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Original Research Article

Growth, Yield and Economics of Wheat Crop as Influenced by Integrated Nutrient Management Practices

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A B S T R A C T

A field experiment entitled "Effect of integrated nutrient management on growth and yield of wheat" was conducted during *Rabi* season of 2009-10 at AICRP on Integrated Farming System, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiment was laid out in the Randomized Block Design (RBD) with 9 treatments. The treatments were T_1 - RDF (100: 50: 50 NPK kg ha^{-1}), T_2 - 75 % RDF + 5 t FYM ha^{-1}, T_3 -75% RDF + 5 t FYM ha^{-1} + 2% urea spraying, T_4 -75% RDF + 5 t FYM ha^{-1} + 10 kg $ZnSO_4$ + 2 % urea spraying, T_5 - RDF + 5 t FYM ha^{-1} + 10 kg $ZnSO_4$ ha^{-1} + 5 kg boron ha^{-1}, T_6 -75% RDF + *Azotobacter* seed treatment, T_7 -75% RDF + PSB seed treatment, T_8 -75% RDF + *Azotobacter* seed treatment + PSB seed treatment, T_9-75% RDF + *Azotobacter* seed treatment + PSB seed treatment + 2 % Urea spraying replicated thrice having gross and net plot size 5.4 m x 3.6 m and 3.6 m x 2.7 m, respectively. Variety NIAW-301 of wheat was sown on 25th November, 2009 from the result it can be concluded that growth factors *viz.* number of functional leaves, leaf area (cm^2), effective tillers plant^{-1}, length of spike (cm) and yield attributing character *viz.* dry matter accumulation (g), number of grain spike^{-1}, number of spikelet spike^{-1}, weight of grain plant^{-1}, test weight of wheat was recorded in highest in treatment T_5- RDF + 5 t FYM ha^{-1} + 10 kg $ZnSO_4$ ha^{-1} + 5 kg boron ha^{-1}. The highest grain yield (26.87 q ha^{-1}), straw yield (41.47 q ha^{-1}) and biological yield (68.14 q ha^{-1}) was recorded in treatment T_5- RDF + 5 t FYM ha^{-1} + 10 kg $ZnSO_4$ ha^{-1} + 5 kg boron ha^{-1}, whereas the lowest grain, straw and biological yield recorded in treatment T_7 -75% RDF + PSB seed treatment.

Keywords

INM, Growth, Yield, Economics and Wheat

Introduction

Wheat (*Triticum spp.)* is the world's most widely cultivated food crop. In India it is second important staple food, rice being the first. Wheat compares well with other important cereals in its nutritive value. It contains more protein than other cereals and besides their significance in nutrition they are principally concerned in providing the characteristic substance 'gluten' which is a very essential for bakers.

Integrated nutrient supply and management system aimed at sustainable crop production by orchestrating the combined use of inorganic fertilizers. Balanced and efficient fertilizer application is essential to compensate the increased yield and hence greater removal of soil nutrients.

The recent concept of integrated use of various sources (organic, inorganic and biofertilizer) of nutrient in crop production has started gaining ground. The basic concept underline the principal of integrated nutrient supply system is the improved of soil fertility for sustainable crop production on long term basis. It may be achieved through integrated use of all the possible sources of plant nutrient and their scientific management in different crops and cropping system. But there is limited work on the integrated nutrient management. Thus, it becomes essential to study the response of *T. aestivum* to the integrated nutrient management supply system.

Consequently the present research project entitled "Effect of integrated nutrient management on growth and yield of wheat" has been planned and conducted during *rabi* season 2009 at AICRP on Integrated farming system, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

Materials and Methods

The field experiment was conducted at AICRP on Integrated farming system, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *Rabi* season 2009-2010. The topography of plot was fairly leveled. Before sowing, the soil samples from 0 to 60 cm depth were collected randomly from spread all over the experimental field and later on one composite soil sample was prepared and analyzed for various physico-chemical properties of soil.

The mechanical analysis was done by International pipette method (Piper, 1950), pH by Blackman's glass electrode pH meter (Jackson, 1967), total nitrogen by modified Kjeldahl's method (Piper, 1966), available phosphorus by Metavendate method (Olsen, 1954) and available potassium by Flame emission method (Black, 1965).

