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Effect of Wheat Varieties and Integrated Nutrient Management Practices on Nutrient Content, Uptake and Soil Nutrient Status

C.R. Kantwa[1], P.K. Saras[2], K.G. Vyas[3], H.L. Chaudhari[2],
R.R. Choudhary[4], Sweta A. Patel[5], S.R.K. Singh[6], B.J. Patel[2]

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ABSTRACT

Background: A field experiment was conducted during two consecutive *Rabi* (winter) seasons of 2016-17 and 2017-18 at Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India to assess the impact of wheat varieties and integrated nutrient management practices on nutrient content and uptake and soil nutrient status. The soil of the experimental plot was loamy sand in texture, low in organic carbon (0.24%), available nitrogen (159 kg/ha) and Zn (0.41 mg/kg), medium in available phosphorus (38.90 kg/ha) and high in available potash (287 kg/ha).

Methods: Experiment was laid out in a Factorial RBD with three replications, consist of four wheat varieties *viz*. GW 273, GW 322, GW 451 and GW 496 and six integrated nutrient management (INM) practices *viz*. control, 100% RDF, 100% RDF + *Azotobacter* + PSB, 75% RDF + *Azotobacter* + PSB, 75% RDF + *Azotobacter* + PSB + $ZnSO_4$ and 50% RDF + 25% N through FYM + *Azotobacter* + PSB + $ZnSO_4$.

Result: The pooled results indicated that uptake of nitrogen, phosphorus and potassium by grain and straw, grain yield and straw yield were found higher with wheat variety GW 451 as compared to other wheat varieties. Nutrient content in grain and straw was not significantly affected by different wheat varieties. Among nutrient management practices, nitrogen, phosphorus and potassium content, uptake, grain yield and straw of wheat were significantly higher under application of 100% RDF + *Azotobacter* + PSB. Further, result revealed that different wheat varieties did not bring any significant variation in available nitrogen, phosphorus, potassium, zinc and organic carbon content in soil. Moreover, highest available nitrogen and phosphorus in soil was recorded with the application of 100% RDF + *Azotobacter* + PSB. However, significantly higher organic carbon and zinc content in soil was observed under 50% RDF + 25% N through FYM + *Azotobacter* + PSB +$ZnSO_4$.

Key words: Integrated nutrient management, Nutrient content, Nutrient uptake, Soil nutrient status, Wheat varieties.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important staple food crop of the world and it is emerged as the backbone of India's food security. It is grown all over the world for its wider adaptability and higher nutritive value. Wheat is the second most important cereal crop after rice covering an area of 30.79 million hectares, total annual production of wheat was 103.6 million tonnes with the productivity of 3533 kg per hectare (Anonymous 2018-19). The dwarf varieties of wheat have great potential but require more nutrients and have posed a great threat to long-term sustainability of crop production due to exhaustive nature. Application of all the needy nutrients through chemical fertilizers have deteriorating effect on soil health leading to unsustainable yields (Eid *et al*., 2006) and it is the prime threat to Indian agriculture which is being more aggravated with continuous excessive use of fertilizers in soils containing low organic matter (Singh and Pal, 2011). The nutrient supply, the flows and the added nutrient should be managed properly in order to achieve as high yield as possible while minimizing environmental pollution (Finck, 1998).

Hence, for long term agricultural sustainability, optimization of the crop nutrition through integrated use of all available nutrient sources is a must. Integrated nutrient management (INM) involves the conjunctive use of chemical fertilizers, organic manures, biofertilizers *etc*. and assumes

[1]Subject Matter Specialist, Krishi Vigyan Kendra, Jaora-457 226, Ratlam, Madhya Pradesh, India.
[2]Department of Agronomy, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar-385 506, Gujarat, India.
[3]Subject Matter Specialist, Krishi Vigyan Kendra, Jaisalmer-II, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Pokharan-345 021, Jaisalmer, Rajasthan, India.
[4]ICAR-Directorate of Groundnut Research, Regional Research Station, Bikaner-334 006, Rajasthan, India.
[5]Department of Agrometeorology, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar-385 506, Gujarat, India.
[6]ICAR-Agricultural Technology Application Research Institute, Jabalpur-482 001, Madhya Pradesh, India.

