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VK Verma

Assistant Professor,
Department of Agronomy,
C.S. Azad University of
Agriculture & Technology,
Kanpur, Uttar Pradesh, India

Ram Pyare

Professor, Department of
Agronomy, C.S. Azad University
of Agriculture & Technology,
Kanpur, Uttar Pradesh, India

Ashutosh Pandey

M.Sc. Student, Department of
Agronomy, C.S. Azad University
of Agriculture & Technology,
Kanpur, Uttar Pradesh, India

Sunil Kumar

M.Sc. Student, Department of
Agronomy, C.S. Azad University
of Agriculture & Technology,
Kanpur, Uttar Pradesh, India

Girish Goyal

Ph.D., Scholar, Department of
Agronomy, C.S. Azad University
of Agriculture & Technology,
Kanpur, Uttar Pradesh, India

Superimposition effect of micronutrients, organic manure and microbial inoculants over NPK does on wheat (*Triticum aestivum* L.)

VK Verma, Ram Pyare, Ashutosh Pandey, Sunil Kumar and Girish Goyal

Abstract

The present study was conducted during the *Rabi* seasons of 2014-15 and 2015-16 at Students Instructional Farm of C.S. Azad University of Agriculture and Technology, Kanpur with the objective to find out suitable superimposed nutritional doses to improve production, productivity and economics of wheat under irrigated conditions. The treatments consisted of superimposed doses of Sulphur (25.0 kg/ha), Zinc (2.0 kg/ha), Boron (1.0 kg/ha), Iron (5.0 kg/ha), FYM (5 t/ha), Azotobacter and PSB as individually and in combination along with NPK doses compared with only NPK doses (control treatment), were laid out in Randomized Block Design and replicated three times. The response of above fertility levels was analyzed on growth parameters, yield attributes and yield as well as economics of normal sown wheat variety Mahi (K-402). The superimposition of micro nutrients and microbial inoculants over NPK doses in different treatments exhibited significant response in terms of increasing grain yield from 11.94 to 26.10% compared to control treatment. The combined doses of NPK+FYM+S+Zn+B+Fe recorded highest grain yield (47.50q/ha and 53.05 q/ha), gross income (Rs. 90325/ha and Rs. 103734/ha) and Net income (Rs. 46866/ha and Rs. 58088/ha) during 2014-15 and 2015-16, respectively.

Keywords: Superimposition effect, micronutrients, organic manure, microbial supplements, wheat

Introduction

The major challenge for the next two to three decades of 21st century is going to be food and nutritional security for all and specially for families living below poverty line. Wheat (*Triticum aestivum* L.) is considered as king of cereal in the world and is grown on the largest area. Wheat contains more nutritive value than other cereals specially high content of niacin and thiamine. Based on the rate of population growth of 1.5 percent and percapita consumption of 180g of wheat per day, in India, the demand of wheat is expected to be around 109 million tons by 2020. Wheat area has risen from 12.8 million hectare in 1966-67 to 29.25 million hectare in 2015-16. Wheat production in 2015-16 was around 88.94 million tonnes and the productivity of wheat in India was 3119 kg/ha (Anonymous 2017) [3]. In India during last one to two decades the practice of reducing in organic fertilizer doses by 25-50 percent with complimentary doses of organic manures did not achieve sustainability in wheat production. The integration of superimposed quantity of micronutrients, organic manures, microbial inoculants along with 100 percent doses of inorganic fertilizers (NPK only) is catching attention of scientific community, now a days. Organic and mineral fertilizers are complimentary in nature and often the best yields are achieved when applied together. The micronutrients along with major nutrients play an important role in improvement of growth, yield attributing characters, yield and quality of wheat. Thus keeping all above points in view, the present investigation was conducted during 2014-15 and 2015-16, with the objectives to assess root and shoot vigour and yield potential of wheat and evaluate the economics of treatments.

Materials and Methods

A field experiment was conducted at Students' Instructional Farm of C.S. Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh), during two consecutive *Rabi* seasons of 2014-15 and 2015-16 to study the superimposition effect of micronutrients, organic manure and microbial inoculants over NPK does on the performance of wheat (*Triticum aestivum* L.) variety Mahi (K-402) under irrigated situation.

