The Journal of Rural and Agricultural Research Vol. 20 No. 1, 92-95 (2020)
Received February 2020; Acceptance June 2020

Impact of Integrated Nutrients (NPK) Management on Growth, Yield Attributes and Yield of Wheat (Triticum aestivum L.) in Pearlmillet-Wheat Cropping System

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Abstract

A field experiment was conducted during the winter (Rabi) season of 2017-18 at Agricultural Research Farm in Farming Systems Research Centre (ICAR), R.B.S. College, Bichpuri, Agra (U.P.) in a Impact of Integrated Nutrients (NPK) Management on Growth, Yield Attributes and Yield of Wheat in Pearl millet – Wheat Cropping System. The treatments were 12 having integration of organics i.e. FYM/WRC/Green manure with fertilizers taking 4 replications. The results indicated that amongst the fertility treatments tested, fertility treatment, having 100 per cent RDF (recommended dose of fertilizers – 120 – 60 – 40 kg N.P.K. ha^{-1}) applied in wheat, grown after pearl millet fertilized with 50% N. Substitution through FYM @ 8 t ha^{-1} with 50% recommended NPK dose through fertilizers (40-20-20) in continuous cropping system i.e. 'pearl millet-wheat' proved better for maximum grain yield of wheat under semi-arid conditions of Agra region of Western, U.P. Treatment having $N_0P_0K_0$ (control) and farmer's practice were proved to be poorest. From economic point of view, with regard to maximum net return (Rs. 81624 ha^{-1}) as well as higher B/C ratio (3.52), the same treatment having 100% NPK i.e. 120-60-40 followed by pearl millet (50% NPK + 50% N substitution through FYM stood ranked first.

Key words: Continuous, Cropping, Integrated Nutrient Management, Sustainable, Yield

Introduction

In India wheat is the second most important food crop next to be rice and it contributes nearly 35% to the national food basket. Among winter crops, it contributes about 49% of the food grains. India is the second largest wheat producer 106.21 million tonnes next only to China 121.72 million tonnes and covers the largest area under wheat cultivation (30.60 m ha), which is about 13.77% of the world wheat area 217 million hectare (2019-20). Pearl millet-wheat is a popular cropping system in semi-arid Agro-Eco Region IV of the country, particularly in some states like south-west U.P., Rajasthan, Haryana and Gujarat, covering million-hectare land. In view of the spread and contribution of food pool of the nation, as a coarse cereal-wheat system, there appeared a need to sustain the decline crop yields and depleting soil fertility due to continuous cropping, over mining of soil nutrients, imbalance and inadequate fertilizer use, also decreasing crop response to nutrients. In fact, integrated nutrients supply system (INSS) is the combined use of fertilizers with organic resources such as organic manures (FYM, compost, crop residues, green manuring and bio fertilizers (Antil, 2011). Its basic concept is sustaining soil and crop productivity through optimization of all possible sources of plant nutrients in an integrated manner. In this system all mineral and organic nutrient sources are integrated into the crop production system and are utilized in an efficient and judicious manner for it contributes in attaining sustainable crop production and sound environmentally viable, economically feasible, agronomically sustainable high crop yields by enhancing nutrient use efficiency and soil fertility, increasing carbon sequestration, reducing nitrogen losses due to nitrate leaching. Therefore, the nutrient needs of crop production systems can best be met through integrated nutrient management (Sharma et al., 2015). Moreover, for higher fertilizer use efficiency and sustainability of cropping system, there is need to recommend and develop site specific nutrient management strategies

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considering the cropping system as a whole, instead of component crops in isolation. Keeping in view these facts, the present investigation was carried out to "Impact of integrate nutrients (NPK) management on growth, yield attributes and yield of wheat in pearl millet-wheat cropping system".

Materials and Methods

The field experiment was conducted during 2017-18 on wheat crop in pearlmillet-wheat cropping system on a fixed site in Farming Systems Research Project, (ICAR)at R.B.S. College, Research Farm Bichpuri, Agra (U.P.). The soil was sandy loam, with pH 8.1, organic carbon 0.32%, available N 183.0 kg ha^{-1}, P_2O_5 28.30 kg ha^{-1}, Potash 290.0 kg ha^{-1}. The experiment was laid out in Randomized Block Design having 12 treatments as given below and 4 replications in pearl millet-wheat system.

