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ASSESSMENT OF THE INTEGRATED NUTRIENT MANAGEMENT EFFECTS ON YIELD ATTRIBUTES AND YIELD OF WHEAT CV. PBW-550

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Abstract

A study was conducted with the aim to know the effect nutrient integration on the yield attributes and yield of the cultivar PBW-550. The study was comprised sixteen combinations of nutrients from different organic and inorganic sources. The field trials were conducted in the randomized block design with three replications. The study revealed that maximum increases in yield attributing characteristics were recorded with T_{11} (100 % R.D.F. + 25 % N through vermicompost + S + Zn + bio Fertilizer (*Azotobacter* + P.S.B.) followed by T_9 (100 % R.D.F. + 25 % N through F.Y.M. + S + Zn + bio-fertilizers (*Azotobacter* + P.S.B.) and minimum at control. Integration of inorganic, organic and bio-fertilizers influenced yield attributing parameters with 100 % and 75 % RDF treatments. Integration of vermicompost showed highest increase in yield attributing characteristics in comparison to FYM. Grain and straw yield in all the treatments increased significantly over control highest grain and straw yield were recorded with T_{11} (100 % R.D.F. + 25 % N through vermicompost + S + Zn + bio Fertilizer (*Azotobacter* + P.S.B.) which was 104 % and 108 % higher in grain and 96.5 % and 98.3 % in straw to lowest grain yield and straw yield at control (T_1).

Keywords **:** INM, Wheat, Grain yield and bio-fertilizers

Introduction

Wheat (*Triticum aestivum* L.) belongs to family Gramineae and subfamily Poaceae and is a staple food of the world. India is one of the principal wheat producing and consuming countries in the world. Its importance in Indian agriculture is second after rice. About 55% of the world population depends on wheat for intake about 20% of food calories. Globally, wheat is being grown in 124 countries and occupies area of 215.61 million ha and production nearly 725.50 million tonnes of grain during 2014-15 (Anonymous, 2015). Total world consumption of wheat is around 600 million tonnes per year and this is expected to grow continuously over coming years. India is second largest wheat growing country after China in the world. In India the area under wheat increased since the start of green revolution in 1967 along with production and productivity. The area under wheat increased from 12.8 million hectares in 1966-67 to 31.50 million hectares in 2014-15. In this period production has also increased from 11.4 to 90.78 million tonnes and the productivity increased from 887 to 3146 kg ha^{-1} (Anonymous, 2015).

Wheat (*Triticum* spp., most commonly *T. aestivum*) is a cereal grain (botanically, a type of fruit called a caryopsis), originally from the Levant region but now cultivated worldwide. In 2016, world production of wheat was 749 million tonnes, making it the second most-produced cereal after maize (1.03 billion tonnes), with more than rice (499 million tonnes). Since 1960, world production of wheat and other grain crops has tripled and is expected to grow further through the middle of the 21st Century. This grain is grown on more land area than any other commercial food (220.4 million hectares, 2014). World trade in wheat is greater than for all other crops combined. Globally, wheat is the leading source of vegetable protein in human food, having a protein content of about 13%, which is relatively high compared to other major cereals and staple foods. The archaeological record suggests that wheat was first cultivated in the regions of the Fertile Crescent around 9600 BC. When eaten as the whole grain, wheat is a source of multiple nutrients and dietary fibre and is associated with lower risk of several diseases including coronary heart disease, stroke, cancer and type 2 diabetes. In a small part of the general population, gluten – the major part of wheat protein – can trigger coeliac disease, non-coeliac gluten sensitivity, gluten ataxia and dermatitis herpetiformis.

Uttar Pradesh is the major wheat producing states of India are followed by Punjab and Haryana with the production of 30, 16.47 and 11.63 million tonnes, respectively. But Punjab has highest productivity followed by Haryana with 4693 kg/ha, 4624 kg/ha, respectively. (Anonymous, 2015). U.P. is the leading player in wheat production in India and leads the front with more than 34% share of total wheat production in India.

Fertilizers have played a key role in the sustainable food grain production of our nation. **Nitrogen** (N) is an essential element for both crop development and biomass. The absorption of nitrogen by plants plays an important role in their growth. However, excessive use of nitrogen is economically costly as well as environmentally damaging with excess nitrogen lost by leaching into groundwater and runoff into surface water. Both to avoid pollution by nitrates and to maintain economic balance, there is need to identify genotypes that can efficiently use N. Efficient use of nitrogen by wheat is needed to sustain or increase yield and quality, while reducing the negative impacts of fertilizer on the environment. Assimilation of inorganic N into organic form has a marked influence on plant productivity and crop yield. Grain yield is the main target of crop production.

