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Residual effect of nutrient management of *kharif* groundnut on growth, yield attributes, yield and quality of subsequent wheat under organic farming

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Abstract
A field experiment entitled, **"**Residual effect of nutrient management of *kharif* groundnut on growth, yield attributes, yield and quality of subsequent wheat under organic farming" was carried out during two consecutive *kharif* and *rabi* seasons of 2021-22 and 2022-23 on loamy sand soil of Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The nine nutrient management treatments under organic farming applied to groundnut during *kharif* season were laid out in randomized block design and twenty-seven treatment combinations comprising residual effect of preceding nine nutrient management treatments of groundnut followed by three levels of RDN through organic manure along with cow-based bio-enhancer to wheat tested in spilt plot design with three replications. Growth parameters, yield attributes, yield and quality of wheat after nutrient management treatments of groundnut remained unaffected due the residual effect of various nutrient management treatments under organic farming. 75% RDN through FYM: castor cake: vermicompost (1:1:1) + *panchgavya* @ 4% spray at 30 and 60 DAS to wheat recorded significantly higher growth parameters, yield attributes, grain yield (2779 kg/ha), straw yield (3926 kg/ha) and quality parameters of wheat. It also gave the highest net return (₹36727/ha).

Keywords: Groundnut, wheat, FYM, castor cake, vermicompost and *Panchgavya*

Introduction
The overuse of inorganic fertilizers and other chemicals that causes environmental contamination and pest epidemics has been a major concern in recent years. The guiding principle of organic farming is to let Mother Nature give us the food that intended. Instead of forcing the plant to grow quickly against its natural course, organic farming feeds the plant as well as the miniature of life that exists in the soil. Organic farming is all about producing healthy food and fiber without the use of synthetic agrochemicals while ensuring animal welfare and environment sustainability. Organic system relay on a modern and synthetic understanding of ecology and soil science, while also integrating traditional agricultural knowledge.

Now-a-days, organic farming is becoming more and more popular, which promotes the switch from a high volume to a high value production system. Management techniques that preserve soil health, effective nutrients supply systems that rely on organic materials rather than chemicals, and integrated pest management are important to attaining these goals. Therefore, the use of botanicals and bio-enhancers derived from cows in combination with organic manures was discovered to be beneficial components in organic farming for a reliable and economical supply of nutrients. These combinations were eco-friendly, safe and improve soil fertility by improving physical, chemical and biological condition of soil.

Wheat (*Triticum aestivum* L.) has been described as "king of cereal" and one of the most important staple food crops of the world. Wheat has its own outstanding importance as human food; the nutritive value of wheat is fairly high as compared to other cereals. It contains protein, fat, carbohydrate, mineral matter, calcium and phosphorus, respectively. Apart from food purpose, wheat grains have also industrial importance for manufacturing paste, alcohol, gluten *etc*.

Wheat straw is utilized as a fodder for feeding the livestock and also useful in manufacturing mattresses, straw hats *etc*. It is consumed mostly in the form of bread "Chapati." Wheat ranks first in the world among the cereals both in respect of area and production. In India, wheat is second most important food crop next to rice and its contribution to the green revolution is significant. Wheat is the world's leading cereal crop cultivated over an area 221.11 million hectares with a production of 773.43 million tonnes (Anonymous, 2020) [1] and China is a major wheat producing country and contributed to 10.65 per cent (23.57 million ha) and 17.31 per cent (137.00 million tonnes) of the world total wheat harvest area and yield production in 2021, respectively (Anonymous, 2020) [1]. In India, it is cultivated in almost all parts of the country and occupied 31.12 million hectares with the production of 109.58 million tonnes and with an average productivity of 3551 kg/ha (Anonymous, 2020) [1]. The major wheat producing states are Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Haryana and Bihar which occupies 9.85, 6.08, 3.53, 3.00, 2.56 and 2.22 million hectares area with the production of 35.50, 18.18, 17.18, 11.03, 12.39 and 6.14 million tonnes of total wheat cultivation in the country, respectively.