During 2017-18 in both crops, basal application of half quantity of nitrogen through urea (46% N) - as per treatments, full quantity of phosphorus and potash through DAP (18% N – 46% P_2O_5) and muriate of potash (60% K_2O), respectively, as per treatment, were drilled in furrows 3-4 cm below the seed at sowing time. Remaining half quantity of nitrogen as per treatment was top dressed at the crop stage of 30 days after. The amount of various organic manures viz. FYM / waste residue of crops (WRC) / green manure-dhaincha (*sesbania aculeata*) were applied under respective treatments during experimentation in pearl millet crop only.

Table 1: Treatment details

Treatments	Kharif (Pearl millet)	Rabi (Wheat)
T_1	Control (No fertilizer, No organics)	Control (No fertilizers No organics)
T_2	50% recommended NPK dose through fertilizers (40-20-20)	50% recommended NPK dose through fer tilizers (60-30-20)
T_3	50% recommended NPK dose through fertilizers (40-20-20)	100% recommended NPK dose through fertilizers (120-60-40)
T_4	75% recommended NPK dose through fertilizers (60-30-30)	75% recommended NPK dose through fer tilizers (90-45-30)
T_5	100% recommended NPK dose through fertilizers (80-40-40)	100% recommended NPK dose through fertilizers (120-60-40)
T_6	50% recommended NPK dose through fertilizers (40-20-20) + 50% N substitution through FYM@ 8 t ha^{-1}	100% recommended NPK dose through fertilizers (120-60-40)
T_7	75% recommended NPK dose through fertilizers (60-30-30) + 25% N substitution through FYM@ 4 t ha^{-1}	75% recommended NPK dose through fertilizers (90-45-30)
T_8	50% recommended NPK dose through fertilizers (40-20-20) + 50% N substitution through waste residue of crop (WRC)@ 6.6 t ha^{-1}	100% recommended NPK dose through fertilizers (120-60-40)
T_9	75% recommended NPK dose through fertilizers (60-30-20) + 25% N substitution through waste residues of crop (WRC) @ 3.3 t ha^{-1}	75% recommended NPK dose through fertilizers (90-45-30)
T_{10}	50% recommended NPK dose through fertilizers (40-20-20) + 50% N substitution through green manure (*dhaincha*) @ 4 t ha^{-1}	100% recommended NPK dose through fertilizers (120-60-40)
T_{11}	75% recommended NPK dose through fertilizers (60-30-30) + 25% N substitution through green manure (*dhaincha*) @ 2 t ha^{-1}	75% recommended NPK dose through fertilizers (90-45-30)
T_{12}	Farmer's Practice (Conventional Method) 40-0-0 NPK only	Farmer's Practice conventional method 90-0-0 NPK dose only

Results and Discussion

Growth and Development

Data pertaining to different growth, yield attributing traits and yield are presented in Table 2 & 3. Higher level of fertility 100% NPK through fertilizers alone in wheat and in conjunction with the organic manures, viz. FYM/WRC/GM for 50 per cent N in *kharif* pearl millet, followed by 100 per cent NPK through fertilizers in wheat resulted in increased number of shoots m^{-1} row length and ear bearing shoots

Table 2: Effect of various fertility treatments on growth and yield attributing characters in wheat crop

Treatments	No. of effective shoots meter row length at harvest	Height of main shoot(cm) at harvest	Dry matter accumulation(g) in plants of 25 cm row length at harvest	Length of spike (cm)	No. of spikelets spike^{-1}	No. of grains spike^{-1}	Grain wt (g) spike^{-1}	1000-grain wt (g)
T_1	60.12	64.50	67.50	7.87	15.20	27.50	1.40	37.01
T_2	70.01	76.18	81.00	8.72	20.75	39.12	1.95	43.52
T_3	75.62	82.80	85.50	9.16	22.75	42.62	1.73	40.65
T_4	81.75	81.18	87.00	8.75	21.68	41.62	2.01	39.18
T_5	84.25	83.81	89.50	9.33	22.80	44.81	2.23	45.11
T_6	85.12	83.93	92.00	9.40	23.20	45.18	2.60	46.10
T_7	76.62	79.87	87.50	9.00	22.95	43.18	2.07	43.91
T_8	76.50	80.18	84.00	9.30	22.00	43.25	2.18	42.81
T_9	75.87	78.68	81.50	9.06	21.31	39.31	1.95	42.97
T_{10}	75.62	76.18	86.00	9.12	21.18	41.25	2.10	43.07
T_{11}	74.12	79.18	88.13	8.67	20.50	39.87	1.88	42.33
T_{12}	69.50	75.43	71.67	7.96	18.31	37.62	1.67	40.72
SEm ±	2.99	2.78	4.25	0.39	0.86	1.99	0.19	1.44
CD(P = 0.05)	8.60	8.02	12.24	1.12	2.47	5.46	0.54	4.14

plant^{-1} than reduced level of NPK through fertilizers, control and farmer's practice.

