Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-7: 3473-3479

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 Special Issue-7 pp. 3473-3479
Journal homepage: http://www.ijcmas.com

Original Research Article

Effect of Different Nutrient Management Treatments on Growth, Yield Attributes, Yield and Quality of Wheat (*Triticum aestivum* L.)

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A B S T R A C T

A field experiment entitled "Yield maximization through nutrient management in irrigated wheat (*Triticum aestivum* L.)" was carried out at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh during the *rabi* season of 2015-16. The experiment comprising ten treatments of nutrient management *viz*., T_1 (control), T_2 (RDF 120:60:60 NPK kg ha^{-1}), T_3 (75% N from urea + 25% N from FYM), T_4 (FYM @ 10 t ha^{-1}), T_5 [RDF + $ZnSO_4$ @ 25 kg ha^{-1} (P from DAP)], T_6 [RDF + $ZnSO_4$ @ 25 kg ha^{-1} (P from SSP)], T_7 [RDF (N from Zn coated urea + P from SSP)], T_8 (75% RDF + *Azotobacter* + PSB), T_9 [RDF (N from neem coated urea + P from SSP)] and T_{10} (RDF 50% N from neem coated urea + 50% N from Zn coated urea + P from SSP) were evaluated in randomized block design with three replications. The experimental soil was clayey in texture, medium in available N, P, K and low in available zinc. Wheat variety 'GW-336' was sown at 22.5 cm row spacing. The experimental results revealed that significantly higher values of growth parameters *viz*., plant height, dry matter per plant, number of total tillers and effective tillers, and yield attributes *viz*., length of spike, number of grains per spike, grain weight per spike and 1000-seed weight, higher grain yield (4227 kg ha^{-1}) and straw yield (5792 kg ha^{-1}), quality parameters *viz*., protein content and protein yield were recorded significantly higher under the treatment RDF (120-60-60 kg N-P_2O_5-K_2O ha^{-1}) + $ZnSO_4$ @ 25 kg ha^{-1} (P from DAP), being at par with treatments RDF, RDF + $ZnSO_4$ @ 25 kg ha^{-1} (P from SSP), RDF (N from Zn coated urea + P from SSP), 75% RDF + *Azotobacter* + PSB, RDF (N from neem coated urea + P from SSP) and RDF (50% N from neem coated urea + 50% N from Zn coated urea) + P from SSP.

Keywords

Wheat, Nutrient management, biofertilizers, growth, yield

Introduction

Wheat, *Triticum aestivum* L., a native of South West Asia, is one of the most important staple food crop that has been labelled as 'king of cereals'. India is the second largest wheat producer country in the world. It is the second most important crop in India after rice, both in terms of area and production. In the world, wheat is grown on an area of 226.60 million ha with 716.1 million tonnes production and 3.2 tonnes ha^{-1} productivity (Anon., 2014). India occupied wheat area of 30.23 million ha with production of 93.50 million tonnes and average productivity of 3093 kg ha^{-1} (Anon., 2016).

The major wheat producing states are Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Haryana and Bihar which occupy 33%, 18%, 12%, 10%, 9% and 8% area of total wheat cultivation in the country, respectively. In India, the highest productivity of wheat is recorded in Punjab, whereas Gujarat stands 6^{th} rank with productivity of 2919 kg ha^{-1}.

Integrated nutrient management is vital for sustaining food production. Use of organic, bio-fertilizers and green manures along with inorganic fertilizers has been found effective in improving and maintaining soil fertility, increasing nutrient use efficiency for maximizing productivity in different cropping systems. Verma *et al.,* (2005) reported that the integration of inorganic fertilizers with organic manures will not only sustain the crop production but also effective in improving soil health and enhancing the nutrient use efficiency. Use of bio-fertilizers provide primary nutrients to the plants and maintains good soil health. Neem coated urea is a special formulation of natural neem oil and humic acid which contains high quantity of Triterpenes, the denitrifying factors. The integrated use of concentrate organic materials and inorganic fertilizers has received considerable attention in the past with a hope of meeting the farmer's economic need as well as maintaining favorable ecological conditions on long-term basis (Kumar *et al.*, 2007). A balanced fertilizer means not only the use of major and secondary nutrients, but also other essential micronutrients in correct proportions. Nutrients affected all most growth and yield attributing characters and yields through its doses as well as sources. Keeping in view the importance of these factors, the present study was designed to investigate the Effect of different nutrient management treatments on growth, yield and quality of wheat (*Triticum aestivum* L.)