The soil of the experimental plot was clayey in texture. The soil reaction was slightly alkaline. It was medium in total nitrogen, low in available phosphorus and high in available potassium. Depth of soil layer was 140 cm. The composite soil samples from 0-30 cm soil layer were taken with the help of screw auger before starting the field experiment. Soil thus collected was air dried and preserved properly in corrugated boxes. It was then analyzed for studying various physico-chemical properties. The techniques used for the determination of the properties are given in Table 1. The soil of the experimental field was clayey in texture and slightly alkaline in reaction. It was medium in available nitrogen, phosphorus and high in available potassium.

Geographically Parbhani is situated 409 m above the mean sea level, $19^{0}16'$ North latitude and $76^{0}47'$ East longitude and has sub-tropical climate. The climate of Marathwada is characterized by hot summer and general dryness throughout the year except during rainy season. Agriculturally the year is divided into three seasons viz. *Kharif* (16^{th} June to 15^{th} October), rabi (16^{th} October to 16^{th} February) and summer (16^{th} February to 15^{th} June). About 85 per cent rainfall is received from south-west monsoon and remaining 15 per cent from post monsoon season. Parbhani receives annual mean precipitation of 804.2 mm in about 57 rainy days and it is grouped under assured rainfall zone.

The data on weather parameters collected during experimental period showed that precipitation received during experimental period was 19.9 mm distributed over two rainy days. The maximum and minimum temperature levels during the experimental period were (28.1 to 37.2^{0}C) and (8.5 to 17.3^{0}C) respectively. (Normal maximum and minimum temperature ranged from 31.2

and 11.8). While relative humidity ranged from 55 to 81 per cent during morning hours and 21 to 47 per cent during afternoon hours (Normal varied from 74.70 to 33.1 per cent). In case of photoperiods it ranged from 8.0 to 10.6 hour/day.

The experimental field was laid out as per plan after preparatory cultivation. The layout consisted of 27 experimental plot in 3 replications. Each replication was divided into 09 experimental units. The allotment of treatments of these plots was done by randomization within the replication. The land was ploughed 20 cm deep with iron plough immediately after the harvest of previous crop. It was subsequently harrowed twice with blade harrow to achieve loose and friable seed bed. Stubbles of previous crops were collected and last harrowing was given.

Basal dose of fertilizer was applied through DAP and Urea mixed fertilizer, murate of potash and top dressing was done with the help of urea. Also well decomposed FYM was incorporated in soil with respect to various treatments in required quantity also the micro nutrient dose of zinc was given through $ZnSO_4$ source. Boron is given through borax powder.

A variety NIAW-301 selected for sowing of the crop. The seed rate 100 kg ha^{-1} was used for sowing of the crop, which was treated with thirum @ 4 g kg^{-1} seed. Sowing was done by drilling method at 22.5 cm row to row distance with weighed quantity of seed for each plot. Sowing was followed immediately by seed covering operation. The emergence started 7 days after sowing and completed after 14 to 15 days. After fine seedbed preparation sowing was done, immediately after sowing irrigation was given to experimental plot. The irrigation treatments comprises of I) application of irrigation at five critical growth stages viz. CRI, tillering, jointing, flowering and grain development. Irrigation was applied to different plots by the surface irrigation method. Two hand weeding were given on 26^{th} December and 10^{th} January i.e. 30 and 45 days after sowing.

Results and Discussion

The results of present investigation have been made to establish the reasons for the variation recorded in various treatment.

The data on weather parameters collected during experiment period showed that precipitation received during experimental period was 44.9 mm distributed over three rainy days. The maximum and minimum temperature during the experimental period was ranged between 28.1 to 37.2^{0}C and 8.5 to 17.3^{0}C respectively. Normal maximum and minimum temperature ranged from 31.2 and 11.8. Relative humidity ranged from 55 to 81 per cent during morning hours and 21 to 47 per cent during afternoon hours (Normal varied from 75 to 33 per cent). In case of photoperiods it ranged from 8.0 to 10.6 hour/day.

Growth attributes

The growth of wheat crop in general could be understood if series of physiological processes are observed critically during various growth stages. The crop has six growth stages *viz.* seedling, tillering, jointing, heading, flowering and ripening. Each stages takes about 15-20 days. During first 30 DAS crop attains height of 7.73 cm. The plant height 60, 90 DAS and at harvest was 50.58 cm, 71.07 cm and 91.80 cm, respectively.

