The Pharma Innovation Journal 2022; 11(1): 1629-1633

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(1): 1629-1633

www.thepharmajournal.com
Received: 05-10-2021
Accepted: 15-11-2021

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Effect of *Azotobacter* and phosphate solubilizing bacteria on the yield of different wheat (*Triticum aestivum* L.) Cultivar

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Abstract
A field experiment was conducted during the rabi season of 2020-21, at Guru Ghasi Das Research Station Kawardha (C.G.) to study the "Effect of *Azotobacter* and phosphate solubilizing bacteria on the yield of different wheat (*Triticum aestivum* L.) cultivar" and observations were recorded in a systematic way with sixteen cultivar along with control. All the cultivar of wheat variety was treated with liquid biofertilizer *Azotobacter* and PSB except control plot with three replications in the randomized block design. In this experiment result was found that the best variety response in biofertilizer application. Among all the treatment varieties T3 CG 2006 and T4 CG 2007, in this trial these are the two varieties which performed very well at different stage of the crop growth.T3 (CG 2006) it performed best in various characters like germination percentage at 90.33%, 50% flowering at 75 days, root length (120:60:40 kg/ha NPK+*Azotobacter* and PSB) recorded a significant maximum root length of 15.933 cm, grain yield (4873.333 Kg/ha), and straw yield(7760.000 kg/ha) and also, T4CG 2007 plant height 42.6 cm, spike length (12.8 cm), performance in characters like no. of seed per spike, 68 seeds and grain yield per plant (5163.333 kg/ha).

Keywords: Biofertilizer *Azotobacter* and PSB, wheat (*Triticum aestivum* L.), germination percentage

Introduction

Wheat is the food crop that takes up the most ground (220.4 percent of total land area in 2014). Wheat exchange exceeds that of all other crops combined. Wheat production reached 772 million tonnes in 2017, and is forecast to reach 766 million tonnes in 2019, making it the second most-produced cereal after maize. In 2019, China, India, Russia, the United States of America, and France produced 766 million tonnes of wheat, accounting for 52.8 percent of global output. Wheat and other grain crop production has tripled since 1960, and is expected to continue into the twenty-first century.

Microbial inoculants, also known as biofertilizers, are capable of mobilizing important nutritional elements in the soil from non-usable to usable form by crop plants through biological processes. Biofertilizers have grown in popularity in agriculture and food production over the last decade due to their renewable, low-cost, and environmentally friendly nature. Chemical fertilizers and pesticides have had a major impact on the climate. The use of bacteria (*Azotobacter*, *Azospirillum*, *Rhizobium*, phosphobacteria) and VAM fungi as biofertilizers to complement nitrogen and phosphorus fertilizers has been extensively researched. Several crop plants grew significantly better as a result of this. Environmentally safe, sustainable farming practices include the use of microbiological fertilizers. *Azotobacter*, *Azospirillum*, P-solubilizing microorganisms and other biofertilizers benefit crop production. While several studies have been performed in this field in different crops to research the impact of biofertilizers alone or in combination with other chemical fertilizers, there has been none in wheat, despite the fact that it is one of the world's most important cereal crops. As a result, the current research aims to determine the effects of *Azotobacter* and PSB on wheat yield.

*Azotobacte*r as a nitrogen fixer and PSB as a phosphate solubilizer have grown in popularity among biofertilizers, and there has been a positive response to *Azotobacter* and PSB inoculation. These non-conventional fertilizer sources are not only cost-effective, but they also significantly increase soil and crop productivity. *Azotobacter* is a type of bacteria that lives on its own. It has been reported that it fixes 20 kg N ha^{-1} in non-legume crop fields and secretes growth-promoting substances. The most practical and cost-effective fertilizer kit is one that increases crop yield without compromising soil health.

In the rhizosphere, *Azotobacter* fixes nitrogen from the atmosphere. *Azotobacter* produces thiomin, riboflavin, nicotin, indolacitic acid, and giberalin in addition to nitrogen fixation. When *Azotobacter* is applied to seeds, seed germination is improved to a considerable extent, so also it controls plant diseases due to the above substances produced by *Azotobacter*. Seeds with a low germination rate can be inoculated with Azotobacter to boost germination by 20–30%. *Azotobacter*-inoculated seeds aid in the uptake of N, P, and micronutrients like Fe and Zn in wheat. For wheat grown in field conditions, *Azotobacter* inoculation replaced up to 50% of the urea-N. In comparison to the non-inoculated control, *Azotobacter* inoculation increases wheat plant height, tillers, ear length, and grain yield. Because of *Azotobacter* seed inoculation, wheat grain and straw yields increased significantly from 39.4 q/ha to 41.8 q/ha and 54.3 q/ha to 57.2 q/ha, respectively. In light of the above, this experiment was conducted to investigate the effect of a biofertilizer (*Azotobacte*r inoculation) on wheat growth and yield.