Materials and Methods

A field experiment entitled "Yield maximization through nutrient management in irrigated wheat (*Triticum aestivum* L.)" was carried out at College of Agriculture, Junagadh Agricultural University, Junagadh during the *rabi* season of 2015-16. The experiment comprising ten treatments of nutrient management *viz*., T_1 (control), T_2 (RDF 120:60:60 NPK kg ha^{-1}), T_3 (75% N from urea + 25% N from FYM), T_4 (FYM @ 10 t ha^{-1}), T_5 [RDF + $ZnSO_4$ @ 25 kg ha^{-1} (P from DAP)], T_6 [RDF + $ZnSO_4$ @ 25 kg ha^{-1} (P from SSP)], T_7 [RDF (N from Zn coated urea + P from SSP)], T_8 (75% RDF + *Azotobacter* + PSB), T_9 [RDF (N from neem coated urea + P from SSP)] and T_{10} (RDF 50% N from neem coated urea + 50% N from Zn coated urea + P from SSP) were evaluated in randomized block design with three replications. The soil of the experimental plot was clayey in texture and slightly alkaline in reaction (pH 7.9 and EC 0.33 dS/m). The soil (0-15 cm depth) was low in zinc (0.41 mg kg^{-1}), medium in available nitrogen (254-269 kg/ha), available phosphorus (28.4-30.7 kg/ha) and available potassium (183-185 kg/ha). Wheat variety 'GW-336' was sown at 22.5 cm row spacing with 120 kg seed ha^{-1} in last week of November. The recommended dose of fertilizers @ 120:60:60 kg $NPKha^{-1}$ was considered as 100% RDF. The crop was fertilized as per treatments at the time of sowing, while well decomposed FYM containing 0.5% N, 0.2% P_2O_5, and 0.5% K_2O and vermicompost containing 1.5% N, 1.0% P_2O_5 and 1.5% K_2O were applied based on the nutrient equivalent basis of wheat nutrient requirement at preparation of soil. The seeds were treated with *Azotobacter* (*A. chroococcum*) and PSB (*Bacillus coagulans*) @ 10 ml kg^{-1} seed as per the treatments, shade dried before sowing. Other cultural operations were done as per recommendation and crop requirements. Regularly biometric observations were recorded at specific time intervals by selecting randomly five plants in each treatment. Finally the crop was harvested and produce were dried, threshed, cleaned and weighed. The yield data was subjected to statistical analysis.

Results and Discussion

Growth attributes

Wheat growth parameters *viz*., plant height at harvest, dry matter accumulation plant^{-1} at harvest, number of total tillers per metre^{-1} row length at harvest, effective tillers metre^{-1} row length at harvest were significantly influenced by different treatments (Table 1).

Application of RDF (120-60-60 kg N-P_2O_5-K_2O ha^{-1}) + $ZnSO_4$ @ 25 kg ha^{-1} (P from DAP) (T_5) recorded significantly taller plants at harvest, higher dry matter accumulation plant^{-1}, maximum number of total tillers m^{-1} row length, more number of effective tillers metre^{-1} row length compared to control (T_1), it was remained at par with the treatments T_2, T_6, T_7, T_8, T_9 and T_{10}.

The improvement in growth parameters with application of RDF (120-60-60 kg N-P_2O_5-K_2O ha^{-1}) + $ZnSO_4$ @ 25 kg ha^{-1} (P from DAP), treatments (T_5), T_2 (RDF 120:60:60 NPK kg ha^{-1}), T_6 [RDF + $ZnSO_4$ @ 25 kg ha^{-1}(P from SSP)], T_7 [RDF (N from Zn coated urea + P from SSP)], T_8 (75% RDF + *Azotobacter* + PSB), T_9 [RDF (N from neem coated urea + P from SSP)] and T_{10} [RDF (50% N from neem coated urea + 50% N from Zn coated urea) + P from SSP]. Fertilizer provides all the essential growth promoting elements for shoot growth, root development, photosynthesis, cell division and cell enlargement as a result meristmatic activity increased which favors the growth of wheat. Beneficial effect of chemical fertilizer on increasing growth and superior yield attributes were also reported by Jat *et al.*, (2013), Singh and Kushwaha (2013) and Kumar *et al.*, (2016). Inorganic nutrient application with zinc plays a pivotal role in regulating the auxin concentration in plant and nitrogen metabolism and might have improved the growth parameters. The nitrogen from fertilizer helped in the promotion of growth during the early stages and it is considered to be a vitally important plant nutrient. Further, an adequate supply of phosphorous early in the life cycle of plant through chemical fertilizer is important in laying down the primordia of its reproductive parts. While, micronutrient fertilization with zinc indicate the importance of Zn to plants, being involved in many enzymatic reactions and consequently for better growth and development.