One of the most valuable organic fertilisers for preserving soil fertility in alternative agricultural systems is farmyard manure (Jarvan *et al.*, 2017) [6]. Prior to the invention of chemical fertilizers in the middle of the nineteenth century, the only known sources of plant nutrients added to the soil were farmyard manure and compost (Hack, 1982) [5]. Regular addition of organic materials, especially composted ones, boosted aggregate stability and decreased soil bulk density, which in turn enhanced soil physical qualities (Diacono and Montemurro, 2010) [2]. Also addition of cattle manure resulted in significant increases in soil organic carbon, macro-aggregate stability and aggregate protected carbon. Addition of animal manure may increase biodiversity in the soil, thereby causing alteration in composition, size and activity of soil microorganisms and enzyme activities (Watts *et al.*, 2010) [15]. An earlier analysis revealed that, in terms of production, each tonne of farmyard manure was equivalent to 3 kg of fertilizer nutrients for single crops and 5 kg for double cropping (Tandon, 1983) [13]. According to Gaur (1986) [4], 1,000 tonnes of fresh cow dung might theoretically include 15 tonnes of nitrogen and 4 tonnes each of P and K.

Vermicompost is a very effective organic manure created from farm waste that has the potential to boost production and enhance the quality of agricultural output. Vermicompost raises the NPK content, water retention capacity, and productivity of the land, increasing its value. The agricultural system benefits from the addition of farmyard manures and vermicompost by improving soil structure, soil microbial activity, and soil moisture conservation, all of which serve to enhance crop yield and productivity. Vermicompost is finely-divided mature peat-like materials with a high porosity, aeration, drainage and water-holding capacity and microbial activity which are stabilized by interactions between earthworms and microorganisms in a non-thermophilic process (Edwards and Burrows, 1988) [3].

Castor cake is non-edible oil cake and serves as a versatile organic manure, particularly for horticultural crops. After mineralization, the nutrients in oil cake become available to crops 7 to 10 days after application. For equal distribution and accelerated breakdown, oil seed cakes must be well powdered before application. Even though, castor oil cake contains toxins like ricin and is high in protein (Between 21% and 50%), it cannot be used as cattle feed due to its anti-nutritional properties. Because of its high organic matter content, castor cake is suitable for all types of soil. Castor cake contains 5.5-5.8% N, 1.8-1.9% P_2O_5 and 1.0-1.1% K_2O. Therefore, it is generally considered as manure. The improvement in growth characters with application of castor cake that favourably modify the yield attributes and consequently growth and yield attributes showed significant positive correction in seed and stalk yields of sesame. The results are substantiated with the studies conducted by Sujathamma *et al*. (2003) [12].

Material and Methods

A field experiment was conducted at Organic Unit, Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the *kharif* and *rabi* seasons of 2021-22 and 2022-23, entitled with "Residual effect of nutrient management of *kharif* groundnut on growth, yield attributes, yield and quality of subsequent wheat under organic farming." The treatments consisted of nutrient management under organic farming *viz.*, G_1: 100 % RDN through FYM, G_2: 100 % RDN through castor cake, G_3: 100 % RDN through vermicompost, G_4: 100 % RDN through FYM + *Panchagavya* @ 4% spray at 30 and 60 DAS, G_5: 100 % RDN through castor cake + *Panchagavya* @ 4% spray at 30 and 60 DAS, G_6: 100 % RDN through vermicompost + *Panchagavya* @ 4% spray at 30 and 60 DAS, G_7: 100 % RDN through FYM + *Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut* @ 500 lit/ha at 30 and 60 DAS, G_8: 100 % RDN through castor cake + *Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut* @ 500 lit/ha at 30 and 60 DAS and G_9: 100 % RDN through vermicompost + *Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut* @ 500 lit/ha at 30 and 60 DAS to groundnut in *kharif* season as main plot treatments and replicated three times in Randomized Block Design. During *rabi* season each main plot treatment was spited in to three sub-plot treatments with three levels of nutrient management *viz.*, W_1: *Panchgavya* @ 4% spray at 30 and 60 DAS, W_2: 50% RDN through FYM: Castor cake: Vermicompost (1:1:1) + *Panchgavya* @ 4% spray at 30 and 60 DAS and W_3: 75% RDN through FYM: Castor cake: Vermicompost (1:1:1) + *Panchgavya* @ 4% spray at 30 and 60 DAS to wheat resulting in twenty-seven treatment combinations replicated three times in Split Plot Design. The experiment was conducted on the same site without changing the randomization of the treatments for the successive year to assess the residual effects. Organic manure *viz.*, farm yard manure, vermicompost and castor cake (in 1:1:1 ratio) were applied to groundnut crop 15 days before sowing as per the treatments and uniformly mixed with soil at the time of bed preparation as per the treatment. The foliar application of *panchagavya* @ 4% applied after the 30 and 60 DAS of wheat. Before sowing, seeds were treated with *Azotobactor* and PSB biofertilizers @10 ml/kg seed during both the years. The seeds were sown manually at 22.5 cm row apart by maintaining the seed rate of 100 kg/ha and the seeds were sown in previously opened furrow at the depth of 2 to 3 cm and seeds were properly covered with soil and light irrigation was applied in each plot immediately after sowing. The observation on plant growth, yield attributes and yield were recorded as per standard procedure. Economics was worked out on the basis of prevailing market prices of inputs and output obtained from each treatment. The data were statistically analyzed for various characters as described by (Panse and Sukhatme, 1967) [8].

