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CONTENTS

Integrated Nutrient Management for growth and yield enhancement of Wheat (*Tritium aestivum)* under irrigated conditions of Doon Valley, Uttarakhand

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ABSTRACT: The field experiment was carried out during the *Rabi* season of 2021-22 at the experimental block of the School of Agricultural Sciences of the Shri Guru Ram Rai University (SAS-SGRRU), Pathribagh, Dehradun, Uttarakhand to study the effect of various nutrient management approaches on growth, yield and net profit of wheat crop. The experiment was laid out in Randomized Complete Block Design (RBD) with eight treatments viz., Control (T_1);Vermicompost @ 5 t ha^{-1}+ Seed inoculation with Bijamrit + 50 % RDF (T_2); Vermicompost @ 5 t ha^{-1}+ PSB seed inoculation + 25 % RDF(T_3); FYM @5 t ha^{-1}+ PSB seed inoculation + 2 foliar spray of fermented buttermilk (T_4); 50% RDF + FYM @5 t ha^{-1}+ mulching @ 5 t ha^{-1}(T_5); 25% RDF + Jivamrit + seed inoculation with Bijamrit + 2 foliar spray of vermiwash + 2 foliar spray of fermented buttermilk (T_6); FYM @5 t ha^{-1}+ Bijamrit seed inoculation + 2 foliar spray of vermiwash (T_7) and 100 % RDF (T_8) which were replicated 3 times. The soil of the experimental field was sandy loam with low available nitrogen and organic carbon, medium available phosphorous and available potassium Application of 50 % RDF + FYM @ 5t ha^{-1}+ mulching has recorded more yield which is significantly higher than other nutrient management approaches. Substitution of 50 % inorganic fertilizers with FYM can be adopted for economically viable and sustainable wheat production with improved yield in irrigated conditions of Doon Valley areas of Uttarakhand.

Key words: Bijamrit, FYM, Jivamrit, nutrient management, wheat

Wheat (*Triticum aestivum)*, also known as the king of cereals is the second most important staple food grain crop. It plays a vital role in the food and nutritional security of the country. Nearly 55% of world's population depends on wheat for about 20 %of the calorie intake. The diverse environmental conditions and food habits of people in India support the cultivation of three types of wheat (bread, durum, dicoccum). Among these, bread wheat is contributing approximately 95% to total production. Proper combination of both organic and inorganic fertilizers has beneficial effects on crop growth and development and the yield component of wheat. Combination of all possible sources of nutrients like organic sources, inorganic sources and biological sources in a judicious way for obtaining an ecologically sound environment and economically optimal farming is well documented. This helps in gaining sustainable yield and improved soil quality for enhanced production. Many studies also revealed that the application of organic matter with chemical fertilizer increases the yield of biomass and grain yield of crops (Khan *et al.*, 2007).

Continuous use of synthetic fertilizers creates issues viz., nutrient deficiency in plants, and heavy metal accumulation, which further leads to food contamination besides deterioration of soil health, reduced productivity and sustainability. The deteriorating soil health, declining soil organic matter and increase in micronutrient deficiencies have put a big question mark on the sustainability of wheat production. For this, the use of indigenous sources like farm yard manure (FYM) should be encouraged as it supplies plant nutrient, improve the physical, chemical and biological properties of the soil and thereby increase the fertility and productivity of the soil while maintaining the ecological balance. To address these, the inclusion of inexpensive organic fertilizers either sole or with other organic resources in combination with inorganic fertilizers enhances soil health,and soil fertility and brings about sustainable crop yields without any negative impact on the environment (Verma, 2019a).

The use of organic and inorganic fertilizers offers

many advantages, including minimizing the dependency on inorganic sources, reducing potential environmental risks, and utilizing favorable impacts on soil characteristics to improve the efficiency of applied inorganic sources.This is seen as a key practice in the eco-friendly system to ensure sustainable and safe production. Yield attributing parameters like dry matter accumulation, no. of effective tillers, grains spike^{-1} and the test weight were shown to be influenced by the integrated use of inorganic and organic fertilizer (Mary *et al.,* 2018).Therefore, an integrated approach to plant nutrient management has gained momentum and importance in recent years. The objective of this approach is efficient, judicious and economic use of all major sources of plant nutrients in an integrated manner so as to maximize/ optimize yield of a crop or a cropping system without any adverse effect on the agro- ecosystem.

An integrated use of organic manure with inorganic fertilizer resulted in build-up of available nutrients in soil much more effectively than that of chemical fertilizer alone as reported by Bhatt *et al.* (2017). Therefore, the purpose of this field experiment was to find out the economical viable and sustainable nutrient management practices for achieving higher yield of wheat crop with appreciable chapatti making quality parameters under assured irrigated conditions of Western Himalayan region of Uttarakhand, India.