Methodology

A field experiment was conducted during the rabi season of 2020-21, at Guru Ghasi Das Research Station Kawardha (C.G.) to study the "Effect of *Azotobacter* and phosphate solubilizing bacteria on the yield of different wheat (*Triticum aestivum* L.) cultivar" and observations were recorded in a systematic way with sixteen cultivar along with control. All the cultivar of wheat variety was treated with liquid biofertilizer inoculants *Azotobacter* and PSB in the wheat crop (variety-TAW 155, CG 1038, CG 2006, CG 2007, CG 2008, CG 2009, CG 2010, CG 1917, CG 1921, PYT DWR 14-15B, BSP 17-68, PYT 16-11, CG 1934, GW 322 (C), HI1544 (C), CG Gehnu-3 (SC). Crops were grown with the recommended package of practices under irrigated conditions.

The sixteen treatment including control were tested using 3 replicate to assess the yield of wheat in a plot size of 5*2.5 meter. Seed treatment were used for assessing the yield. The microbiological fertilizers i.e. PSB and *Azotobacter* were used in liquid forms equally for seed treatment.

The doses of *Azotobacter* and PSB were equally fixed for seed treatment in liquid form. The doses of application were equally proportional for the microbiological fertilizers i.e. PSB and *Azotobacter.* The details of the doses provided to the wheat variety are Table 1.

The crop were sown during November, 2020 when autumn in toward its end of and the month end gradually welcome winter. It is also known as Rabi season.

The growth and yield attributes were recorded *viz.* Germination percent(%), Plant height (cm), Number of tillers/plant, Spikelet count per ear, Length of ear, Number of grain per ear, 1000 grains weight Grain yield and Straw yield to know the influence of the inoculation.

Result and Discussion

Result of the experiment included that seed treatment with *Azotobacter* and PSB significantly increased the growth characters germination percentage, plant height, day to 50% flowering, and days to maturity in different cultivar of wheat.

During investigation, the combination of *Azotobacter* + PSB with N-120, P-60, and K-40 gave a maximum percent germination 92.50%, the variety of T3 CG2006, gave maximum plant height at 60 an 90 DAS, 45.60 cm and 98.55 cm, the variety of T4 CG2007, and 106 days for day of maturity in the variety of PYT DWR 14-15B. The best performance variety T3 CG 2006 and T4 CG 2007 was observed in treated plot *Azotobacter* + PSB with N-120 P-60 and K-40 kg/ha.

Inoculation of biofertilizer significantly increased grain and straw yield as compared to uninoculation or control. There was too much difference in yield. Inoculation was better than uninoculation in relation to grain and straw yield.

Within variety better performance was given by CG 2006, which has given better in germination percentage (92.50%), length of root (13.25cm), grain yield (5050.00qt/ha) and straw yield (7910.00kg/ha), respectively. Similarly, CG 2007 has also shown its better performance in plant height (98.55cm in 90 DAS), number of grain per ear (55) and grain yield (5275.00 qt/ha), respectively.

The bio-fertilizer treatments of *Azotobacter* and PSB with inorganic fertilizer performed better than those without *Azotobacter* and PSB treatments. This could be attributed to the supply of additional N: P: K 120:60:40 through the fixation and solubilization activities of the inoculated bio-fertilizers. The positive effect of the application of *Azotobacter* and PSB on germination, germination percentage and plant height, has also been reported by Madhu *et al*., (2012) and Shaharoona *et al*., (2006). Then, *Azotobacter* is known to produce plant growth hormones such as gibberilic acid, Indole acetic acid, and cytokinin, which might have favoured the growth of wheat.