Results and Discussion

1. Effect on growth attributes

The mean data on plant height, dry matter accumulation, crop growth rate, relative growth rate of wheat as affected by

different treatments in pooled study are presented in Table 1 to Table 3.

Residual effect of nutrient management of groundnut

It was evident from the Table 1 to Table 3 that plant height, dry matter accumulation, crop growth rate, relative growth rate of wheat were found non-significant due to nutrient management treatments to preceding groundnut crop during pooled study of experimentation.

Effect of nutrient management in wheat

The mean data presented in Table 1 to Table 3 indicated that the plant height of wheat (at 30, 60, 90 DAS and harvest), dry matter accumulation (at 30, 60 and 90 DAS), crop growth rate (at 0-30, 30-60 and 60-90 DAS), relative growth rate (at 0-30, 30-60 and 60-90 DAS) of wheat were recorded significantly the highest with the treatment W_3 (75% RDN through FYM: castor cake: vermicompost in 1:1:1 ratio + *panchgavya* @ 4% spray at 30 and 60 DAS) in pooled study. Significant increments in growth values might be due to the increased availability of all essential nutrients due to application of higher qualities of organic sources such as farm yard manure, castor cake and vermicompost along with two spray of *Panchgavya*. It is well known that addition of FYM, castor cake and vermicompost could increase the macronutrients as well as micronutrients concentration in the soil and increased the adsorption power of soil for cations and anions, particularly, phosphates and nitrates and they were released slowly for the benefit of the crop during entire growth period. On the other hand, favourable influence of nitrogen to produce larger cells with thinner cell walls and its contribution in cell division and cell elongation, which promoted vegetative growth and ultimately increased plant height as well dry matter. These results are inclose proximity with those of Verma *et al*. (2018) [14]. *Panchagavya* is the fermented organic liquid manure with high microbial load, which includes effective microorganisms (EMO) and methylotrophs profile bacteria (MPB) also. These would have enhanced the production of phyto hormones like auxins and gibberellins. The increase in plant growth might be due to application of nutrients through foliar spray of *Panchagavya* enhanced the growth rate of plant since it contains the favourable macro and micro nutrients, growth hormones and biofertilizers in liquid formulation. Moreover the presence of growth enzymes in *Panchagavya* might have favoured rapid cell division and elongation and increased the activities of beneficial microorganisms in soil by application of FYM which ultimately resulted into production of growth promoting substances and improved nutrient availability for longer period and thus, beneficial effects on growth parameters of wheat. Similar findings have been reported by Kumar *et al.* (2011) [7] and Sahare (2015) [11].