MATERIALS AND METHODS

The field experiment was conducted during *Rabi* season of 2021-2022 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. During summer of the experimental year, maximum & minimum temperature was ranged between 32^0 C and 18^0 C while winter temperature varied between 24^0 C and 7^0 C. The weekly relative humidity ranged from 78 – 85 %. The mean daily sun shine duration the crop growing period was 8.81 hours while mean maximum and minimum weekly bright sunshine duration were recorded 9.7 hours to 4.4 hours respectively during the period of experiment.

The soil of experimental field was sandy loam with neutral pH of 7.4. The experiment was laid out in Randomized Complete Block Design (RBD) with three replications and eight treatments. The treatments were Control (T_1); Vermicompost @ 5 t ha^{-1} + Seed inoculation with Bijamrit + 50 % RDF (T_2); Vermicompost @ 5 t ha^{-1} + PSB seed inoculation + 25 % RDF (T_3); FYM @ 5 t ha^{-1} + PSB seed inoculation + 2 foliar spray of fermented buttermilk (T_4); 50 % RDF + FYM @ 5 t ha^{-1} + mulching @ 5 t ha^{-1} (T_5); 25 % RDF + Jivamrit + seed inoculation with Bijamrit + 2 foliar spray of vermiwash + 2 foliar spray of fermented buttermilk (T_6); FYM @ 5 t ha^{-1} + Bijamrit seed inoculation + 2 foliar spray of vermiwash (T_7) and 100 % RDF (T_8).

At optimum moisture condition, the land of the experimental site was ploughed thoroughly cross wise for two times with tractor drawn harrow and final land preparation was done with mould board plough followed by proper leveling with the help of tractor drawn leveler. The wheat variety Jai Ram super 303 was sown on 12th of November 2021 by line sowing method in the open furrows at a row-to-row distance of 22.5 cm with the seed rate of 100 kg ha^{-1}. Vermicompost, PSB, Bijamrit, fermented buttermilk and mulch (corn stubbles) were applied as per the treatments given in different blocks of the design at the time of field preparation by incorporating and mixing it in the soil.Half of the total nitrogen and full P_2O_5 and K_2O were applied as basal and the remaining half nitrogen was top dressed in two splits at 21 DAS and 50 DAS.First irrigation was given at crown root initiation (CRI) stage usually 21-25 days after sowing and subsequent irrigations were given as per soil moisture content. The crop was harvested when the grain became hard with a moisture content of 19-20 %. Harvesting was done manually by the sickle and harvested produce was allowed to sundry for 3-4 days and threshed to separate grain and straw.

The observation of growth- dry weight and leaf area and yield attributes were taken on the basis of randomly selected 5 plants from each plot. Plants from the randomly selected places using a one- meter row length in each plot was cut close to the ground to record dry weight at 30, 60, 90 DAS and at harvest. Samples were first dried in sun and then oven dried at 65± 2^0 C till constant weight was achieved. After drying, the samples were weighed for recording dry weight. Crop growth rate (CGR), relative growth rate (RGR) and met assimilation rate (NAR) were analyzed by using following formula:

$$CGR = \frac{w_2 - w_1}{t_2 - t_1}$$

$$RGR = \frac{Log_e w_2 - Log_e w_1}{t_2 - t_1}$$

Where,

W_1= dry weight per unit area at t_1, W_2= dry weight per unit area at t_2.

t_1= first sampling, t_2= second sampling

$$NAR = \frac{(w_2 - w_1) \times (Log_e LA_2 - Log_e LA_1)}{(t_2 - t_1) \times (LA_2 - LA_1)}$$

Where,

W_1= dry weight per unit area at t_1, W_2 = dry weight per unit area at t_2

LA_1= leaf area at t_1, LA_2 = leaf area at t_2

t_1= first sampling, t_2= second sampling

Net return was calculated by subtracting respective values of cost of cultivation from gross return.

RESULTS AND DISCUSSION

Crop growth rate (CGR) and relative growth rate (RGR) of wheat crop (*Triticum aestivum*) was influenced by all the treatments used.These values were found to be maximum in T_5 and lowest in T_1. Net assimilation ratio (NAR) was found highest in T_3 with lowest in T_1 at 30 DAS. At 60 DAS the maximum NAR was found in T_6 treatment with lowest value from the T_2. However, application of organic manure to soils is well known to increase microbial population and their activities for nutrient cycling and production of plant growth enhancing substances results in enhanced growth of the crop (Arancon *et al.*, 2006; Verma, 2019b; Verma, 2019c; Verma, 2019d; Verma 2019e; Verma, 2019f).

Other growth parameters like Number of spike, spike length, number of grains per spike, yield were also influenced by the different eight treatments. The highest value of these parameters was recorded in T_5 treatment and found to be lowest in T_1.