Correspondence**VK Verma**

Assistant Professor,
Department of Agronomy,
C.S. Azad University of
Agriculture & Technology,
Kanpur, Uttar Pradesh, India

There were ten treatments viz. NPK (150:60:40 kg/ha) only NPK + S (25 kg/ha), NPK + Zn (5 kg/ha), NPK + Bo (1 kg/ha), NPK + Fe (5 kg/ha), NPK + FYM (10 t/ha), NPK + Azotobacter + PSB, NPK + FYM + Azotobacter + PSB, NPK + S + Zn + Bo+Fe and NPK + FYM + S + Zn + Bo + Fe. The experiment was laid out in Randomized Block Design with a plot size of 4.0×5.0m and replicated thrice. The soil was alluvial having low in available nitrogen (125 kg/ha), medium in available phosphorus (22.48 kg/ha) and potash (170 kg/ha). The status of available S (15.25 ppm), Zn (1.13 ppm), Fe (19.89 ppm), and Boron (1.31 ppm). The pH of the soil was neutral in reaction (pH 7.69) having EC of 0.54 dS/m with low organic carbon (0.41%) content. The plant nutrients were supplied in the form of Urea, DAP, MOP, Zinc sulphate fertilizers and iron and boron in elemental form. The growth and yield observations were recorded from randomly selected plants from each plot/treatment. The cost of cultivation and gross returns were worked out based on the prevailing market rates of all inputs, labour and for final produce and B:C ratio was worked out by dividing gross returns by the total cost of cultivation.

Results and Discussion

Growth of crop

The data summarized in Table -1 revealed that plant population of wheat recorded almost similar in all the treatments and statistically non-significant but plant height shown significant difference compared to control treatment. The minimum plant height (105.63 cm and 113.70 cm during 2014-15 and 2015-16, respectively) recorded under NPK only treatment while maximum (114.27 cm and 117.81 cm during 2014-15 and 2015-16, respectively) recorded under NPK + FYM + S + Zn+B+Bo+Fe treatment. The effect of different micronutrients applied either individually or in combination with or without FYM and NPK with Azotobacter and PSB with or without FYM exhibited significant positive impact on shoot and root characterised during both seasons over control treatment. The maximum plant height (114.27 and 117.81), fresh weight of shoot (61.28g and 65.11 g), dry weight of shoot (27.38g and 29.04 g), fresh weight of root (4.78 g and 4.82g) dry weight of root (2.45g and 2.55g) and root length (26.43 cm and 27.01 cm) recorded during 2014-15 and 2015-16, respectively, under NPK + FYM + S + Zn + Bo + Fe treatment were found significantly superior over control treatment. Other treatments found significantly at par. Similar findings were reported by Fageria (2002) [4] and Nadim *et al.* (2011) [6].

Yield attributes

The yield attributes viz length of ear, number of ears/ plant, number of grains weight/ ear shown significant improvement with combined doses of organic manure, micronutrients, along with NPK doses compared to control treatment. The maximum length of ear (9.38 cm and 9.69 cm), number of ears/ plant (5.83 and 7.23), number of grains/ear (52.83 and 54.94) and grain weight/ear (2.31g and 2.78g) during 2014-15 and 2015-16, respectively recorded under NPK + FYM + S + Zn + Bo + Fe treatment and minimum length of ear (7.78 cm, and 8.82 cm), number of ear/ plant (4.34 and 5.33) number of grain/ear (38.66 and 47.51) and grain weight/ ear (1.63g and 2.10 g) during 2014-15 and 2015-16, respectively under control treatment (NPK only).