Interaction effect

The data on interaction effect due to nutrient management treatments to preceding groundnut crop and nutrient management to wheat crop (G × W) were found non-significant with respect to plant height of wheat (at 30, 60, 90 DAS and harvest), dry matter accumulation (at 30, 60 and 90 DAS), crop growth rate (at 0-30, 30-60 and 60-90 DAS), relative growth rate (at 0-30, 30-60 and 60-90 DAS) in pooled study of experimentation.

2. Effect on yield attribute, yield and quality

The mean data of yield attribute, yield and quality of wheat as affected by different treatments are presented in Table 3 and Table 4.

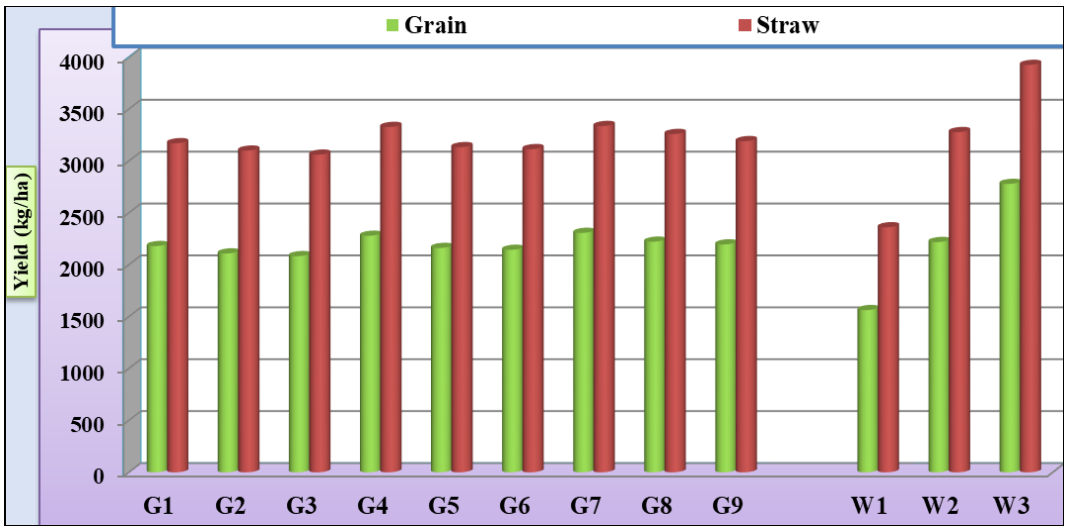

Fig 1: Grain and straw yield of wheat as influenced by nutrient management under organic farming (Pooled of two years)

Residual effect of nutrient management of groundnut

An examination of data presented in Table 3 and Table 4 revealed that effect of nutrient management treatments applied to groundnut were found to be non-significant on yield attribute, yield and quality of wheat crop.

Effect of nutrient management in wheat

The significantly highest effective tillers per metre row length, length of spike (cm), Grains per spike, test weight (g), harvest index (%), grain and straw yield (kg/ha) as well as protein content (%) at harvest of wheat was recorded under treatment W_3 (75% RDN through FYM: castor cake: vermicompost in 1:1:1 ratio + *panchgavya* @ 4% spray at 30 and 60 DAS) in pooled results. The minimum number of effective tillers per metre row length, length of spike (cm), grains per spike, test weight (g), grain and straw yield (kg/ha) as well as protein content (%) at harvest was recorded in the treatment W_1 (*Panchgavya* @ 4% spray at 30 and 60 DAS) in pooled results. The data exhibited in Table 4, revealed that harvest index did not differed significantly due to nutrient management treatments applied to wheat crop in pooled study. The positive effect of organic manure as well as liquid organic manure on growth

parameters may be due to that, liquid as well as organic manure has a stimulatory effect on many physiological processes, such as respiration activities, cell division and many enzymes activities. It also plays an important role in the regulation of photosynthetic carbon reduction. The liquid and organic manure can affect direct and indirect physiological processes of plant growth. Their direct effects including an increase in cell membrane permeability, respiration, nucleicacid biosynthesis, ion uptake, enzyme activity and sub-enzyme activity. Humic acid makes plant tolerant against heat stress, drought stress, cold, diseases, insects and other environmental and agricultural pressures led to higher the production of total plant weight and increases yield. Yield of wheat crop is a function of several yield components which are dependent on complementary interaction between vegetative and reproductive growth of the crop. As most of these growth and yield attributes showed significantly positive correlation with grain yield of wheat evidently resulted in higher yield which get timely nitrogen appears to be on account of their influence on dry matter production and indirectly via increase in plant height, number of effective tillers and possibly a result of higher uptake of nutrients. The present findings are in close agreement with the results obtained by Patel *et al.* (2018) [9] and Ranva *et al*. (2022) [10] in wheat.

