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Effect of bio-fertilizers on growth and productivity of wheat (*Triticum aestivum*)

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ABSTRACT

Field experiment was conducted during the rabi season of 2003-04 and 2004-05 at the farmer fields in village Bhiuraha, district Jaunpur to study the efficacy of bio-ertilizers on growth and productivity of wheat (*Triticum aestivum*). Leaf and shoot dry weight increased up to 90 days after sowing (DAS) and then gradually declined. Shoot dry weight also gradually increased up to 120 DAS and then decreased. However, dry matter in panicle increased rapidly from 120 DAS till harvesting. At early stage (30-60 DAS), dry matter production was slow and the rate of dry matter accumulation increased from 60 DAS onwards. About 21.5 per cent of dry matter of whole plant was observed at 60 DAS, 61.2 per cent at 90 DAS and 94.4 per cent at 120 DAS. The result showed significant response of bio-fertilizers on growth and productivity of wheat. Combined application of bio-fertilizers caused considerable increase in plant height over all the treatments. Tillering enhanced significantly due to application of bio-fertilizers either alone or in combination. Greater tillering was noticed when the crop received combined treatments than other treatments. Similar trend of results was also observed in case of yield components of wheat ie ears/m^2, grains/ear and 1000 grain weight increased significantly when the crop received bio-fertilizers either alone or combined. Accordingly, the highest grain yield was recorded when the crop received combined bio-fertilizers.

Key words: Bio-fertilizer, growth, productivity, wheat.

INTRODUCTION

The quantity of organic matter in the soil is a major indicator of latter's quality. To achieve higher grain yield, we should apply chemical, bio and organic fertilizers. For sustainability, it is important to incorporate bio-organisms and organic matter into the soil. Koopmans and Goldstein (2001) stated that to improve soil quality we should treat our organic matter like a bank account. A bank account lets us deposit, save, and withdraw something we value. For sustainability, it is important to deposit in the account active bio-fertilizers along with organic matter in the soil on a regular basis, thereby, building cultural fertility. Poulton (1995) summarized that

long term experiments are essential in determining the factors affecting soil fertility and sustainable production. The use of non symbiotic nitrogen fixer, Azotobactor sp, as a bio-inoculant is known to benefit a wide variety of crops due to its properties like nitrogen fixation, secretion of growth promoting substances, vitamins and antifungal metabolites and phosphate solubilization (Mishustin and Shiki nova 1971). In India, there are more than 100 commercial units (Motsara et al 1995) and most of them produce carrier based bio-fertilizers, as per existing ISI specifications (IS: 8268-1976/86 and IS: 9138-1979/86). The use of bio-fertilizers is now common practice in Indian agriculture but their current consumption is not more than 15000 tons/year. The present investigation was conducted at farmer fields under validation trial through Krishi Gyan Kendra, Jaunpur, Uttar Pradesh to assess the effect of bio-fertilizers on growth and productivity of wheat (*Triticum aestivum*).

MATERIAL AND METHODS

Field experiment was conducted during the rabi season of 2003-04 and 2004-05 at the farmers fields in village Bhiuraha, dist Jaunpur to study the efficacy of different bio-fertilizers on growth and productivity of wheat (*Triticum aestivum*). The experimental soil was sandy loam in texture, low in available N (152.6 kg/ha), high in available P (12.5 kg/ha) and K (346.2 kg/ha) and was slightly alkaline in reaction (pH 7.8). The experiment was laid out in factorial randomized block design with three replications. The treatments consisted of ten levels of nutrients viz (T0-RDF), T1-Azotobactor seed inoculation@200g/10 kg seed, T2- PSB seed inoculation@200g/10 kg seed, T3- Azotobactor soil application @ 3 kg/ha with 50 kg FYM at the time of land preparation, T4- PSB soil application @ 3 kg/ha with 50 kg FYM at the time of land preparation, T5- Azotobactor broadcast @ 3 kg/ha with 100 kg FYM at the time of 1st irrigation, T6- PSB broadcast @ 3 kg/ha with 100 kg FYM at the time of 1st irrigation, T7- (T1+T3+T5); T8-(T2+T4+T6) and T9- (T7+T8). Wheat variety HUW 234 was sown on 21 and 25 November 2003 and 2004, respectively in rows 20 cm apart @ 100 kg seed/ha. The crop was fertilized with a uniform dose of 120 kg N through urea, 60 kg P_2O_5 through single super phosphate, 40 kg K_2O through murate of potash and 25 kg $ZnSo_4$/ha. FYM was applied before a month of sowing @ 10 tons/ha. Half of N and full P and K were applied at the time of sowing and remaining N was top dressed after 1st irrigation. The adequate irrigation was applied at CRI, tillering, jointing, flowering and milk stages. Wheat crop was harvested on 16 and 12 April in first and second year, respectively. For dry matter accumulation and partitioning, plants were harvested from 25 cm row length from three places in second row on either side in each plot. Plant parts were sundried separately, till a constant weight was obtained. Spike weight before

its emergence was added to the shoot dry weight and peduncle was considered as shoot and was added to the shoot dry weight (Bauer et al 1987).

