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Effect of Organic Management of Nutrients and Bio-Stimulants on Growth and Yield Attributes of Wheat (*Triticum aestivum* L.)

Rajesh Choudhary, Roshan Choudhary, S.K. Sharma, Ashok Kumar Samota, Naveen Kumar

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ABSTRACT

A field experiment was conducted at organic farming unit of Agronomy Farm, Rajasthan, College of Agriculture, MPUAT, Udaipur, Rajasthan during *rabi* 2021-22 to study the influence of different levels of organic management of nutrients and bio-stimulants on growth and yield attributes of wheat grown under organic farming. All the organic management of nutrient treatments resulted in significant increase in plant height and dry matter accumulation at different growth stages of wheat crop. The significantly maximum values of yield attributes viz., effective tillers meter^{-1} row length, spikelets ear^{-1}, grains ear^{-1} and grain weight ear^{-1}, were higher under the effect of 100% RDN through 1/3 FYM+ 1/3 Vermicompost + 1/3 Neem cake over 75% RDN, 50% RDN and control. However, application of 100% RDN failed to exhibit significant variation in test weight and ear length of wheat. Application of panchagavya 5% at 60 and 75 DAS as foliar spray + jeevamrut 500 L ha^{-1} at sowing and 10% at 30 DAS as foliar spray significantly increase in plant height and dry matter accumulation at 45, 90 DAS and at harvest. Application of different bio-stimulants was recorded significantly higher effective tillers meter^{-1} row length, spikelets ear^{-1}, grains ear^{-1}, ear length and grain weight ear^{-1} as compared to control.

Keywords Growth, Yield attributes, Panchagavya, Organic farming, Wheat.

INTRODUCTION

The harmful effects of chemicals used in agriculture are converting the mindset of consumers of different countries who are now buying organic produce with high rate for health. Policy makers are championing organic farming as a dual solution: Revitalizing soil health and bolstering rural economies, all while fostering a healthier environment. Organic farming is being practiced in 190 countries of the world. The global area under organic agriculture is about 74.9 million hectare and world organic market is now 120.6 billion US$ (FiBL and IFOAM 2021). In India, about 4.33 million ha area is under organic cultivation and total production of certified organic products is 3.49 MMT (APEDA 2021). India is fast becoming as a key hub

Rajesh Choudhary[1]*, Roshan Choudhary[2], S.K. Sharma[3], Ashok Kumar Samota[4], Naveen Kumar[5]

[1, 4, 5]PhD Research Scholar, [2]Deputy Director Research, [3]Assistant Director General
[1]Department of Agronomy, SKRAU, Bikaner, Rajasthan 334006, India

[2]SKNAU, Jobner, Jaipur, Rajasthan 303329, India

[3]Human Resource Management, ICAR, New Delhi 110012, India
[4]Department of Agronomy, MPUAT, Udaipur, Rajasthan 313001, India

[5]Department of Agronomy, SKNAU, Jaipur 303329, India

Email: rajeshchoudhary6323@gmail.com
*Corresponding author

for production and distribution of organically cultivated agricultural products to the global market. Due to health consciousness preference of consumers for organic wheat is increasing now a days. It has been reported that comparison to conventional wheat the yield of organic wheat found to be reduce by 5 to 8% after 6 years of organic cycle. However, organically produce wheat fetches 20–25% high premium price in the market. Manure has long been considered a desirable soil amendment and reports of its effects on soil properties are numerous. According to (Dunjana *et al.* 2012), the addition of FYM, vermicompost and neem cake resulted in significant enhancement in soil organic carbon level, macro-aggregate stability and the preservation of carbon within soil aggregates. Vermicompost is a mixture of worm castings, undigested organic wastes, microbes, vitamins, enzymes, hormones and antibiotics. Neem seed cake not only nourishes plants but also improve the earthworms population and produces organic acids, which helps in the mitigation of soil alkalinity. Bio-stimulants play a vital role on plant performance by enhancing their resistance to diseases and pests and increasing yields (Sobczak *et al.* 2020). Metabolic and enzymatic processes in plants are influenced by bio-stimulants and bio-stimulants help to increasing their yield and quality. Bio-stimulants used in organic farming like jeevamrut and panchagavya are the fermented products which used as plant growth promoting substances prepared with material available at farmers field. Devakumar *et al.* (2008) and Sreenivasa *et al.* (2010) have reported that in jeevamrut and beejamrut presence of numerous beneficial micro-organisms such as nitrogen fixing bacteria, phosphorus solubilizing bacteria, actinomycetes and fungi.