Adequate nitrogen nutrition is required for full development of tillers and leaves. Nitrogen application has a tremendous effect on tiller formation and survival of tillers.

Application of nitrogen at later stages of maize increased plant height, kernel number and high biomass at maturity that results in high yield. Nitrogen use efficiency (NUE) is defined as the grain yield per unit of available N in the soil. NUE varies with the growth stage of the plant. NUE as reflected in grain yield of winter wheat has also been shown to change with time and rate of application. Grain yield and nitrogen content of cereal crops increase significantly with applied nitrogen. Efficient N utilization is crucial for economic wheat production and protection of ground and surface water.

Balanced fertilizers through organic and inorganic sources improve the soil health as well as boost the productivity of wheat. Organic matter is the substrate for a large number of soil living beneficial organisms which are essential to keep the plant healthy.

Phosphorus is also a major nutrient essential for the production of the crops. Phosphorus has a great role in energy storage and transfer. It is a constituent of nucleic acid, phytin and phospholipids. Phosphorus is an essential constituent of majority of enzymes and is closely related to division and development of cell. The concentration of phosphorus in plant may vary from 0.1 to 0.5 %.

Potassium is also a major nutrient element, the concentration of which in vegetable tissue usually varies from 1-4% on dry matter basis. It regulates and maintains the cellular organization by regulating the permeability of cellular membrane and keeps the protoplasm in a proper degree of hydration by stabilizing the emulsion of high calorial properties. Potassium plays an important role in photosynthesis and translocation of food from leaves to the seeds. It affects the metabolism of carbohydrates and proteins, also govern their proportion in plant. It increases the resistance of plants against various insects and pests. Potassium deficiency leads to the malfunctioning of stomata.

Materials and Methods

The field experiment was conducted at Nawabganj farm, College of Agriculture, Chandra Shekhar Azad University of Agriculture & Technology Kanpur (U.P.) for two consecutive years (2013-14 and 2014-15) in irrigated condition.

The study was comprised sixteen treatments *viz.,* T_1-control, T_2-(100 % R.D.F), T_3-(100 % R.D.F. + S), T_4-(100 % R.D.F. + S + Zn), T_5-(100 % R.D.F. + S + Zn + bio-fertilizers (*Azotobacter* + P.S.B.), T_6-(100 % R.D.F. + 25 % N through F.Y.M.), T_7-(100 % R.D.F. + 25 % N through F.Y.M. + S), T_8-(100 % R.D.F. + 25 % N through F.Y.M. + S + Zn), T_9-(100 % R.D.F. + 25 % N through F.Y.M. + S + Zn + bio-fertilizers (*Azotobacter* + P.S.B.), T_{10}-(100 % R.D.F. + 25 % N through vermicompost), T_{11}-(100 % R.D.F. + 25 % N through vermicompost + S + Zn + bio-fertilizers (*Azotobacter* + P.S.B.), T_{12}-(75 % R.D.F.), T_{13}-(75 % R.D.F. + 25 % N through F.Y.M.), T_{14}-(75 % R.D.F. + 25 % N through vermicompost, T_{15}-(75 % R.D.F. + 25 % N through F.Y.M. + S + Zn + bio-fertilizers (*Azotobacter* + P.S.B.), T_{16}-(75 % R.D.F. + 25 % N through vermicompost + S + Zn + bio-fertilizers (*Azotobacter* + P.S.B.) in randomized block design with three replications.

The observations were recorded on yield attributing parameters that is number of effective tillers plant^{-1}, ear length (cm), number of spikelets ear^{-1}, number of grains ear^{-1}, grain weight ear^{-1}, grain weight plant^{-1}, test weight, ear length, number of spikelets, test weight, grain yield and straw yield in all the treatments.