Interaction effect

The interaction effect due to nutrient management treatments in preceding groundnut crop and different nutrient management practices in wheat crop (G × W) in case of effective tillers per metre row length, length of spike (cm), Grains per spike, test weight (g), harvest index (%), grain and straw yield (kg/ha) as well as protein content (%) at harvest were found non-significant in pooled study of experimentation.

Effect on economics

The data on economics of wheat as influenced by different treatments are furnished in Table 5.

Residual effect of nutrient management of groundnut

From the data presented in Table 5, it could be inferred that the maximum net realization (₹35739/ha) and BCR (1.74) of wheat were gained with the application of 100 % RDN through FYM + *bijamrut* @ seed treatment 200 ml/kg seed + *jivamrut* @ 500 lit/ha at 30 and 60 DAS (G_7) to groundnut crop followed by treatment G_4 (₹34816/ha net realization and 1.72 BCR). The minimum net realization (₹27743/ha) and BCR (1.58) of wheat was noted under the application of 100 % RDN through vermicompost (G_3) to groundnut.

Effect of nutrient management in wheat

Net realization increased remarkably with each successive increase in organic manure quantity. The maximum net realization (₹36727/ha) of wheat was recorded under the application of 75% RDN through FYM: castor cake: vermicompost (1:1:1) + *panchgavya* @ 4% spray at 30 and 60 DAS (W_3), followed by treatment W_2 (₹28329/ha). Whereas, the treatment W_1 noted minimum net realization (₹29304/ha) of wheat. Where in case of BCR, which was decreased with increase in organic manure quantity. The maximum BCR (2.05) of wheat was recorded under the application of *panchgavya* @ 4% spray at 30 and 60 DAS (W_1), followed by treatment W_3 (1.57).

Table 1: Plant population and plant height of wheat as influenced by nutrient management under organic farming (Pooled of 2 year)

Treatments	Plant population per metre row length		Plant height (cm)			
	At 20 DAS	At harvest	At 30 DAS	At 60 DAS	At 90 DAS	At harvest
Main plot: Residual effect of nutrient management of groundnut						
G_1	39.81	34.35	25.77	39.73	52.22	54.56
G_2	39.67	34.22	25.57	39.27	51.81	54.10
G_3	39.59	34.19	25.48	39.09	50.45	53.84
G_4	40.02	34.56	26.28	39.83	52.69	54.81
G_5	39.87	34.33	25.71	39.64	52.09	54.45
G_6	39.81	34.26	25.61	39.43	51.97	54.13
G_7	40.20	34.61	26.30	39.94	52.79	55.01
G_8	40.06	34.50	26.06	39.78	52.51	54.80
G_9	39.89	34.41	25.89	39.75	52.37	54.60
S. Em. ±	0.62	0.55	0.50	0.85	1.21	1.19
C. D. (P=0.05)	NS	NS	NS	NS	NS	NS
C. V. %	6.57	6.83	8.26	9.13	9.84	9.29
Sub plot: Nutrient management in wheat						
W_1	39.59	33.98	23.60	36.45	46.59	48.35
W_2	40.09	34.40	25.62	39.09	53.59	54.92
W_3	39.96	34.76	28.34	43.28	56.12	60.16
S. Em. ±	0.25	0.26	0.24	0.38	0.55	0.59
C. D. (P=0.05)	NS	NS	0.67	1.06	1.56	1.67
Significant interactions	-	-	-	-	-	-
C. V. %	4.55	5.53	6.73	6.96	7.79	8.00