MATERIALS AND METHODS

Treatments and agronomic practices : Field experiment was conducted at organic farming unit of Instructional Agronomy Farm, RCA, MPUAT Udaipur during *rabi* 2021-2022. The soil of the experimental field was clay loam in texture with 283.42, 22.23 and 279.31 kg ha^{-1} available nitrogen, phosphorus and potassium, respectively with pH 7.9. The field trail was conducted in factorial RBD with 3 replications and assigning 16 treatment combinations consisting of control and three levels of organic nutrients (100% RDN, 75% RDN and 50% RDN through 1/3 FYM+ 1/3 Vermicompost + 1/3 Neem cake) as nutrient supplier and control and three levels of bio-stimulants (panchagavya 5% at 60 and 75 DAS as foliar spray, jeevamrut 500 L ha^{-1} at sowing and 10% at 30 DAS as foliar spray and panchagavya 5% at 60 and 75 DAS as foliar spray + jeevamrut 500 L ha^{-1} at sowing and 10% at 30 DAS as foliar spray). Wheat variety Raj-4079 was sown on 17 November 2021 and harvested between 26 and 27 March 2022.

Application of organic manures : 8000 kg ha^{-1} farm yard manure, 4000 kg ha^{-1} vermicompost was applied as basal application before the sowing and 770 kg ha^{-1} neem cake applied half at the time of wheat sowing and half at tillering stage.

Pest and disease control : Pest and disease free seeds of the Raj-4079 variety of wheat were used for sowing. For pest control, 7 yellow mataka traps per acre were installed at 15 days after sowing and 0.4% neem oil spray at 20 days after sowing.

Preparation and application method of jeevamrut : 200 liters of water was taken in a barrel, 10 kg of freshly collected dung from indigenous cows was added followed by 10 liters of cow's urine, for this 2 kg of gram pulse flour, 2 kg of jaggery and 100 g of live soil from under canopy of the banyan tree are added. Stirred the solution well and let it ferment for 48 hrs in the shade. Now jeevamrut was ready for application. 490 liters of jeevamrut is enough for one hectare of land (Palekar 2006). Different-different concentrations of jeevamrut liquid were applied as foliar spray and with irrigation as per treatment during crop period.

Bio-chemical composition of jeevamrut : The nutritional composition of jeevamrut was 1.84–1.97% N, 0.19–0.20% P_2O_5, 0.20–0.29% K, 4.20–4.32 ppm Zn and 280–287 ppm Fe, whereas 5.30×10^8–7.25×10^8 cfu/ml bacteria, 4.15×10^4–5.85×10^4 cfu/ml fungal and 2.35×10^4–3.70×10^4 actinomycetes were detected. Also 0.74–1.25 µg/ml acid phosphates, 0.87–3.79 µg/ml alkaline phosphates and 0.94–4.47 µg/ml dehydrogenase activity were recorded. The pH of jeevamrut is 3.9–4.1 and electric conductivity 1.6–1.7 dS/m was observed.

Panchagavya preparation and application : In an earthen container, first mix 5 kg fresh cow dung and 1 kg cow ghee thoroughly and keep it for 3 days. Mix it twice daily (morning/evening) at least for 15 minutes. Added 3 liter cow urine, 3 liter cow milk, 2 kg cow curd and also 500 g jaggery and mix thoroughly. Keep it for 15 days with regular mixing in morning and evening hours. Panchagavya stock solution was ready after proper sieving through a fine cloth. Different concentrations of jeevamrut were applied as foliar spray as per treatment during crop period.