Yield

The yield data summarized in Table-2 depicted that biological yield, grain yield and straw yield of wheat influenced significantly with different treatments. The biological yield recorded minimum (94.17 q/ha and 108.33 q/ha) under only NPK treatment which maximum (118.0 q/ha and 129.16 q/ha) recorded under NPK + FYM + S + Bo + Zn + Fe treatment during 2014-15 and 2015-16, respectively. The grain yield recorded minimum (37.67 q/ha and 39.55 q/ha) under NPK only treatment while maximum grain yield (47.50 q/ha and 53.05 q/ha) recorded under NPK + FYM + S + Zn + Bo + Fe treatment during 2014-15 and 2015-16, respectively. The increment in biological yield (25.30% and 19.22%), grain yield (26.09% and 34.13%) and straw yield (26.24% and 10.67%) recorded during 2014-15 and 2015-16, respectively over control treatment. The findings of this study were clearly matched with the findings of Armin *et al.* (2014) [2] and Ali *et al.* (2009) [1].

Economics

The data summarised in table-3 revealed that minimum cost (Rs. 32711 and Rs. 39669) incurred under NPK only (control) treatment while maximum cost (Rs. 43459 and Rs. 45646) involved under NPK + FYM + S + Zn + Bo+Fe treatment during 2014-15 and 2015-16, respectively. The cost of cultivation increased 32.85% and 15.06% during 2014-15 and 2015-16, respectively, while gross income increased 26.22% and 28.15% and Net income increased 20.61% and 40.73% during 2014-15 and 2015-16, respectively. The maximum B:C ratio (2.43 and 2.34 evaluated during 2014-15 and 2015-16, respectively under NPK + Bo treatment due to involvement of less cost compared to other treatments. Similar findings were reported by Mali *et al.* (2015) [5].

Table 1: Effect of treatments on growth characters on wheat

Treatment	Plant population/m ² at maturity		Plant height/(cm) at harvesting		Shoot fresh weight /plant (g) at harvesting		Shoot dry weight/plant (g) at harvesting		Root fresh weight/plant (g) at harvesting		Root dry weight/plant (g) at harvesting		Root length at harvesting (cm)		Effective tillers / m ² At harvesting	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
NPK(150:60:40)	126.66	126.43	105.63	113.70	48.50	55.33	20.63	23.39	3.56	3.98	1.75	2.28	18.76	21.44	418.28	427.35
NPK+S(25Kg/ha)	129.41	124.04	108.13	114.24	52.47	55.10	22.46	24.67	4.13	4.37	2.10	2.30	21.26	22.34	445.36	466.21
NPK+Zn(5 Kg/ha)	127.04	131.75	109.43	114.37	53.76	59.49	23.27	25.45	4.26	4.39	2.16	2.33	22.34	23.04	456.34	472.22
NPK+Bo(1Kg/ha)	121.43	136.96	110.04	114.46	54.80	59.60	22.97	25.53	4.21	4.39	2.26	2.38	21.78	23.77	475.98	509.47
NPK+Fe(5Kg/ha)	128.75	132.04	110.97	114.79	54.95	59.95	23.77	25.61	4.35	4.54	2.29	2.39	22.95	24.46	498.76	527.09
NPK+FYM(10tonnes/ha)	129.96	137.43	109.61	115.19	53.16	60.32	22.57	25.89	4.18	4.64	2.21	2.42	23.06	25.27	485.10	535.91
NPK+Azoto.+PSB)	130.04	130.16	107.88	115.40	52.73	60.53	21.43	26.08	4.13	4.75	2.19	2.43	21.67	25.58	465.16	541.91
NPK+FYM+Azoto.+PSB)	131.43	128.61	109.95	116.11	54.16	60.92	24.38	26.75	4.27	4.77	2.31	2.43	24.56	26.27	478.35	564.74
NPK+S+Zn+Bo+Fe)	132.67	132.88	112.03	116.32	58.66	61.55	25.16	26.84	4.65	4.81	2.36	2.48	25.35	26.92	510.23	579.16
NPK+FYM+S+Zn+Bo+Fe)	133.61	135.65	114.27	117.81	61.28	65.11	27.38	29.04	4.78	4.82	2.45	2.55	26.43	27.01	526.76	593.58
SE (d) ±	4.36	3.77	1.67	1.75	1.76	1.86	1.43	1.75	0.29	0.32	0.19	0.20	1.34	1.32	39.10	38.08
CD (P=0.05)	N/A	N/A	3.51	3.68	3.70	3.91	3.00	3.68	0.61	0.67	0.39	0.42	2.81	2.78	82.11	80.00