G_1: 100 % RDN through FYM, G_2: 100 % RDN through castor cake, G_3: 100 % RDN through vermicompost, G_4: 100 % RDN through FYM + *Panchgavya* 4% spray at 30 and 60 DAS, G_5: 100 % RDN through castor cake +*Panchgavya* 4% spray at 30 and 60 DAS, G_6: 100 % RDN through vermicompost + *Panchgavya* 4% spray at 30 and 60 DAS, G_7: 100 % RDN through FYM +*Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut*@ 500 lit/ha at 30 and 60 DAS, G_8: 100 % RDN through castor cake + *Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut*@ 500 lit/ha at 30 and 60 DAS, G_9: 100 % RDN through vermicompost + *Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut*@ 500 lit/ha at 30 and 60 DAS, W_1: *Panchgavya* 4% spray at 30 and 60 DAS, W_2: 50% RDN through FYM: Castor cake: Vermicompost (1:1:1) +*Panchgavya* 4% spray at 30 and 60 DAS, W_3:75% RDN through FYM: Castor cake: Vermicompost (1:1:1)+*Panchgavya* 4% spray at 30 and 60 DAS

Table 2: Dry matter accumulation and crop growth rate of wheat as influenced by nutrient management under organic farming (Pooled of 2 year)

Treatments	Dry matter accumulation (g/plant)			Crop growth rate (g/m^2/day)		
	At 30 DAS	At 60 DAS	At 90 DAS	0-30 DAS	30-60 DAS	60-90 DAS
Main plot: Residual effect of nutrient management of groundnut						
G_1	0.854	4.678	7.072	1.266	5.665	9.212
G_2	0.846	4.600	7.041	1.253	5.561	9.178
G_3	0.844	4.597	7.134	1.250	5.560	9.318
G_4	0.863	4.773	7.082	1.278	5.792	9.213
G_5	0.853	4.673	7.065	1.263	5.659	9.203
G_6	0.849	4.603	7.061	1.257	5.562	9.204
G_7	0.866	4.775	7.092	1.283	5.791	9.224
G_8	0.860	4.768	7.081	1.274	5.789	9.216
G_9	0.855	4.683	7.076	1.266	5.671	9.217
S. Em. ±	0.017	0.099	0.121	0.025	0.142	0.182
C. D. (P=0.05)	NS	NS	NS	NS	NS	NS
C. V. %	8.34	8.94	7.26	8.34	10.65	8.40
Sub plot: Nutrient management in wheat						
W_1	0.753	3.722	5.528	1.116	4.398	7.073
W_2	0.865	4.762	7.181	1.282	5.773	9.357
W_3	0.944	5.566	8.525	1.399	6.846	11.231
S. Em. ±	0.008	0.035	0.054	0.012	0.053	0.077
C. D. (P=0.05)	0.023	0.099	0.151	0.033	0.148	0.218
Significant interactions	-	-	-	-	-	-
C. V. %	6.89	5.53	5.56	6.89	6.82	6.17

G1: 100 % RDN through FYM, G2: 100 % RDN through castor cake, G3: 100 % RDN through vermicompost, G4: 100 % RDN through FYM + Panchgavya 4% spray at 30 and 60 DAS, G5: 100 % RDN through castor cake +Panchgavya 4% spray at 30 and 60 DAS, G6: 100 % RDN through vermicompost + Panchgavya 4% spray at 30 and 60 DAS, G7: 100 % RDN through FYM +Bijamrut (seed treatment 200 ml/kg seed) + Jivamrut@ 500 lit/ha at 30 and 60 DAS, G8: 100 % RDN through castor cake + Bijamrut (seed treatment 200 ml/kg seed) + Jivamrut@ 500 lit/ha at 30 and 60 DAS, G9: 100 % RDN through vermicompost + Bijamrut (seed treatment 200 ml/kg seed) + Jivamrut@ 500 lit/ha at 30 and 60 DAS, W1: Panchgavya 4% spray at 30 and 60 DAS, W2: 50% RDN through FYM: Castor cake: Vermicompost (1:1:1) +Panchgavya 4% spray at 30 and 60 DAS, W3:75% RDN through FYM: Castor cake: Vermicompost (1:1:1)+Panchgavya 4% spray at 30 and 60 DAS