RESULTS AND DISCUSSION

Leaf dry weight increased up to 90 DAS and then gradually declined (Table 1). Shoot dry weight also gradually increased up to 120 DAS and then followed decreasing trend. Application of Azotobactor and PSB in combination with seed, soil and broadcast (T9) recorded significantly more dry matter accumulation in different plant parts than rest of the treatments over control followed by T8-(T1+T3+T5); T1-Azotobactor seed inoculation@200g/10 kg seed, T7-(T2+T4+T6), T3- Azotobactor soil application @ 3 kg/ha with 50 kg FYM at the time of land preparation, T5-Azotobactor broadcast @ 3 kg/ha with 100 kg FYM at the time of 1st irrigation, T4-PSB soil application @ 3 kg/ha with 50 kg FYM at the time of land preparation, T2-PSB seed inoculation@200g/10 kg seed, T6- T6- PSB broadcast @ 3 kg/ha with 100 kg FYM at the time of 1st irrigation. This is due to the shedding of lower leaves and leaf sheath and translocation of sugar, N and P to the grains (Sharma and Singh 2008). Dry matter in panicle increased rapidly from 120 DAS to harvest. After ear emergence, near all the photosynthesis appears to translocation at head. The contribution of panicle was total 60 per cent, whereas the contribution of stem and leaf were 32 and 8 per cent, respectively.

The dry matter accumulation increased progressively with advancement of crop age (Table 2). At early stage (30-60 DAS), dry matter production was slow and the rate of dry matter accumulation increased from 60 DAS onwards. About 21.5 per cent of dry matter of whole plant was observed at 60 DAS, 61.2 per cent at 90 DAS and 94.4 per cent at 120 DAS. These findings are in agreement with those of Singh and Andersen (1978) and Sharma and Singh (2008).

Due to inoculation of nitrogen fixing bacteria and phosphorus solubilising bacteria (either through seed inoculation, soil application, broadcasting in standing crop, alone or in combination), an increase in leaf, shoot, panicle and total dry weight was observed in increasing order from first sampling (30 DAS) till harvest. Application of Azotobactor and PSB in combination with seed, soil and broadcast (T9) recorded significantly more dry matter accumulation in different plant parts then rest of the treatments over control followed by T8-(T1+T3+T5), T1- Azotobactor seed inoculation@200g/10 kg seed, T7-(T2+T4+T6), T3- Azotobactor soil application @ 3 kg/ha with 50 kg FYM at the time of land preparation, T5-Azotobactor broadcast @ 3 kg/ha with 100 kg FYM at the time of 1st irrigation, T4-

Table 1. Effect of bio-fertilizers on leaf, shoot and panicle weight (g/m row length) of wheat (pooled data of 2003-04 and 2004-05)

Treatment	30 DAS		60 DAS		90 DAS		120 DAS			At harvest		
	Leaf	Shoot	Leaf	Shoot	Leaf	Shoot	Leaf	Shoot	Panicle	Leaf	Shoot	Panicle
T0	4.90	0.97	18.25	5.85	21.90	38.00	13.25	42.05	24.65	4.65	27.10	51.00
T1	6.38	1.22	35.06	9.70	50.00	81.10	40.50	99.76	55.98	19.10	70.10	123.98
T2	5.50	1.10	25.50	7.75	32.08	52.65	22.00	59.00	32.94	7.62	39.34	73.45
T3	6.46	1.25	37.00	10.25	55.32	86.50	45.25	99.98	62.12	20.25	72.78	130.45
T4	6.35	1.21	35.00	10.10	49.30	80.20	40.00	98.75	55.25	18.25	68.10	122.00
T5	5.82	1.12	27.10	7.98	35.20	57.98	24.50	66.67	38.25	11.20	44.35	84.20
T6	5.10	1.02	21.10	7.34	25.67	43.50	17.20	49.10	28.25	8.90	33.25	65.50
T7	6.50	1.25	36.50	11.25	54.24	86.10	45.25	108.06	62.10	21.25	75.10	136.56
T8	6.20	1.20	35.50	9.75	51.10	82.25	42.34	101.20	56.98	20.21	71.25	128.25
T9	6.51	1.25	38.10	11.50	55.56	88.20	46.15	111.50	65.25	21.75	73.45	142.25
SEM+	0.36	0.07	1.65	0.36	2.78	3.52	3.34	6.54	3.11	2.02	3.30	10.12
	NS	NS	NS	NS	S	S	S	S	S	S	S	S

Table-2. Effect of bio-fertilizer ons total dry weight (g/m row length) of wheat (pooled data of 2003-04 and 2004-05)