Table 2: Effect of treatments on yield attributes of wheat

Treatment	Length of ear (cm)		No. of ear/plant		No. of grain/ear		Grain weight /ear(g)		Biological yield (q/ha.)		Grain yield (q/ha)		Straw yield (q/ha.)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
NPK(150:60:40)	7.78	8.82	5.33	4.34	38.66	47.51	1.63	2.10	94.17	108.33	37.67	39.55	56.50	68.77
NPK+S(25Kg/ha)	8.35	8.90	6.73	4.52	39.50	48.49	1.64	2.06	110.00	115.27	43.00	42.50	67.00	72.97
NPK+Zn(5 Kg/ha)	8.45	8.91	6.83	4.65	39.93	48.96	1.68	2.24	100.67	123.58	40.33	43.74	60.33	79.86
NPK+Bo(1Kg/ha)	8.78	9.01	5.50	4.80	50.00	49.17	2.05	2.29	105.83	124.90	42.17	45.83	63.67	79.16
NPK+Fe(5Kg/ha)8.93	8.93	9.02	6.16	4.94	43.80	50.73	1.72	2.29	110.67	126.38	44.33	47.10	65.17	79.28
NPK+FYM(10tonnes/ha)	8.54	9.14	5.46	5.00	39.30	51.67	1.64	2.42	109.00	124.27	43.67	47.80	65.33	76.47
NPK+Azoto.+PSB)	8.48	9.15	5.26	5.27	39.63	51.96	1.75	2.49	94.33	114.88	37.83	41.88	56.50	73.00
NPK+FYM+Azoto.+PSB	8.92	9.22	5.73	5.27	40.90	52.84	1.70	2.58	114.00	124.44	45.67	44.36	62.89	80.08
NPK+S+ZN+Bo+Fe	9.21	9.32	7.13	5.35	51.30	52.95	1.82	2.62	117.33	127.78	47.00	51.49	70.33	76.28
NPK+FYM+S+Zn+Bo+Fe	9.38	9.69	7.23	5.83	52.86	54.94	2.31	2.78	118.50	129.16	47.50	53.05	71.33	76.11
SE (d)	0.36	0.40	0.37	0.56	0.78	1.12	0.18	0.32			2.66		1.02	1.79
CD (P=0.05)	0.75	0.84	0.77	1.18	1.68	2.71	0.37	0.68			5.60		2.13	3.77

Table 3: Effect of treatments on yield attributes of wheat

Treatment	Cost of cultivation (Rs./ha)		Gross income (Rs./ha)		Net income (Rs./ha)		B:C ratio	
	2015	2016	2015	2016	2015	2016	2015	2016
NPK(150:60:40)	32711	39669.83	71566	80944.75	38855	41274.92	2.19	2.04
NPK+S(25Kg/ha)	35891	42789.83	82450	86398.50	46559	43608.67	2.29	2.01
NPK+Zn(5 Kg/ha)	33877	39981.83	76581	90661.50	742704	50679.67	2.26	2.26
NPK+Bo(1Kg/ha)	33018	40002.63	80238	93638.75	47220	53636.12	2.43	2.34
NPK+Fe(5Kg/ha)8.93	33506	40241.83	83835	95611.50	50329	55369.67	2.50	2.37
NPK+FYM(10tonnes/ha)	38011	44869.83	82914	95836.00	44903	50966.17	2.19	2.13
NPK+Azoto.+PSB)	33558	39753.03	71803	85767.00	38245	46013.97	2.13	2.15
NPK+FYM+Azoto.+PSB	38859	29753.03	82079	91673.00	43220	51919.97	2.11	2.30
NPK+S+ZN+Bo+Fe	38159	44006.67	89249	101406.25	51090	57399.58	2.33	2.30
NPK+FYM+S+Zn+Bo+Fe	43459	45646.57	90325	103734.25	46866	58087.68	2.07	2.27

Conclusion

Based on results it can be concluded that super imposition of organic manure (FYM), micronutrients (S, Zn, Bo and Fe) and microbial inoculants (*Azotobacter* and *PSB*) along with NPK doses in wheat improved growth characteristics, yield attributes, yield per ha and economics during both years of study.

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