capacity or productive life of flag leaves, which accounts for up to 80% of grain filling. The good effect of K on enhanced wheat production is mostly owing to higher kernel weight. K-fertilization contributes to both quality improvement and a reduction in some plant illnesses. Highest colonies of the microorganisms viz., bacteria, fungi and actinomycetes during both the years of investigation were found when organic farming practices were adopted followed by the natural farming and no organic manure application which might be due to the fact that vermicompost and vermiwash plays important role by excreting so many enzymatic substances which would result in increased microbial growth and its proliferation (Ibiene *et al.*, 2012). However, under various doses of RDF, significantly higher colonies of these microbes were observed when lower doses (25% RDF) via synthetic chemical fertilizers were applied as compared to higher doses (100% RDF). These finding were in line with the study done by Treseder, 2008 who observed chemical fertilizers have detrimental effects on soil microbial colonies, 84% of the study reported that soil microbes prone to be sensitive by adding N, P and K fertilizers

Organic farming practices along with 75% RDF resulted in higher grain production and net returns for both years as compared to rest of the treatment combinations (Table 4) which showed 15% and 18% yield advantages during 2022 and 2023, respectively

Table 3: Effect of natural farming, organic farming practices and different fertilizer doses on yield, economics and microbial count of wheat during *rabi* 2021 & 22

Treatment	Yield								Economics				Microbial count					
	Grain Yield q ha^{-1}		Straw Yield q ha^{-1}		Biological Yield q ha^{-1}		Harvest Index		Net Return (Rs.)		B: C Ratio		Bacteria Log cfu		Fungi Log cfu		Actinomycetes Log cfu	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Organic/natural farming practicesAbsolute control																		
	34.5	36.0	76.8	90.7	126.3	128.5	34.5	35.2	45,632	47,001	1.12	1.15	7.98	8.01	4.37	4.36	6.21	6.31
Organic Farming practices	48.1	54.9	82.9	92.4	132.2	140.2	41.2	42.2	75,490	76,030	2.54	2.64	8.05	8.09	4.44	4.46	6.26	6.35
Natural farming practices	42.2	43.6	80.9	91.1	128.1	134.5	39.7	40.2	67,691	69,680	1.95	2.01	8.02	8.06	4.42	4.44	6.24	6.32
CD (5%)	3.18	2.24	1.11	1.65	2.124	3.142	0.52	0.45	2024	3521	0.21	0.20	0.02	0.02	0.02	0.02	0.01	0.02
Fertilizer doses																		
100 % RDF	44.4	47.0	82.3	90.1	130.1	133.2	39.6	40.0	63,483	64,739	2.14	2.18	7.92	7.90	4.21	4.25	6.20	6.24
75 % RDF	45.6	48.4	84.7	92.3	135.1	141.2	42.2	44.0	64,530	65,998	2.57	2.64	7.92	7.94	4.28	4.32	6.14	6.26
50 % RDF	40.3	43.2	81.4	90.1	129.7	130.2	40.2	41.2	61,565	63,663	2.31	2.39	8.10	8.10	4.41	4.50	6.21	6.27
25 % RDF	36.1	40.8	80.1	89.4	128.4	128.6	40.0	40.4	61,552	62,547	2.25	2.30	8.12	8.14	4.45	4.46	6.24	6.30
CD (5%)	3.21	1.12	2.51	1.23	2.314	3.321	1.23	0.91	1240	1410	0.11	0.13	0.02	0.01	0.03	0.03	0.01	0.01

Table 4: Interaction effect of natural/ organic farming practices and different doses of NPK fertilizers on grain yield and net income of the wheat during *rabi* 2021 and 22

Organic/natural farming practices (A) Fertilizer doses (B)	Grain Yield (q ha^{-1})								Net Income (Rs.)							
	2021				2022				2021				2022			
	100 % RDF	75 % RDF	50 % RDF	25 % RDF	100 % RDF	75 % RDF	50 % RDF	25 % RDF	100 % RDF	75 % RDF	50 % RDF	25 % RDF	100 % RDF	75 % RDF	50 % RDF	25 % RDF
Absolute control	37.4	38.1	30.1	32.5	40.1	38.5	32.4	32.9	44,560	46,580	46,795	44,592	46,527	47,840	47,955	45,680
Organic Farming practices	50.4	53.2	48.5	40.1	52.3	58.5	54.9	53.9	76,540	78,560	70,410	74,590	77,540	78,910	74,120	73,550
Natural farming practices	45.3	45.4	42.2	35.6	48.5	48.0	42.2	35.6	69,350	68,450	67,490	65,475	70,150	71,245	68,915	68,410
CD at 5 %																
Factor (B) at same level of A	2.19				2.56				1155				1021			
Factor (A) at same or different levels of B	1.05				1.21				2564				2014			

over natural farming + 75% RDF and 29% and 35% over absolute control + 75% RDF. Vermicompost along with vermiwash and seed inoculation with bio-fertilizers greatly increases vegetative growth of the crop resulting in enhanced productivity (Kale, 2004). When inorganic fertilizers are combined with products made from organic manure, such as vermicompost, crop nutrient absorption is improved compared to when inorganic fertilizers are applied alone (Prakash *et al*., 2008). These outcomes are consistent with conclusions of several studies that the use of fertilizers and manures together enhanced wheat crop yields (Joshi and Vig, 2010). Present findings also support the claim that farmers can benefit from strategic planning that integrates the use of manures and inorganic fertilizers to preserve crop yields (Singh *et al*., 2007). Organic farming practices + 75% RDF recorded 13% and 10% monetary benefit during 2022 & 2023, respectively over natural farming + 75% RDF and 40% and 41% over absolute control + 75% RDF.

CONCLUSION

In view of the two years of the experimentation, it can be concluded that organic farming practices + 75% RDF showed 15% and 18% yield advantages during 2022 & 2023, respectively over natural farming + 75% RDF and 29% and 35% over absolute control + 75% RDF. Similarly organic farming practices + 75% RDF showed 13% and 10% monetary benefit during 2022 & 2023, respectively over natural farming + 75% RDF and 40% and 41% over absolute control + 75% RDF. Thus, adoption of organic farming practices + 75% RDF can be suggested for higher grain yield, net income generation of the wheat crop in western Himalayan zones of the Uttarakhand.

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