Corresponding Author: C.R. Kantwa, Subject Matter Specialist, Krishi Vigyan Kendra, Jaora-457 226, Ratlam, Madhya Pradesh, India. Email: crkantwa@gmail.com

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greater importance due to decreasing soil health and fertility and reduced factor productivity (Prasad *et al.,* 2010). According to prevailing circumstances, INM practice is perceived as a feasible option to restore soil health fertility and get sustained higher crop yields. Organic manures, when applied in conjunction with mineral nutrients, not only improve the yield levels but also improves the soil health through their favourable effects on the physical, chemical and biological properties of the soil and thus, help to sustain the productivity (Lourduraj, 1999). Use of organic manure supplies primary, secondary and micronutrients and helps in avoiding the deficiencies of these nutrients, which in recent year have become the key factor in reducing the response of crops to NPK applied through fertilizers only. Organic manures also have a pronounced residual effect on the soil fertility (Babhulkar *et al.,* 2000). Biofertilizers are the main source of microbial inoculants, which have brought hopes for many countries both in economically and environmentally. In developing countries like India, biofertilizers can solve problems of higher cost of fertilizers and thus can save the economy of the country (Gupta *et al.,* 2003). Biofertilization is receiving steadily increased attention and recognition because biofertilizers are not only inexpensive but also eco-friendly (Mahdi, 1993).

Therefore, the present investigation was carried out to study the effect of INM practices with wheat varieties on nutrient content, uptake and nutrient status of soil after experimentation. We hypothesised that INM practices would improve nutrient uptake in crop and soil nutrient status.

MATERIALS AND METHODS

Site description

The experiment was conducted at Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat (24°19′N latitude and 72°19′E longitude with an elevation of 154.5 m above the mean sea level) during two consecutive *rabi* seasons of 2016-17 and 2017-18. The climate of the region is semi-arid with hot summers and cold winters. The annual rainfall received during first and second crop season was 585 and 2083 mm, respectively.

Experimental design and crop management

The experiment was laid out in a factorial randomized block design consisting of four wheat varieties (GW 273, GW 322, GW 451 and GW 496) and six integrated nutrient management (INM) practices (control, 100% RDF, 100% RDF + *Azotobacter* + PSB, 75% RDF + *Azotobacter* + PSB, 75% RDF + *Azotobacter* + PSB + $ZnSO_4$ and 50% RDF + 25% N through FYM + *Azotobacter* + PSB + $ZnSO_4$) with three replications. Crop was grown as per recommended practices except the treatments under study. Field was prepared for sowing of crop and furrows were opened at 22.5 cm spacing with tractor. Fertilizer application was done as per the treatments. 100 percent recommended dose of fertilizer (RDF) *i.e.* 120 kg N: + 60 kg P_2O_5 per hectare was applied through urea and diammonium (DAP). Full dose of phosphorus and one third dose of nitrogen were applied at sowing and remaining nitrogen was top dressed in two equal splits at first and second irrigations after sowing. Wheat seeds were treated with both *Azotobacter* and PSB@ 6g kg^{-1} of seed or separately either with *Azotobacter* or PSB in the concerned treatments. Farm Yard Manure (FYM) (0.5, 0.2 and 0.5 per cent N, P and K, respectively) was broadcasted thoroughly in the respective plots one month before sowing. Zinc sulphate @ 25 kg ha^{-1} was applied as per treatments. Sowing was done using the seed rate of 120 kg ha^{-1} on 17th and 14th November and harvested on 3rd March and 1st March during 2016-17 and 2017-18, respectively. Total six irrigations in each season were given in crop during both the years of study.