Results and Discussion

Data pertaining to yield attributing parameters mainly effective tillers plant^{-1}, ear length, number of spikelet ear^{-1}, number of grains ear^{-1}, grain weight ear^{-1}, grain weight plant^{-1} and test weight (1000 seeds) in gram presented in Table 1 clearly revealed that these attributes were significantly influenced in all the treatments in comparison to control except ear length cm, number of spikelet ear^{-1} and test weight (1000 grain) during both years. Maximum increase in yield attributing characteristics were recorded with T_{11} (100 % R.D.F. + 25 % N through vermicompost + S + Zn + bio-fertilizers (*Azotobacter* + P.S.B.) followed by T_9 (100% R.D.F. + 25 % N through F.Y.M. + S + Zn + bio-fertilizers (*Azotobacter* + P.S.B.) and minimum at control (T_1) during both the years. It is also obvious from the data that integration of sulphur, zinc, bio-fertilizers, FYM and vermicompost with 100% RDF and 75% RDF treatments influences yield attributing parameters but the increase in yield attributing parameters with 100% RDF and 75% RDF treatments was found in general non-significant during both the years. It was also observed that 100% RDF treatment (T_2) showed significant increase in yield attributing parameters in comparison to 75% RDF treatment (T_{12}) during both the years. Integration of FYM (T_{13}) and vermicompost (T_{14}) with 75% RDF treatments showed non-significant increase in yield attributing parameters in comparison to 100% RDF (T_2) treatment during both the years. The increase in yield attributes might be attributed to increased cell expansion and various metabolic processes in the presence of adequate available nutrients. These findings are related to the findings of Singh and Agrawal (2000), Kaur *et al.* (2001), Sharma and Vyas (2001), Patel *et al.* (2003), Parihar (2004), Kumar *et al.* (2007), Rather and Sharma (2010), Khan *et al.* (2013), Khan *et al.* (2013) and Verma *et al.* (2014).

A perusal of the data presented in table 1 clearly revealed that all the treatments significantly influenced the grain and straw yield over control during both the years. The highest grain yield 46.50 and 44.70 q ha^{-1} and straw yield 58.35 and 55.90 q ha^{-1} were recorded with T_{11} (100 % R.D.F. + 25 % N through vermicompost +S + Zn + bio-fertilizers (*Azotobacter* + P.S.B.) which was 104 % and 108 % and 96.5 % and 98.3 % higher than the yield of control (T_1) during 1st year and 2nd year respectively. Integration of sulphur 30 kg ha^{-1} produced 10.80 % and 10.81 % higher grain and 10.14 % and 9.24 % higher straw yield in comparison to 100 % RDF (T_2) . Like-wise sulphur integration of 5 kg Zn ha^{-1} also produced 4.81 and 4.47 % higher grain and 4.25 and 3.91 % higher straw yield in comparison to 100 % RDF + S (T_3) during 1st year and 2nd year, respectively integration of bio-fertilizers (100% RDF + S + Zn + bio-fertilizers (*Azotobacter* + P.S.B.) T_5 also influence 2.60 and 2.33 % higher grain and 2.23 and 2.03 % higher straw yield in comparison to T_4 (100 % RDF + S + Zn) during 1st year and 2nd year. Integration of vermicompost T_{10} (100% R.D.F. + 25% N through vermicompost) produced 12.96 and 11.56 % higher grain yield and FYM T_6 (100 % R.D.F. + 25 % N through FYM) produced 8.50 and 7.50% higher grain yield in comparison to 100 % RDF treatment (T_2) during 1st year and 2nd year respectively. It was also observed that integration of 25% N through vermicompost with 75 % RDF treatment (T_{14})

produced higher grain and straw yield in comparison to 75% RDF + 25 % N through FYM (T_{13}) and found at par to 100 % RDF treatment (T_2) during both the years. It was also observed that integration of vermicompost produced higher grain and straw yield with 100 % RDF and 75 % RDF treatments in comparison to FYM. Increases in grain and straw yields might be due to increasing in growth and yield attributes of wheat due to integration of organic and bio-fertilizers with chemical fertilizers. Organics besides release of their own nutrients might have increase the nutrient use efficiency of applied inorganic fertilizers in wheat crop. The results of the present study are in agreement with those of several investigations Banwasi and Bajpai (2001), Sharma and Manohar (2002), Singh and Pathak (2002), Agarwal *et al.* (2003), Ali *et al.* (2004), Anand and Patil (2005), Kulkarni *et al.* (2005), Hasina Gul *et al.* (2011) and Verma *et al.* (2015).