However, the maximum benefit was accured with T_6, where wheat under 100 per cent NPK raised after 50 per cent N substitution through FYM in pearl millet, in sequence. This may be attributed to proper utilization of supplied nutrients in balanced form and substitution of organics in *kharif*. An increase in effective shoots, N application has been reported by Desai, H.A. *et al.* (2015), Bavar *et al.* (2016), Kumar *et al.* (2017).

All the growth manifestations such as, height of the main shoot (cm) and dry matter accumulation (g) plant^{-1} were also promoted significantly with the application of recommended level of NPK nutrients (120-60-40) in wheat, especially when 50 per cent N through FYM/WRC was substituted in preceding crop of pearl millet. It is, thus, imperative to apply the fertilizers up to optimum level in balanced form (100% NPK) to encourage per plant dry matter. The favorable effect of 100 per cent NPK in wheat raised after 50% N substitution through FYM in pearl millet, in sequence on plant growth might be due to the fact that the integrated use of organic and inorganic fertilizers is more effective through correction of deficiencies of primary, secondary and micro nutrients.

Yield attributes and yield

Higher per hectare production of grain, straw and bio-mass under 100 per cent recommended level of fertility (120-60-40 kg ha^{-1} NPK) through fertilizers were the result of more effective shoots per plant and per m row length, plant height (cm) and dry matter accumulation (g) per plant, spikelet's per spike, grains per spike, grain weight (g) per spike and 1000-grain weight (g) when wheat raised after 50 per cent N substitution through FYM in pearl millet (50% N through FYM substitution with 50% NPK through fertilizers–T_6), compared to other treatments of 100 per cent NPK through fertilizer alone, 75 and 50 per cent of recommended, control and farmer's practice.

The combined application of NPK in balanced form have also been recorded by Pandey *et al.* (2017), they all have confirmed the optimum application of 120 kg N, 60 kg P_2O_5 and 40 kg K_2O separately for wheat, Rajput *et al.* (2006) reported that there was no scope for reducing the fertilizers dose from recommended level (120-60-40) to either 50 or 75 per cent recommended NPK in wheat. Besides, it may also be argued here that high yielding varieties (HYVs) of wheat exhibit their yield potential only when the adequate quantity of nutrients is applied in *kharif* to leave residual effect over succeeding wheat has also been reported by several workers (Rawal *et al.* 2016, Rathwa *et al.* 2017 and Kumar and Singh, 2018, Pandey *et al.* 2017. The treatment T_6 also recorded higher B : C ratio (3.52), owing to the fact higher net return per hectare. The similar findings were also reported by Sharan *et al.* (2017).

Table 3: Bio-mass, grain and straw yield, harvest index and B/C ratio of wheat crop as affected by various fertility treatments

Treatments	Bio-mass yield (Q ha^{-1})	Grain yield (Q ha^{-1})	Straw yield (Q ha^{-1})	Harvest Index (%)	B/C ratio
T_1	41.84	14.76	27.08	35.28	1.35
T_2	95.54	35.97	59.47	37.65	2.91
T_3	121.86	43.61	78.25	35.79	3.30
T_4	105.01	39.69	65.32	37.80	3.06
T_5	123.01	45.30	77.71	36.83	3.39
T_6	126.50	47.50	79.00	37.55	3.52
T_7	112.37	45.91	66.46	40.86	3.43
T_8	119.12	45.08	74.04	37.84	3.33
T_9	115.67	43.79	71.88	37.86	3.38
T_{10}	120.89	44.20	76.69	36.56	3.31
T_{11}	110.24	42.40	67.84	38.46	3.25
T_{12}	76.72	27.60	49.12	35.97	2.39
SEm ±	3.03	1.50	3.07	0.74	-
CD(P = 0.05)	8.73	4.32	8.82	2.12	-

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