Bio-chemical composition of panchagavya : Panchagavya solution was analyzed after 15 days of its preparation. The nutrient content of panchagavya was 0.438–0.442% N, 0.413–0.422% P_2O_5, 0.993–0.999% K, 70–74 ppm Zn and 112–116 ppm Fe, whereas $38.15 \times 10^8 – 43.75 \times 10^8$ cfu/ml bacteria, $34.75 \times 10^5 – 36.65 \times 10^5$ cfu/ml fungal and $9.75 \times 10^5 – 11.25 \times 10^5$ actinomycetes were detected. Also 9.75×10^5-11.25×10^5 µg/ml acid phosphates, 136.42–147.89 µg/ml alkaline phosphates and 416.30–445.76 µg/ml dehydrogenase activity were recorded. The pH of panchagavya is 6.50–6.70 and electric conductivity 7.02–7.12 dS/m was recorded.

RESULTS AND DISCUSSION

Growth attributes : Increasing levels of organic nutrients significantly increased plant height at 45, 90 DAS and at harvest. Significantly higher plant height of 49.33 cm, 88.27 cm and 93.38 cm was recorded with the application of 100% RDN at 45, 90 DAS and at harvest, respectively (Table 1). Significantly highest dry matter was found with the application of 100% RDN over other treatment tested. Application of 100% RDN accounted for 13.97, 16.82 and 12.23% increase in dry matter accumulation over control at 45, 90 DAS and at harvest, respectively (Table 1). This might be due to mineralization of FYM and vermicompost which had beneficial effect in improving the soil health leading to significant improvement in growth of soybean. The results are in conformity with those reported by Singh *et al*. (2019). Similar results were reported by Lambade (2013) with the application of farmyard manure and vermicompost in combination with each other. An appraisal of data mentioned in Table 1 indicates that in comparison to control, significant increase in plant height of wheat was recorded by combined application of panchagavya @ 5% at 60 and 75 DAS as foliar spray + jeevamrut @ 500 L ha^{-1} at sowing and 10% at 30 DAS as foliar spray at 45, 90 DAS and at harvest. The data presented in Table 1 shows that increasing concentrations of bio-stimulants as soil application and foliar spray application significantly increased dry matter accumulation at 45, 90 DAS and at harvest. Availability of smaller quantities of macronutrients, micronutrients and growth promoting substances. Significant improve in plant height and dry matter accumulation of pearl millet. Application of panchagavya and jeevamrut, whether as a foliar spray of through soil application they trigger the necessary plant growth in addition to fostering a significant population of beneficial microorganism in the soil (Upperi *et al.* 2009). These results corroborate with

Table 1. Effect of levels of organic nutrients and bio-stimulants on plant height and dry matter accumulation of wheat at different stages. N_1- Control, N_2-100% RDN (1/3 FYM+ 1/3 Vermicompost + 1/3 Neem cake), N_3-75% RDN (1/3 FYM+ 1/3 Vermicompost + 1/3 Neem cake), N_4-50% RDN (1/3 FYM+ 1/3 Vermicompost + 1/3 Neem cake), B_1- Control, B_2- Panchagavya 5% at 60 and 75 DAS as foliar spray, B_3- Jeevamrut 500 L/ha^{-1} at sowing and 10% at 30 DAS as foliar spray, B_4- Panchagavya 5% at 60 and 75 DAS as foliar spray + Jeevamrut 500 L ha^{-1} at sowing and 10% at 30 DAS as foliar spray.

Treatments	Plant height (cm)			Dry matter accumulation (g $plant^{-1}$)		
	45 DAS	90 DAS	At harvest	45 DAS	90 DAS	At harvest
Levels of organic nutrients						
N_1	41.65	77.18	81.63	6.87	63.94	71.53
N_2	49.33	88.27	93.38	7.83	74.70	80.28
N_3	46.82	84.30	89.45	7.56	71.22	77.51
N_4	44.60	80.74	85.59	7.24	67.79	74.46
SEm±	0.76	1.21	1.27	0.06	1.18	0.95
CD (p= 0.05)	2.20	3.49	3.66	0.18	3.41	2.74
Bio-stimulants						
B_1	42.80	78.53	82.83	6.90	65.69	72.99
B_2	45.00	82.62	87.01	7.43	69.29	75.95
B_3	45.51	82.85	88.14	7.49	69.50	76.01
B_4	49.10	86.48	92.06	7.70	73.18	78.81
SEm±	0.76	1.21	1.27	0.06	1.18	0.95
CD (p= 0.05)	2.20	3.49	3.66	0.18	3.41	2.74

Table 2. Effect of levels of organic nutrients and bio-stimulants on yield attributes of wheat.