The rate of increase in height was faster at early stage.

Table.1 Yield attributes as influenced by various treatments

Treatments	**No. of effective tillers plant^{-1}**	**Length of spike (cm)**	**Number of spikelets spike^{-1}**	**No. of grains spike**	**Test weight**	**Grain yield plant^{-1} (g)**
T_1-RDF (100 : 50 : 50 NPK kg ha^{-1})	1.68	7.5	15.51	46.39	35.88	1.5
T_2- 75 % RDF + 5 t FYM ha^{-1}	1.8	8.3	17.36	49.05	37.00	1.7
T_3- 75% RDF + 5 t FYM ha^{-1} + 2% urea spraying	1.8	8.3	17.45	49.44	37.80	1.8
T_4-75% RDF + 5 t FYM ha^{-1} + 10 kg $ZnSO_4$ + 2 % urea spraying	1.8	8.5	17.56	50.19	37.97	1.8
T_5- RDF + 5 t FYM ha^{-1} + 10 kg $ZnSO_4$ + 5 kg boron	1.9	9.0	17.79	50.80	38.12	2.0
T_6-75% RDF + *Azotobacter* seed treatment	1.6	7.3	15.11	46.00	35.72	1.5
T_7-75% RDF + PSB seed treatment	1.7	7.7	14.66	44.00	34.18	1.4
T_8-75% RDF + *Azotobacter* seed treatment + PSB seed treatment	1.7	8.0	15.53	46.67	36.00	1.5
T_9-75% RDF + *Azotobacter* seed treatment + PSB seed treatment + 2 % Urea spraying	1.8	8.0	15.56	47.16	36.668	1.6
S.E. $\pm$	0.31	0.18	0.20	0.60	0.69	0.29
C.D. at 5 %	0.93	0.54	0.61	1.80	2.00	0.87
G. Mean	1.80	8.13	16.28	47.74	36.00	1.7

Table.2 An extract of relevant data of mean of growth, yield attributes and yield of wheat as influenced by different treatments

Sr. No.	Particular	*Treatments*								
		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
1.	Plant height at maturity	92.76	94.64	96.41	97.64	98.25	92.50	65.03	94.25	95.45
2.	Number of tillers m^{-1} row length	55.67	57.67	58.33	58.67	59.00	55.67	55.33	55.67	56.00
3.	Number of functional leaves $plant^{-1}$ at 90 DAS	34.77	42.16	42.80	43.83	44.60	33.30	32.56	37.03	39.53
4.	Leaf area (dm^2) at 90 DAS	0.71	0.80	0.83	0.84	0.93	0.70	0.62	0.70	0.71
5.	Dry matter (g $plant^{-1}$) at harvest	7.6	8.30	8.80	8.80	8.80	8.90	8.90	7.90	8.40
6.	Effective tillers $plant^{-1}$ at harvest	1.67	1.80	1.80	1.80	1.90	1.60	1.70	1.70	1.80
7.	Length of spike (cm)	7.5	8.30	8.30	8.50	9.00	7.30	7.70	8.00	8.00
8.	No. of spikelets $spike^{-1}$	15.21	17.36	17.45	17.56	17.79	15.11	14.66	15.53	15.56
9.	No. of grains $spike^{-1}$	46.39	49.05	49.44	5.19	50.80	46.00	44.00	46.67	47.16
10.	Test weight (g)	35.88	37.00	37.80	37.97	38.12	35.72	34.18	36.00	36.68
11.	Grain yield $plant^{-1}$ (g)	1.5	1.70	1.80	1.80	2.00	1.50	1.40	1.50	1.60
12.	Grain yield (q ha^{-1})	21.70	25.39	26.68	26.64	26.87	18.78	17.02	22.04	22.40
13.	Straw yield (q ha^{-1})	32.04	37.49	40.38	40.27	41.47	30.07	29.98	32.12	34.72
14.	Biological yield (q ha^{-1})	53.73	62.88	67.19	67.07	68.14	48.46	46.99	54.17	57.14

Normally vegetative growth becomes slow when reproductive phase of crop starts. This might be due to higher availability of nutrient to the plant through various means i.e. cultural, biological, chemical practices. As the nutrients are available to sufficient quantity their utilization by plants results in vigorous growth and it ultimately increases the plant height.