Table 3: Relative growth rate (g/g/day) and yield attributes wheat as influenced by nutrient management under organic farming (Pooled of 2 year)

Treatments	Relative growth rate (g/g/day)			Effective tillers (per metre row length)	Length of spike (cm)	Grains per spike
	At 30 DAS	At 60 DAS	At 90 DAS			
Main plot: Residual effect of nutrient management of groundnut						
G_1	0.854	4.678	7.072	62.33	5.72	31.56
G_2	0.846	4.600	7.041	61.42	5.71	30.65
G_3	0.844	4.597	7.134	61.08	5.69	30.64
G_4	0.863	4.773	7.082	63.39	5.75	31.87
G_5	0.853	4.673	7.065	62.21	5.74	31.42
G_6	0.849	4.603	7.061	62.06	5.72	30.89
G_7	0.866	4.775	7.092	63.66	5.75	31.94
G_8	0.860	4.768	7.081	63.25	5.75	31.84
G_9	0.855	4.683	7.076	63.10	5.74	31.58
S. Em. ±	0.017	0.099	0.121	1.47	0.13	0.75
C. D. (P=0.05)	NS	NS	NS	NS	NS	NS
C. V. %	8.34	8.94	7.26	10.00	9.30	10.17
Sub plot: Nutrient management in wheat						
W_1	0.753	3.722	5.528	48.58	4.88	27.53
W_2	0.865	4.762	7.181	62.92	5.95	32.19
W_3	0.944	5.566	8.525	75.99	6.35	34.41
S. Em. ±	0.008	0.035	0.054	0.70	0.04	0.19
C. D. (P=0.05)	0.023	0.099	0.151	1.98	0.12	0.53
Significant interactions	-	-	-	-	-	-
C. V. %	6.89	5.53	5.56	8.26	5.42	4.40

G_1: 100 % RDN through FYM, G_2: 100 % RDN through castor cake, G_3: 100 % RDN through vermicompost, G_4: 100 % RDN through FYM + *Panchgavya* 4% spray at 30 and 60 DAS, G_5: 100 % RDN through castor cake +*Panchgavya* 4% spray at 30 and 60 DAS, G_6: 100 % RDN through vermicompost + *Panchgavya* 4% spray at 30 and 60 DAS, G_7: 100 % RDN through FYM +*Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut@* 500 lit/ha at 30 and 60 DAS, G_8: 100 % RDN through castor cake + *Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut@* 500 lit/ha at 30 and 60 DAS, G_9: 100 % RDN through vermicompost + *Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut@* 500 lit/ha at 30 and 60 DAS, W_1: *Panchgavya* 4% spray at 30 and 60 DAS, W_2: 50% RDN through FYM: Castor cake: Vermicompost (1:1:1) +*Panchgavya* 4% spray at 30 and 60 DAS, W_3:75% RDN through FYM: Castor cake: Vermicompost (1:1:1)+*Panchgavya* 4% spray at 30 and 60 DAS

Table 4: Test weight, yield and protein content of wheat as influenced by nutrient management under organic farming (Pooled of 2 year)

Treatments	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)	Protein content (%)
Main plot: Residual effect of nutrient management of groundnut					
G_1	31.84	2180	3171	40.72	9.35
G_2	31.30	2109	3100	40.44	9.18
G_3	31.14	2083	3061	40.21	9.12
G_4	32.11	2279	3328	40.54	9.44
G_5	31.61	2162	3133	40.76	9.32
G_6	31.57	2144	3114	40.72	9.20
G_7	32.24	2307	3337	40.82	9.51
G_8	32.00	2222	3260	40.45	9.43
G_9	31.94	2196	3191	40.68	9.41
S. Em. ±	0.71	67.18	99.61	1.10	0.12
C. D. (P=0.05)	NS	NS	NS	NS	NS
C. V. %	9.52	13.03	13.26	11.46	5.64
Sub plot: Nutrient management in wheat					
W_1	30.10	1563	2361	39.94	9.01
W_2	31.96	2219	3278	40.38	9.30
W_3	33.18	2779	3926	41.47	9.68
S. Em. ±	0.31	31.70	49.56	0.50	0.04
C. D. (P=0.05)	0.88	89	140	NS	0.10
Significant interactions	-	-	-	-	-
C. V. %	7.22	10.65	11.42	9.00	2.77