Zn play a major role in the shoots and roots elongation due to auxin hormones activation in the wheat crop plant, higher dry matter production with the application of zinc might be due to reduced leaf senescence and it helps in increasing inter nodal length. These results are in accordance with the findings of Behera *et al.,* (2007), Khan *et al.,* (2007), Dhaliwal *et al.,* (2012), Shivay and Prasad (2012), Kumar *et al.,* (2016) and Nazir *et al.,* (2016).

Yield attributes

Wheat yield attributes such as length of spike, number of spikelets spike^{-1}, 1000-grain weight at harvest (Table-1) were improved by integrated nutrient management treatments of T_5 [RDF (120-60-60 kg N-P_2O_5-K_2O ha^{-1}) + $ZnSO_4$ @ 25 kg ha^{-1} (P from DAP)] which was remained statistically equivalent to the treatments T_2, T_6, T_8, T_9 and T_{10} in respect of length of spike, number of spikelets spike^{-1}, number of grains spike^{-1} at harvest, treatments T_2, T_6 and T_8 in respect of grain weight spike^{-1} and T_2, T_6, T_7, T_8, T_9 and T_{10} inrespect of 1000-grain weight.

Table.1 Effect of different nutrient management treatments on growth and yield attributes of wheat

	Treatments	Plant height (cm)	Dry matter plant^{-1} (g)	Number of total tillers m^{-1} row length	Number of effective tillers m^{-1} row length	Length of spike (cm)	Number of spikelets spike^{-1}	1000-grain weight (g)
T_1	Control	68.33	22.33	71.67	52.33	7.11	11.80	39.73
T_2	RDF (120:60:60 NPK kg ha-1)	85.67	26.88	88.78	72.00	8.43	14.25	44.00
T_3	75% N from urea + 25% N from FYM	77.19	24.13	80.00	62.81	7.60	13.34	41.04
T_4	FYM @ 10 t ha-1	75.57	23.87	78.67	62.51	7.50	12.87	40.71
T_5	RDF + ZnSO4 @ 25 kg ha-1 (P from DAP)	87.53	27.83	91.67	75.33	8.70	15.45	46.36
T_6	RDF + ZnSO4 @ 25 kg ha-1 (P from SSP)	86.67	27.62	90.87	74.67	8.65	14.79	45.70
T_7	RDF (N from Zn coated urea+ P from SSP)	77.67	24.41	83.33	63.37	7.70	13.52	42.60
T_8	75% RDF + Azotobacter + PSB	84.22	26.99	88.24	71.43	8.35	14.14	43.23
T_9	RDF (N from neem coated urea + P from SSP)	83.90	26.17	84.93	69.67	8.27	14.05	43.00
T_{10}	RDF (50% N from neem coated urea + 50% N from Zn coated urea) + P from SSP	83.50	25.77	84.50	69.12	8.10	13.93	42.68
	S.Em. ±	3.39	1.14	3.90	4.11	0.33	0.63	1.29
	C.D. (P = 0.05)	10.07	3.40	11.60	12.21	0.98	1.88	3.83
	C. V. %	7.25	7.75	8.03	10.57	7.13	7.94	5.21

Table.2 Effect of different nutrient management treatments on yield and quality of wheat

	Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)	Grain protein content (%)	Protein yield (kg ha^{-1})
T_1	Control	2699	3913	40.80	9.55	257.33
T_2	RDF (120:60:60 NPK kg ha-1)	4019	5482	42.97	12.37	497.33
T_3	75% N from urea + 25% N from FYM	3330	4692	41.44	11.12	370.00
T_4	FYM @ 10 t ha-1	3278	4367	41.16	10.83	355.33
T_5	RDF + ZnSO4 @ 25 kg ha-1 (P from DAP)	4227	5792	42.87	13.62	576.00
T_6	RDF + ZnSO4 @ 25 kg ha-1 (P from SSP)	4192	5613	42.62	12.69	532.00
T_7	RDF (N from Zn coated urea+ P from SSP)	3413	4724	41.93	11.25	385.33
T_8	75% RDF + Azotobacter + PSB	3925	5162	42.61	11.94	468.64
T_9	RDF (N from neem coated urea + P from SSP)	3774	5037	42.19	11.75	445.67
T_{10}	RDF (50% N from neem coated urea + 50% N from Zn coated urea) + P from SSP	3643	4941	42.44	11.15	406.33
	S.Em. ±	300.61	331.29	1.97	0.500	29.734
	C.D. (P = 0.05)	893.17	984.32	NS	1.487	88.343
	C. V. %	14.24	11.49	8.08	7.46	11.97