Number of tillers in wheat crop initiated before 30 DAS continued upto 45 DAS and decreased thereafter up to maturity because of higher mortality in tillers which were produced later. These late produced tillers were weak as compared to earlier tillers. The mean number of functional leaves plant^{-1} increased continuously up to 60 DAS and decreased thereafter due to senescence stage.

The dry matter accumulation at 30, 60, 90 DAS and at harvest was 0.57, 3.4, 5.8, 8.10, respectively.

As regards dry matter accumulation the increase in dry matter plant^{-1} was continuous from initial stage to maturity. Dry matter accumulation was slow during initial stages up to 30 DAS and rapid during 30 to 60 DAS and moderate at 60-90 DAS and slow toward maturity.

This might be due to higher nutrient availability at the initial stage of the crop. It's higher uptake by the plants result in the higher dry matter accumulation at the later stage as crop goes toward the maturity, leaf senescence occurs which result in the lower photosynthetic rate and ultimately rate of dry matter accumulation is slower down.

Mean AGR for plant height between 45 and 60 DAS was maximum and after 60 DAS there was very slight decline in AGR for plant height upto 75 DAS and was slowed down thereafter till maturity.

AGR for dry matter was very slow at initial stage but it was at peak in between 45 and 60 DAS. This may be due to maximum tillering and height during this stage. After 60 DAS there was decline in AGR for dry matter and may be due to leaf senescence.

Highest value of RGR was recorded in early phase of crop growth and declined gradually up to harvest.

In case of LAI, mean LAI was maximum at 60 days and after 60 days, there was rapid decline in LAI up to maturity. This was because of shedding of leaves towards maturity.

Yield attributes

The mean number of effective tillers plant^{-1}, length of spike, number of spikelet spike^{-1}, number of grains spike^{-1}, test weight and grain yield plant^{-1} 1.80, 8.13 cm, 16.28, 47.74, 1.7 g and 36 g, respectively.

Grain yield is the function of yield attributing characters. Mean grain yield recorded was 23.03 q ha^{-1}. Straw yield was the augmenting effect of increased vegetative growth through plant height, number of tillers and plant dry weight. The mean straw yield recorded was 35.39 q ha^{-1}.

In case of fertilizer dose RDF + 5 t FYM 10 kg $ZnSO_4$ + 5 kg Boron showed significant result over 75 per cent RDF + PSB seed treatment with respect to number of tillers m^{-1} row length (Yadav and Verma, 1991). Higher fertilizer dose (100 per cent) recorded maximum and significantly more number of leaves and leaf area per plant at all growth stages except 30 DAS over low fertilizer dose i.e. 75% RDF + PSB seed treatment alone. The treatment T_4 (75% RDF + 5 t FYM ha^{-1} + 10 kg $ZnSO_4$ + 2 % urea spraying) and T_3 (75% RDF + 5 t FYM ha^{-1} + 2 % urea) and T_2 (75% RDF + 5 t

FYM ha^{-1}) were at par with other in respect to mean number of functional leaves at 30 DAS.

The role of nitrogen being both structural and metabolic and it is more related to carbohydrate utilization and protein synthesis. The response of phosphorus and potassium was similar to that of nitrogen. So combined effect of these higher dose might be helpful in increasing leaf number and leaf area.

Yield

As observed in the treatment T_5 (RDF + 5 t FYM ha^{-1} + 10 kg $ZnSO_4$ + 5 kg Boron) the higher grain and straw yield in this treatment is might be the combined effect of availability of various nutrients to the plant at proper growth stage through the various means i.e. chemical (macro and micro nutrients) and organic source (FYM) i.e. treatment T_5 shows higher yield due to the balanced use of fertilizer dose and essential micro nutrients.

Economics of crop cultivation

The treatment T_5 (RDF + 5 t FYM ha^{-1} + 10 kg $ZnSO_4$ + 5 kg Boron) recorded maximum and significantly higher net return (14362 Rs ha^{-1}) and found to be superior over treatment T_4 (Rs 14000 ha^{-1}) and T_3 (Rs 13888 ha^{-1}). This might be due to higher grain yield obtained from the T_5 treated plots.

The highest B: C ratio was recorded by treatment T_5 (1.90) followed by treatment T_4 (1.86).

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