Biological yield

Effect of integrated nutrient management on biological yield of wheat presenting in table 1 and illustrated in showed significant increases in all the treatments in comparison to control. Maximum biological yield 104.85 and 100.60 q ha^{-1} recorded with T_{11} (100 % R.D.F. + 25 % N through vermicompost +S + Zn + bio-fertilizers (*Azotobacter* + P.S.B.) followed by T_9 (100 % R.D.F. + 25 % N through F.Y.M. + S + Zn + bio-fertilizers (*Azotobacter* + P.S.B.) and minimum in control (T_1) during both the years. Integration of sulphur, zinc, FYM and vermicompost influenced biological yield significantly during both the years. Integration of vermicompost showed higher increase in biological yield in comparison to FYM during both the years. Biological yield of 1^{st} year recorded higher in comparison to 2^{nd} year. These results are in the line of the findings of Singh and Agrawal (2000), Jain and Dharma (2007) and Gul *et al.* (2011).

The data in regard to harvest index given in table 1 showed that harvest index of wheat was influenced significantly in all the treatments in comparison to control. Integration of sulphur, zinc, bio-fertilizers and organic manures showed slight increase in harvest index during both the years. Variation in harvest index within all the treatments was recorded narrower and significant during both the years. These results are in accordance to the findings of Shatrughan *et al.* (2003) and Akmal *et al.* (2007).

Table 1 : Effect of Integrated Nutrient Management on yield attributes and yield of wheat CV. PBW-550

Treatment		Number of Effective Tillers Plant^{-1}		Ear Length (cm)		Number of Spicklets ear^{-1}		Number Grains ear^{-1}		Grains Weight (g) ear^{-1}		Grains Weight(g) Plant^{-1}	
		2013-2014	2014-2015	2013-2014	2014-2015	2013-2014	2014-2015	2013-2014	2014-2015	2013-2014	2014-2015	2013-2014	2014-2015
T_1	Control	5.80	5.15	8.10	7.80	17.25	16.90	39.46	38.52	1.30	1.10	6.54	5.60
T_2	100 % R.D.F.	6.90	6.50	9.40	9.00	19.15	18.40	41.10	40.25	1.65	1.60	9.38	8.40
T_3	100 % R.D.F. + S	7.25	7.00	9.65	9.30	19.65	18.80	42.65	41.79	1.85	1.75	11.41	10.50
T_4	100 % R.D.F. + S + Zn	7.65	7.35	9.85	9.65	20.05	19.15	44.73	43.86	2.05	1.90	13.68	11.96
T_5	100 % R.D.F. + S + Zn + Bio- fertilizers (*Azotobactor* + P.S.B.)	7.75	7.45	10.00	9.75	20.10	19.25	45.60	44.72	2.10	2.00	14.27	12.90
T_6	100 % R.D.F. + 25 % N through F.Y.M.	7.10	6.70	9.45	9.10	19.35	18.50	41.37	40.52	1.70	1.65	10.07	9.05
T_7	100 % R.D.F. + 25 % N through F.Y.M. + S	7.90	7.65	10.10	9.90	20.15	19.35	46.48	45.61	2.20	2.05	15.38	13.68
T_8	100 % R.D.F. + 25 % N through F.Y.M. + S + Zn	8.05	7.80	10.25	10.05	20.25	19.55	47.37	46.53	2.25	2.10	16.11	14.38
T_9	100 % R.D.F. + 25 % N through F.Y.M. + S + Zn +Bio -fertilizers (*Azotobactor* + P.S.B.)	8.15	7.90	10.35	10.15	20.35	19.65	48.19	47.33	2.30	2.15	16.74	14.98
T_{10}	100 % R.D.F. + 25 % N through vermicompost	7.45	7.05	9.70	9.40	19.80	18.90	43.40	42.55	1.90	1.80	12.15	10.69
T_{11}	100 % R.D.F. + 25 % N through vermicompost +S + Zn + Bio Fertilize (*Azotobactor* + P.S.B.)	8.25	8.00	10.50	10.25	20.50	19.75	49.10	48.21	2.35	2.20	17.38	15.60
T_{12}	75 % R.D.F.	6.25	5.85	8.80	8.60	18.60	17.90	40.03	39.15	1.50	1.35	7.37	6.08
T_{13}	75 % R.D.F. + 25 % N through F.Y.M.	6.65	6.15	9.05	8.75	18.85	18.10	40.42	39.56	1.55	1.45	8.30	6.91
T_{14}	75 % R.D.F. + 25 % N through vermicompost	6.80	6.35	9.25	8.95	19.00	18.30	40.78	39.96	1.60	1.50	8.88	7.50
T_{15}	75 % R.D.F. + 25 % N through F.Y.M. + S + Zn +Bio-fertilizers (*Azotobactor* + P.S.B.)	7.15	6.80	9.50	9.15	19.50	18.65	41.95	41.10	1.80	1.75	10.87	9.60
T_{16}	75 % R.D.F. + 25 % N through vermicompost + S + Zn + Bio-fertilizers (*Azotobactor* + P.S.B.)	7.50	7.15	9.80	9.50	19.90	18.95	43.87	42.99	2.00	1.85	13.00	11.32
S.E. +	0.571	0.608	0.723	0.807	1.684	1.576		1.850	1.681	0.138	0.153	2.251	2.121
C.D. (at 5 %)	1.173	1.248	NS	NS	NS	NS		3.23	3.13	0.283	0.314	4.120	3.983