G_1: 100 % RDN through FYM, G_2: 100 % RDN through castor cake, G_3: 100 % RDN through vermicompost, G_4: 100 % RDN through FYM + *Panchgavya* 4% spray at 30 and 60 DAS, G_5: 100 % RDN through castor cake +*Panchgavya* 4% spray at 30 and 60 DAS, G_6: 100 % RDN through vermicompost + *Panchgavya* 4% spray at 30 and 60 DAS, G_7: 100 % RDN through FYM +*Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut@* 500 lit/ha at 30 and 60 DAS, G_8: 100 % RDN through castor cake + *Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut@* 500 lit/ha at 30 and 60 DAS, G_9: 100 % RDN through vermicompost + *Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut@* 500 lit/ha at 30 and 60 DAS, W_1: *Panchgavya* 4% spray at 30 and 60 DAS, W_2: 50% RDN through FYM: Castor cake: Vermicompost (1:1:1) +*Panchgavya* 4% spray at 30 and 60 DAS, W_3:75% RDN through FYM: Castor cake: Vermicompost (1:1:1)+*Panchgavya* 4% spray at 30 and 60 DAS

Table 5: Economics of wheat as influenced by nutrient management under organic farming (Average of 2021-22 and 2022-23)

Treatments	Yield (kg/ha)		Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	BCR
	Grain	Straw				
Main plot: Residual effect of nutrient management of groundnut						
G_1: 100 % RDN through FYM	2180	3171	48096	79273	31177	1.65
G_2: 100 % RDN through castor cake	2109	3100	48096	76788	28692	1.60
G_3: 100 % RDN through vermicompost	2083	3061	48096	75839	27743	1.58
G_4: 100 % RDN through FYM + *Panchgavya* @ 4% spray at 30 and 60 DAS	2279	3328	48096	82912	34816	1.72
G_5: 100 % RDN through castor cake +*Panchgavya* @ 4% spray at 30 and 60 DAS	2162	3133	48096	78583	30487	1.63
G_6: 100 % RDN through vermicompost + *Panchgavya* @ 4% spray at 30 and 60 DAS	2144	3114	48096	77950	29854	1.62
G_7: 100 % RDN through FYM +*Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut* @ 500 lit/ha at 30 and 60 DAS	2307	3337	48096	83835	35739	1.74
G_8: 100 % RDN through castor cake + *Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut* @ 500 lit/ha at 30 and 60 DAS	2222	3260	48096	80884	32788	1.68
G_9: 100 % RDN through vermicompost + *Bijamrut* (seed treatment 200 ml/kg seed) + *Jivamrut* @ 500 lit/ha at 30 and 60 DAS	2196	3191	48096	79845	31749	1.66
Sub plot: Nutrient management in wheat						
W_1: *Panchgavya* @ 4% spray at 30 and 60 DAS	1563	2361	27795	57099	29304	2.05
W_2: 50% RDN through FYM: Castor cake: Vermicompost (1:1:1) +*Panchgavya* @ 4% spray at 30 and 60 DAS	2219	3278	52513	80842	28329	1.54
W_3:75% RDN through FYM: Castor cake: Vermicompost (1:1:1) +*Panchgavya* @ 4% spray at 30 and 60 DAS	2779	3926	63979	100706	36727	1.57

Selling price: Grain 32 ₹/kg
Straw 3₹/kg

Conclusion

Based on the findings of two years of experimentation, it is concluded that for securing higher grain yield and net profit from wheat crop under organic farming, apply 75 % RDN (90 kg N) through FYM: castor cake: vermicompost (1:1:1) along with *panchgavya* @ 4% spray at 30 and 60 DAS in loamy sand.

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