Plant analysis and nutrient uptake

Nitrogen, phosphorus and potassium content in grain and straw were determined by drying the samples in hot-air oven at 60°C±2°C till a constant dry weight obtained. The oven-dried samples were ground to pass through 40 mesh sieve in a Macro-Wiley Mill. Nitrogen was estimated by modified Kjeldhal method, P concentration by Vanado-molybdo-phosphoric yellow colour method and K concentration by flame photometer method as per the procedure described by Jackson (1973). Thereafter, the uptake of nutrient was calculated by multiplying concentration with their respective yield.

Soil sampling and analysis

For initial soil parameters, in the year 2016 composite soil sample was collected from 0-15 cm soil depth before preparation of the field and were air dried, ground and passed through 0.2 mm mesh sieve. The textural composition consists of 840 g sand, 75 g silt and 71 g clay kg^{-1} of soil and soil of the experimental site is classified as loamy sand, typic Ustipsamments. The initial soil had pH 7.4, soil organic carbon 0.24 %, $KMnO_4$ oxidizable N 159 kg ha^{-1}, 0.5 N $NaHCO_3$ extractable P 38.9 kg ha^{-1} and 1.0 N NH_4OAc exchangeable K 287 kg ha^{-1} and DTPA extractable Zn 0.41 mg kg^{-1} in the top 15 cm soil layer. After field experimentation soil samples were again collected from 0-15 cm depth in each plot and were air dried, ground and passed through 0.2 mm mesh sieve. Organic carbon content in soil samples were determined by Walkley and Black (1934) method, available N by alkaline potassium permanganate method (Subbiah and Asija, 1956), P by Bray and Kurtz No. 1 method (Olsen *et al.,* 1954), K by ammonium acetate method (Hanway and Heidal, 1952).DTPA-extractable Zn was determined using the diethylene triaminepenta acetic acid (DTPA) extraction method (Lindsay and Norvell, 1978) using atomic absorption spectrometer.

Statistical analysis

The statistical analysis was performed by using the analysis of variance (ANOVA). Least significant differences (LSD 0.05) provided detailed information about the differences among treatment means.

RESULTS AND DISCUSSION

Yield

Yield is significantly affected by wheat varieties and integrated nutrient management (INM) practices. Maximum grain yield (4.99 t ha^{-1}) was registered with variety GW 451, which was 17.0 and 19.0% higher over GW 322 and GW 273, respectively but remained at par with variety GW 496 (4.81 kg ha^{-1}) (Table 1). Further, variety GW 451 also showed its significant superiority by producing the highest straw yield (6.15 t ha^{-1}). Among nutrient management practices, application of 100% RDF + *Azotobacter* + PSB gave significantly highest grain yield and straw yield being at par with 100% RDF. The higher yields might be due to the role of primary, secondary and micro-nutrients which enhanced the translocation of photosynthates towards the sink (reproductive organs) ultimately resulting in higher yield attributing characters (Sepat *et al.,* 2010; Jaga and Upadhyay, 2013).

Nutrient content

Data (Table 2) revealed that different wheat varieties failed to cause any significant variation for nitrogen, phosphorus and potassium content in grain and straw of wheat. Further, results indicated that the highest NPK content in grain and straw was observed with 100% RDF + *Azotobacter* + PSB and was found significantly superior to control. The beneficial effects under these treatments might be due to the fact that plants absorbed these nutrients proportionately in higher amount because the pool of available nutrients were already increased in the soil from applied nutrients. These results are in agreement with those of Sharma and Sharma (2002) and Singh and Pathak (2002).

Nutrient uptake

Maximum total uptake of nitrogen, phosphorus and potassium were recorded by wheat variety GW 451 while lowest uptake in GW 273 (Table 3). Nutrient uptake is dependent on dry matter production. Therefore, in spite of marginal improvement in nutrient concentration, significantly higher nitrogen, phosphorus and potassium uptake was observed with variety GW 451. The results of the present investigation indicated differential behaviour of wheat varieties with respect to nitrogen, phosphorus and potassium uptake and in close conformity with findings of Buldak (1994) and Jat (1995).