Treatments	Yield attributes					
	Number of tillers m^{-1} row length at harvest	Number of spikelets ear^{-1}	Number of grains ear^{-1}	Ear length (cm)	Grain weight ear^{-1} (g)	Test weight (g)
Levels of organic nutrients						
N_1	61.12	15.26	37.02	9.77	2.04	50.66
N_2	71.54	18.46	42.77	10.16	2.29	51.78
N_3	68.01	17.04	40.81	10.05	2.18	51.15
N_4	64.53	15.64	39.02	9.92	2.11	50.73
SEm±	1.15	0.11	0.61	0.10	0.02	0.31
CD (p= 0.05)	3.33	0.31	1.77	NS	0.06	NS
Bio-stimulants						
B_1	62.30	16.06	37.72	9.18	2.06	50.77
B_2	65.76	16.51	39.68	10.04	2.14	51.02
B_3	66.51	16.68	40.08	10.09	2.15	51.18
B_4	70.64	17.15	42.14	10.58	2.28	51.35
SEm±	1.15	0.11	0.61	0.10	0.02	0.31
CD (p= 0.05)	3.33	0.31	1.77	0.30	0.06	NS

the findings of Ramesh *et al.* (2015).

Yield attributes : The values of yield attributes viz., effective tillers $meter^{-1}$ row length, spikelets ear^{-1}, grains ear^{-1} and grain weight ear^{-1}, were maximize under the effect of 100% RDN over 75% RDN, 50% RDN and control. However, application of 100% RDN failed to exhibit significant variation in ear length of wheat (Table 2) (Fig. 1). The combined use of different organic manures like FYM, vermicompost and neem cake are important to maintain and sustain higher level of soil fertility and nutrient availability to crop. The increase in growth and yield attributes

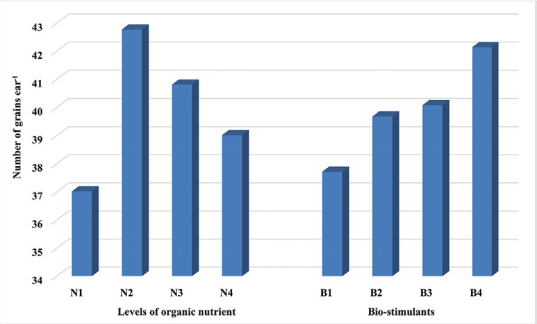

Fig. 1. Effect of levels of organic nutrients and bio-stimulants on number of grains ear^{-1}.

of wheat due to application of 100% RDN could be due to better availability of nutrients and plant growth hormones during the critical period of crop growth during the year of experiment (Reddy *et al*. 2020). The higher values of yield attributes may be attributed to the continuous mineralization and availability of nutrients, matching the plant's requirements during the later stages of growth. The results are in close agreement with the findings of Sharma and Abraham (2010), Yadav *et al.* (2017) and Subrata *et al.* (2020). Application of different bio-stimulants was recorded significantly higher effective tillers $meter^{-1}$ row length, spikelets ear^{-1}, grains ear^{-1}, ear length and grain weight ear^{-1} as compared to control (Table 2) (Fig. 1). Bio-stimulants application registered significant improvement in most of the yield attributes. In the present study, all the yield attributing parameters were significantly higher with application of panchagavya 5% at 60 and 75 DAS as foliar spray + jeevamrut 500 L ha^{-1} at sowing and 10% at 30 DAS as foliar spray which might be due to favorable effects of IAA, GA_3, macro and micro nutrients and also due to presence of beneficial microorganisms in the liquid organic manures (Somasundaram *et al.* 2003). Regular application of liquid manures, at intervals of 2 to 3 times, serves as a stimulus within the plant system, thereby enhancing the production of growth

regulators within the cell system. These findings are in conformity with the results of Pagar *et al.* (2016).

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