Table 1. contd…

Treatment		Test Weight (g) 1000 Grains^{-1}		Biological Yield q ha^{-1}		Grain Yield q ha^{-1}		Straw Yield q ha^{-1}		Harvest index (%)	
		2013-2014	2014-2015	2013-2014	2014-2015	2013-2014	2014-2015	2013-2014	2014-2015	2013-2014	2014-2015
T_1	Control	44.50	43.85	52.50	49.70	22.80	21.50	29.70	28.20	43.42	43.25
T_2	100 % R.D.F.	46.60	45.90	79.55	76.55	34.70	33.30	44.85	43.25	43.62	43.50
T_3	100 % R.D.F. + S	47.05	46.25	87.85	84.15	38.45	36.90	49.40	47.25	43.76	43.85
T_4	100 % R.D.F. + S + Zn	47.40	46.55	91.80	87.65	40.30	38.55	51.50	49.10	43.89	43.98
T_5	100 % R.D.F. + S + Zn + Bio- fertilizers (*Azotobactor* + P.S.B.)	47.55	46.75	94.00	89.55	41.35	39.45	52.65	50.10	43.98	44.05
T_6	100 % R.D.F. + 25 % N through F.Y.M.	46.80	46.05	86.20	82.05	37.65	35.80	48.55	46.25	43.67	43.63
T_7	100 % R.D.F. + 25 % N through F.Y.M. + S	47.65	46.80	96.15	90.50	42.35	39.90	53.80	50.60	44.04	44.08
T_8	100 % R.D.F. + 25 % N through F.Y.M. + S + Zn	47.80	47.00	100.85	94.55	44.50	41.75	56.35	52.80	44.12	44.15
T_9	100 % R.D.F. + 25 % N through F.Y.M. + S + Zn +Bio -fertilizers (*Azotobactor* + P.S.B.)	47.90	47.10	103.30	96.75	45.70	42.80	57.60	53.95	44.24	44.23
T_{10}	100 % R.D.F. + 25 % N through vermicompost	47.15	46.35	89.50	84.60	39.20	37.15	50.50	47.45	43.79	43.91

T 11	100 % R.D.F. + 25 % N through vermicompost +S + Zn + Bio Fertilize (*Azotobactor* + P.S.B.)	48.20	47.50	104.85	100.60	46.50	44.70	58.35	55.90	44.34	44.43
T 12	75 % R.D.F.	46.05	45.15	70.30	67.880	30.60	29.45	39.70	38.35	43.52	43.38
T 13	75 % R.D.F. + 25 % N through F.Y.M.	46.30	45.50	74.85	71.45	32.60	31.05	42.25	40.40	43.55	43.45
T 14	75 % R.D.F. + 25 % N through vermicompost	46.50	45.75	77.60	73.95	33.80	32.15	43.80	41.80	43.56	43.47
T 15	75 % R.D.F. + 25 % N through F.Y.M. + S + Zn +Bio-fertilizers (*Azotobactor* + P.S.B.)	46.95	46.20	87.65	83.25	38.30	36.45	49.35	46.80	43.69	43.78
T 16	75 % R.D.F. + 25 % N through vermicompost + S + Zn + Bio-fertilizers (*Azotobactor* + P.S.B.)	47.30	46.50	90.80	85.65	39.80	37.70	51.00	47.95	43.83	44.01
S.E. +		3.406	3.557	7.290	7.023	3.098	2.986	4.308	3.861	0.204	0.190
C.D. (at 5 %)		NS	NS	14.961	14.413	6.358	5.954	8.841	7.942	0.420	0.391

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