Different nutrient management practices had significant effect on nutrients uptake. Application of 100% RDF +

Table 1: Effect of wheat varieties and integrated nutrient management on yield of wheat (mean data of two years).

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Varieties		
GW 273	4.20	5.47
GW 322	4.27	5.58
GW 451	4.99	6.15
GW 496	4.81	6.04
S.Em±	0.07	0.08
C. D. at 5%	0.20	0.22
Integrated nutrient management		
Control (No fertilizer)	3.73	5.11
100% RDF	4.97	6.25
100% RDF + *Azoto.* + PSB	5.11	6.38
75% RDF + *Azoto.* + PSB	4.33	5.45
75% RDF + *Azoto.* + PSB + $ZnSO_4$	4.61	5.82
50% RDF + 25% N through FYM+ *Azoto.* + PSB + $ZnSO_4$	4.67	5.84
S.Em±	0.09	0.10
C. D. at 5%	0.24	0.27

Table 2: Effect of wheat varieties and integrated nutrient management on N, P and K content in grain and straw (mean data of two years).

Treatments	N content (%)		P content (%)		K content (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Varieties						
GW 273	1.995	0.709	0.413	0.183	0.430	1.494
GW 322	2.016	0.713	0.413	0.183	0.436	1.510
GW 451	2.047	0.734	0.426	0.187	0.443	1.531
GW 496	2.041	0.724	0.426	0.186	0.442	1.521
SEm±	0.015	0.007	0.005	0.001	0.004	0.012
LSD (P=0.05)	NS	NS	NS	NS	NS	NS
Integrated nutrient management						
Control (No fertilizer)	1.928	0.684	0.390	0.175	0.414	1.387
100% RDF	2.063	0.729	0.429	0.188	0.446	1.550
100% RDF + *Azoto.* + PSB	2.075	0.740	0.435	0.189	0.449	1.555
75% RDF + *Azoto.* + PSB	2.025	0.718	0.419	0.185	0.437	1.522
75% RDF + *Azoto.* + PSB + $ZnSO_4$	2.035	0.722	0.420	0.186	0.439	1.532
50% RDF + 25% N through FYM+ *Azoto.* + PSB + $ZnSO_4$	2.023	0.727	0.423	0.186	0.441	1.538
SEm±	0.019	0.009	0.006	0.002	0.005	0.014
LSD (P=0.05)	0.052	0.025	0.017	0.005	0.014	0.04

Azotobacter + PSB significantly increased the N, P and K uptake in grain and straw by 46.4, 10.7 and 35.8 kg ha^{-1}, respectively over control (Table 3). The higher NPK uptake under this treatment might be attributed to higher nutrient content as well as higher yields. Since, uptake of the nutrient is the function of nutrient content and biomass production, the significant increase in nutrient content coupled with increased yield under different treatments enhanced the total uptake of these nutrients. It is fact that plants absorbed these nutrients proportionately in higher amount because the pool of available nutrients was already increased in the soil from applied nutrients (Rahevar *et al.,* 2015).

Soil organic carbon and available nutrients

Different wheat varieties did not bring any significant variation in soil organic carbon (SOC), available NPK and DTPA zinc in soil after both years of experimentation. However, nutrient management practices significantly influenced SOC, available NPK and DTPA Zn in the soil (Table 4). Significantly higher SOC was recorded under 50% RDF + 25% N through FYM + *Azotobacter* + PSB + $ZnSO_4$ than control and 100% RDF.SOC changes are generally directly related to the quantity of organic manure/crop residues applied and agronomic practices that influence yield (Choudhary *et al.*, 2019). Furthermore, the significantly higher values of

Table 3: Effect of wheat varieties and integrated nutrient management on N, P and K uptake by grain and straw (mean data of two years).