It was emphasized that use of chemical fertilizer and zinc source, use of fertilizers did bring about significant improvement in overall growth of the crop by providing needed nutrients from initial stage. Chemical fertilizer provided initial nutrient needed by crop, while Zn increased membrane-integrity, heat-tolerance, synthesis of carbohydrates, cytochrome and nucleotide synthesis, auxin-synthesis, chlorophyll synthesis and metabolism of N thereby enhancing photo-synthesis, photosynthates, their translocation to grain and finally crop yield increased in these treatments. Similar results related to increase in grain yield due to synergistic effect of NPK and Zn by soil application of Zn have been reported by Jan *et al.,* (2013), Shivay *et al.,* (2015) and Kumar *et al.,* (2016)

Yield

A perusal of data (Table-2) revealed that different treatments of nutrient management exerted their significant effect on grain yield and straw yield at harvest. Significantly the highest grain yield of 4227 kg ha^{-1} and straw yield of 5792 kg ha^{-1} at harvest were recorded under treatment RDF (120-60-60 kg $N-P_2O_5-K_2O$ ha^{-1}) + $ZnSO_4$ @ 25 kg ha^{-1} in which P supplied through DAP (T_5) which was found statistically equivalent to treatments T_2, T_6, T_8, T_9 and T_{10}. The magnitude of grain yield under treatments T_2, T_6, T_8, T_9 and T_{10} to the tune of 4019, 4192, 3925, 3774 and 3643 kg ha^{-1} in respect of T_1 (control) which having grain yield 2699 kg ha^{-1}. While, the magnitude of straw yield under treatments T_2, T_6, T_8, T_9 and T_{10} to the tune of 5482, 5613, 5162, 5037 and 4941 kg ha^{-1} in respect of T_1 (control) which having straw yield 3913 kg ha^{-1}. The increase in grain and straw yields might be due to adequate quantities and balanced proportion of plant nutrients supplied to the crop as per need during the critical growth period resulting in favourable increase in yield attributing characters which ultimately led towards an increase in economic yield. Improved physico-chemical properties of the soil through the application of organic manure might be the other possible reason for higher productivity. Pandey *et al.,* (2009), Keram *et al.,* (2012), Shivay and Prasad (2012), Jan *et al.,* (2013), Jat, *et al.,* (2013), Kadlag *et al.,* (2013), Sharma, *et al.,* (2013), Shivay *et al.,* (2015) and Kumar *et al.,* (2016).

Quality parameters

The data in (Table 2) revealed that protein content and protein yield were significantly influence by different nutrient management treatments. Protein content and protein yield were registered higher under the treatment T_5 [RDF (120-60-60 kg $N-P_2O_5-K_2O$ ha^{-1}) + $ZnSO_4$ @ 25 kg ha^{-1} (P from DAP)]. However, it is statistically equivalent to treatments T_2 and T_6. The increased in protein content in wheat grain is influenced by nitrogen and micronutrient availability at the grain formation stage and other environmental conditions.

Significant improvement in grain protein content might be due to its dependence on nitrogen content. While higher protein yield is due to protein content and grain yield. This could explained on the basis of better availability of required nutrients in the crop root zone and enhanced photosynthetic and metabolic activity resulted in better partitioning of photosynthates to sinks, which reflected in quality enhancement in terms of protein contentand protein yield. These findings are in close conformity with those reported by Kharub and Chander (2008), Keram *et al.,* (2012), Gajanand *et al.,* (2013), Kadlag *et al.,* (2013), Seema *et al.,* (2014), Sharma *et al.,* (2013), Kumar *et al.,* (2015), Singh *et al.,* (2015).

Based on field experimentation, it can be concluded that, higher growth, yield attributes, yield and quality from wheat can be secured by application of RDF (120-60-60 kg N-P_2O_5-K_2O ha^{-1}) + $ZnSO_4$ @ 25 kg ha^{-1} in which P supplied through DAP on calcareous clayey soil of South Saurashtra Agro-climatic Zone of Gujarat.

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