Treatment	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T0-RDF120:60:40(N:P:K)	5.85	24.10	59.81	79.75	82.20
T1-Azotobactor seed inoculation@200g/10 kg seed	7.6	44.74	132.00	197.60	213.00
T2-PSB seed inoculation @200g/10 kg seed	6.55	32.32	83.32	112.54	119.05
T3-Azotobactor soil application @ 3 kg/ha with 50 kg FYM at the time of land preparation	7.67	47.06	140.56	215.85	230.20
T4- PSB soil application @ 3 kg/ha with 50 kg FYM at the time of land preparation	7.56	44.18	128.82	193.30	208.11
T5-Azotobactor broadcast @ 3 kg/ha with 100 kg FYM at the time of 1st irrigation	7.67	46.7	139.61	213.50	217.75
T6- PSB broadcast @ 3 kg/ha with 100 kg FYM at the time of 1st irrigation	6.93	32.12	93.10	129.12	137.5
T7- (T1+T3+T5)	7.70	47.10	140.85	216.00	234.0
T8- (T2+T4+T6)	7.67	46.67	139.65	214.5	230.40
T9- (T7 + T8)	7.76	48.10	143.00	220.95	239.50
SEM+	0.77	1.33	5.46	11.20	4.42
	NS	NS	S	S	S

PSB soil application @ 3 kg/ha with 50 kg FYM at the time of land preparation, T2-PSB seed inoculation@200g/10 kg seed, T6-PSB broadcast @ 3 kg/ha with 100 kg FYM at the time of 1st irrigation. It might be due to adequate supply of nitrogen, phosphorus and other nutrients and enzymes etc by these treatments which resulted in better utilization of carbohydrates and formation of protoplasm and other cellular materials rather than their deposition resulting in thickening of cell wall as shown in Table 3 through increase in yield and yield attributing characteristics. Overall improvement of growth of wheat with adequate supply of nutrients either through seed inoculation, soil application, broadcasting in standing crop, alone or in combination of bio-fertilizer (integrated) has also been reported by Azad et al (1998) .

At early stage of observation (30 DAS), irrigation did not influence the dry matter accumulation but adequate irrigation produced significantly higher dry matter in leaf, shoot, panicle and total dry weight up to harvesting than control plot which had limited irrigation at CRR, tillering and flowering. The better biomass accumulation in different plant parts under adequate irrigation (CRI, tillering, jointing, flowering and milk stage) might be attributed to adequate soil moisture supply. Further, the process of plant growth activity of bacteria, cell division and elongation require a relatively adequate moisture supply from soil. Khan et al (1990) also observed improvement in growth of wheat with adequate irrigation.

The result showed significant response of bio-fertilizers on growth and productivity of wheat (Table 3). Combined application of bio-fertilizers caused considerable increase in plant height over all the treatments. Tillering enhanced significantly due to application of bio-fertilizers either alone or in combination. Greater tillering was noticed when the crop received combined (T9) treatment than other treatments. Similar trend of results was also observed in case of yield components of wheat ie ears/m^2, grains/ ear and 1000 grain weight (g) increased significantly when the crop received bio-fertilizers either alone or combined. Accordingly, the highest grain yields were recorded when the crop received combined bio-fertilizers. From the above results it may be stated that the use of bio-fertilizers is beneficial in improving the growth and productivity of wheat. Corroborative findings have been reported by Sharma and Singh (2008) for wheat grown under irrigation and fertility variables.

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Table 3. Effect of bio-fertilizers on yield and yield attributing characters (pooled data of 2003-04 and 2004-05)

Treatment	Plant height (cm)	Tillers/ m^2	Ears/ m^2	Grains/ Ear	1000 grain (g)	Grain yield kg/ha	% increase
T0-RDF120:60:40(N:P:K)	97.7	290	245	24	34.5	3150	-
T1-Azotobactor seed inoculation@200g/10 kg seed	99.9	325	268	27	35.8	3433	8.2
T2-PSB seed inoculation @200g/10 kg seed	99.5	333	268	28	36.1	3415	7.7
T3-Azotobactor soil application @ 3 kg/ha with 50 kg FYM at the time of land preparation	108.0	378	320	31	38.0	3883	18.8
T4- PSB soil application @ 3 kg/ha with 50 kg FYM at the time of land preparation	100.3	363	295	29	36.9	3633	13.3
T5-Azotobactor broadcast @ 3 kg/ha with 100 kg FYM at the time of 1st irrigation	100.0	345	293	30	37.0	3583	12.1
T6- PSB broadcast @ 3 kg/ha with 100 kg FYM at the time of 1st irrigation	100.3	355	290	30	36.7	3567	11.7
T7-(T1+T3+T5)	112.2	417	332	34	40.4	4547	30.7
T8- (T2+T4+T6)	116	408	325	34	40.5	4497	30.0
T9- (T7 + T8)	114.0	410	330	35	40.8	4607	31.6
SEM+	2.4	10.0	7.0	1.3	0.68	98.00	-

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