In an experiment, it has been reported that number

Table 1: Crop growth rate, relative growth rate and net assimilation rate of wheat at different stages as influenced by different INM treatments

Treatments	CGR (g m^{-2} day^{-1})			RGR (mg g^{-1} day^{-1})			NAR (g m^{-2} day^{-1})		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	0.232	0.302	0.791	0.035	0.039	0.054	0.040	0.568	1.370
T_2	0.250	0.272	0.609	0.037	0.040	0.059	0.038	0.565	1.074
T_3	0.310	0.321	0.685	0.040	0.045	0.057	0.538	0.672	1.182
T_4	0.309	0.339	0.751	0.043	0.052	0.068	0.515	0.709	1.245
T_5	0.316	0.341	0.850	0.054	0.059	0.075	0.490	0.730	1.150
T_6	0.307	0.358	0.800	0.040	0.049	0.062	0.515	0.730	1.150
T_7	0.312	0.331	0.842	0.044	0.040	0.063	0.490	0.750	1.240
T_8	0.316	0.360	0.829	0.034	0.041	0.063	0.479	0.630	1.340
SEM±	0.009	0.012	0.032	0.001	0.001	0.001	0.017	0.680	1.215
CD at 5%	0.025	0.040	0.009	0.002	0.003	0.005	0.054	0.116	0.172

Control (T_1) , VC @ 5 t ha^{-1}+ Seed inoculation with Bijamrit + 50 % RDF (T_2) , VC @ 5 t ha^{-1}+ PSB seed inoculation + 25 % RDF(T_3) , FYM @ 5 t ha^{-1}+ PSB seed inoculation + 2 foliar spray of fermented buttermilk (T_4) , 50% RDF + FYM @ 5 t ha^{-1}+ mulching @ 5 t ha^{-1}(T_5) , 25% RDF + Jivamrit + seed inoculation with Bijamrit + 2 foliar spray of vermiwash + 2 foliar spray of fermented buttermilk (T_6), FYM @ 5 t ha^{-1}+ Bijamrit seed inoculation + 2 foliar spray of vermiwash (T_7), 100 % RDF (T_8)

Table 2: Yield attributing characters, yield and net return of wheat as influenced by the INM treatments

Treatments	No. of spikelet per spike	No. of grains per spike	Grain yield(t/ha)	Straw yield(t/ha)	Biological yield(t/ha)	Harvest index	Net return (Rs /ha)
T_1	62.00	26.3	1.80	2.56	4.50	40.1	20,366
T_2	68.1	27.5	3.00	3.30	4.30	42.3	35,660
T_3	74.2	30.2	3.09	4.02	7.72	45.4	50,833
T_4	65.2	31.0	3.13	4.29	8.12	45.6	56,455
T_5	86.1	29.09	5.27	4.83	9.12	46.6	72,500
T_6	82.2	34.6	5.04	4.81	8.90	46.2	65,670
T_7	78.4	35.2	4.12	3.56	6.45	43.2	48,150
T_8	77.8	28.9	4.02	3.32	6.05	42.5	44,633
SEM	3.93	1.89	0.03	0.01	0.12	0.40	930.2
CD at 5 %	12.00	5.30	0.140	0.28	0.45	1.10	2,800

Control (T_1) , VC @ 5 t ha^{-1} + Seed inoculation with Bijamrit + 50 % RDF (T_2) , VC @ 5 t ha^{-1} + PSB seed inoculation + 25 % RDF(T_3) , FYM @ 5 t ha^{-1} + PSB seed inoculation + 2 foliar spray of fermented buttermilk (T_4) , 50 % RDF + FYM @ 5 t ha^{-1} + mulching @ 5 t ha^{-1} (T_5) , 25 % RDF + Jivamrit + seed inoculation with Bijamrit + 2 foliar spray of vermiwash + 2 foliar spray of fermented buttermilk (T_6), FYM @ 5 t ha^{-1} + Bijamrit seed inoculation + 2 foliar spray of vermiwash (T_7), 100 % RDF (T_8)

of grains per spike is increased if farm yard manure or other organic fertilizers were added with NPK (Arif *et al.*, 2017). Kumar *et al.* (2017) also observed similar findings and reported that the maximum no. of grains increased by integrating FYM with NPK. Maximum grain yield 5.27 t $ha^{-1}$was recorded from T_5 treatment and lowest was found to be 1.8 t ha^{-1}in T_1 Treatment among all eight treatments.

Maximum straw yield was found to be 4.83 t ha^{-1}in T_5 treatment and lowest straw yield was found to be in T_1 treatment. For improvement in growth and yield attributes of wheat, the combination of FYM and other nutrients sources seems to be better than FYM alone (Davari *et al.*, 2012). The addition of FYM and nitrogen fertilizer increases the biological yield, harvest index of the crop (Singh *et al.*, 2018; Arif *et al.*, 2016).

Highest net returns of Rs 72,500 were recorded in T_5 treatment followed by T_6 in which net return was that was Rs. 65,670.

CONCLUSION

On the basis of one season study, it can be concluded that the growth, yield and net benefit of the wheat crop was influenced greatly by various nutrient management approaches. Application of FYM @ 3 t ha^{-1} along with 50 % RDF (120: 60: 40) N: P_2O_5:K_2O kg ha^{-1} with mulchingmay be suggested for enhancing grain yield and net returns under irrigated conditions of Doon Valley, Uttarakhand.

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