Treatments	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)	
	Grain	Straw	Grain	Straw	Grain	Straw
Varieties						
GW 273	83.78	38.71	17.38	10.01	18.08	81.66
GW 322	86.20	39.73	17.65	10.24	18.64	84.36
GW 451	102.39	45.20	21.34	11.51	22.21	94.41
GW 496	98.44	43.86	20.53	11.25	21.29	92.14
SEm±	1.46	0.55	0.34	0.15	0.34	1.24
LSD (P=0.05)	4.09	1.55	0.96	0.42	0.94	3.49
Integrated nutrient management						
Control (No fertilizer)	71.95	34.96	14.57	8.96	15.46	70.92
100% RDF	102.50	45.55	21.35	11.71	22.15	96.86
100% RDF + *Azoto.* + PSB	106.05	47.23	22.22	12.05	22.99	99.15
75% RDF + *Azoto.* + PSB	87.66	39.08	18.17	10.09	18.93	83.10
75% RDF + *Azoto.* + PSB + $ZnSO_4$	93.87	42.08	19.35	10.84	20.25	89.13
50% RDF + 25% N through FYM+ *Azoto.* + PSB + $ZnSO_4$	94.19	42.38	19.69	10.85	20.54	89.71
SEm±	1.78	0.67	0.42	0.18	0.41	1.52
LSD (P=0.05)	5.01	1.89	1.18	0.52	1.16	4.27

Table 4: Effect of wheat varieties and integrated nutrient management on soil organic carbon (SOC) and available nutrients in the soil (0-15 cm) (mean data of two years).

Treatments	SOC	Soil available nutrients (kg ha^{-1})			(mg kg^{-1}) DTPA Zn
	(%)	N	P	K	
Varieties					
GW 273	0.244	166.16	40.51	287.26	0.503
GW 322	0.242	164.55	39.66	286.58	0.508
GW 451	0.237	161.73	39.46	284.07	0.495
GW 496	0.239	163.54	39.67	285.25	0.512
SEm±	0.002	1.26	0.30	2.24	0.005
LSD (P=0.05)	NS	NS	NS	NS	NS
Integrated nutrient management					
Control (No fertilizer)	0.225	153.73	38.04	279.91	0.440
100% RDF	0.229	166.16	40.42	282.55	0.473
100% RDF + *Azoto.* + PSB	0.245	167.25	40.72	286.61	0.475
75% RDF + *Azoto.* + PSB	0.245	164.40	39.75	287.09	0.437
75% RDF + *Azoto.* + PSB + $ZnSO_4$	0.247	165.65	39.84	288.61	0.595
50% RDF + 25% N through FYM+ *Azoto.* + PSB + $ZnSO_4$	0.252	166.77	40.17	289.97	0.605
SEm±	0.003	1.54	0.37	2.74	0.006
LSD (P=0.05)	0.007	4.32	1.04	NS	0.017

available N and P in soil were associated with 100% RDF + *Azotobacter* + PSB but it was at par with all other treatments except control. However, higher DTPA Zn was observed under 50% RDF + 25% N through FYM+ *Azotobacter* + PSB + $ZnSO_4$ treatment. This might be due to the direct addition of nutrients through fertilizer, organic manure and biofertilizer. The favourable effect of chemical fertilizer in conjunction with biofertilizers in enhancing the availability of nutrients in soil is well documented. Mikha and Rice (2004) also reported positive effects of manure application on nutrient content of the soil. The results were in close conformity with the findings of Singh and Chandra (2011).

CONCLUSION

The results clearly indicated that wheat variety GW 451 performed better over GW 273, GW 322 and GW 496 in terms of nutrient uptake. Furthermore, INM practice a.i. 100% RDF + *Azotobacter* + PSB in wheat resulted in higher nutrient content in grain and straw in addition to higher nutrient uptake. Similarly,application of 100% RDF + *Azotobacter* + PSB significantly improved available nitogen, phosphorus and potassium in soil. However, availble zinc and organic carbon content in soil incresed under applicaion of 50% RDF + 25% N through FYM+ *Azotobacter* + PSB + $ZnSO_4$.

Conflict of interest: None.

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