Within variety better performance was given by CG 2006, which has given better in germination percentage (92.50%), length of root (13.25cm), grain yield (5050.00qt/ha) and straw yield (7910.00kg/ha), respectively. Similarly, CG 2007 has also shown its better performance in plant height (98.55cm in 90 DAS), number of grain per ear (55) and grain

Table 1: Growth and yield attributes of wheat (*Triticum eastivum L.*) cultivar as influence by *Azotobacter* and PSB

	Treatment	Germination percentage (%)	Plant height at 90 DAS	Days to 50% flowering	Days to Maturity	No. of Tiller per plant 90 DAS	Spike Length (cm)	No. of grain per ear
T1	TAW 155	86.500	85.750	66.500	116.000	5.000	10.600	72.000
T2	CG 1038	89.000	93.050	64.000	109.500	9.000	10.700	51.000
T3	CG 2006	92.500	94.900	76.500	118.000	8.000	9.925	56.000
T4	CG 2007	87.500	98.550	66.500	115.500	10.000	13.500	69.000
T5	CG 2008	86.500	91.850	68.500	116.500	11.000	9.550	44.000
T6	CG 2009	81.000	75.100	61.500	110.500	14.000	8.650	36.000
T7	CG 2010	85.500	91.100	63.000	110.500	6.000	11.650	55.000
T8	CG 1917	85.000	83.300	62.000	114.500	16.000	9.250	48.000
T9	CG 1921	86.500	82.000	58.500	109.500	13.000	9.800	48.000

T10	PYT DWR 14-15B	91.000	92.900	52.500	106.000	5.000	10.100	41.000
T11	BSP 17-68	86.500	92.250	58.500	107.000	7.000	10.300	29.000
T12	PYT 16-11	83.500	89.800	62.000	108.500	7.000	10.550	43.000
T13	CG 1934	85.500	92.200	58.000	107.500	7.000	8.750	32.000
T14	GW 322(C)	85.500	91.400	66.500	112.500	8.000	9.750	62.000
T15	HI 1544 (C)	87.500	87.150	61.000	116.000	11.000	9.400	54.000
T16	CG Genhu-3 (SC)	87.500	88.500	65.500	112.500	7.000	9.150	55.000
	Over All Mean	86.688	89.362	63.188	111.906	9.000	10.101	30.937
	CD at 5%	5.029	4.801	2.859	2.857	3.684	1.568	6.368
	SE(m±)	1.653	1.578	0.940	0.939	1.713	0.515	2.094
	CV%	2.697	2.498	2.104	1.187	19.030	7.215	5.959

Table 2: Grain yield and straw yield of wheat (*Triticum eastivum L.*) cultivar as affected by *Azotobacter* and PSB

	Treatment	1000 grain weight (gm)	Seed Yield (kg/ Plot)	Straw yield (kg/plot)	Seed Yield (qt/ ha)	Straw yield (qt/ha)
T1	TAW 155	45.871	4.405	6.640	4,405.000	6,640.000
T2	CG 1038	52.831	4.495	5.420	4,495.000	5,420.000
T3	CG 2006	48.706	5.050	7.910	5,050.000	7,910.000
T4	CG 2007	54.056	5.275	6.595	5,275.000	6,595.000
T5	CG 2008	51.088	4.670	6.135	4,670.000	6,135.000
T6	CG 2009	51.359	3.435	5.360	3,435.000	5,360.000
T7	CG 2010	54.508	3.840	4.690	3,840.000	4,690.000
T8	CG 1917	48.251	4.320	5.440	4,320.000	5,440.000
T9	CG 1921	49.774	3.380	4.425	3,380.000	4,425.000
T10	PYT DWR 14-15B	54.231	3.680	5.590	3,680.000	5,590.000
T11	BSP 17-68	58.084	2.905	6.170	2,905.000	6,170.000
T12	PYT 16-11	52.144	3.195	4.610	3,195.000	4,610.000
T13	CG 1934	55.788	3.215	4.365	3,215.000	4,365.000
T14	GW 322(C)	42.903	3.410	8.130	3,410.000	8,130.000
T15	HI 1544 (C)	46.396	4.160	4.715	4,160.000	4,715.000
T16	CG Genhu-3 (SC)	43.259	3.435	4.075	3,435.000	4,075.000
	Over All Mean	50.578	3.929	5.641	3929.375	5641.875
	CD at 5%	2.858	1.013	2..021	1,012.905	2,020.587
	SE(m±)	0.939	0.333	0.664	332.994	664.271
	CV%	2.627	11.985	16.651	11.985	16.651

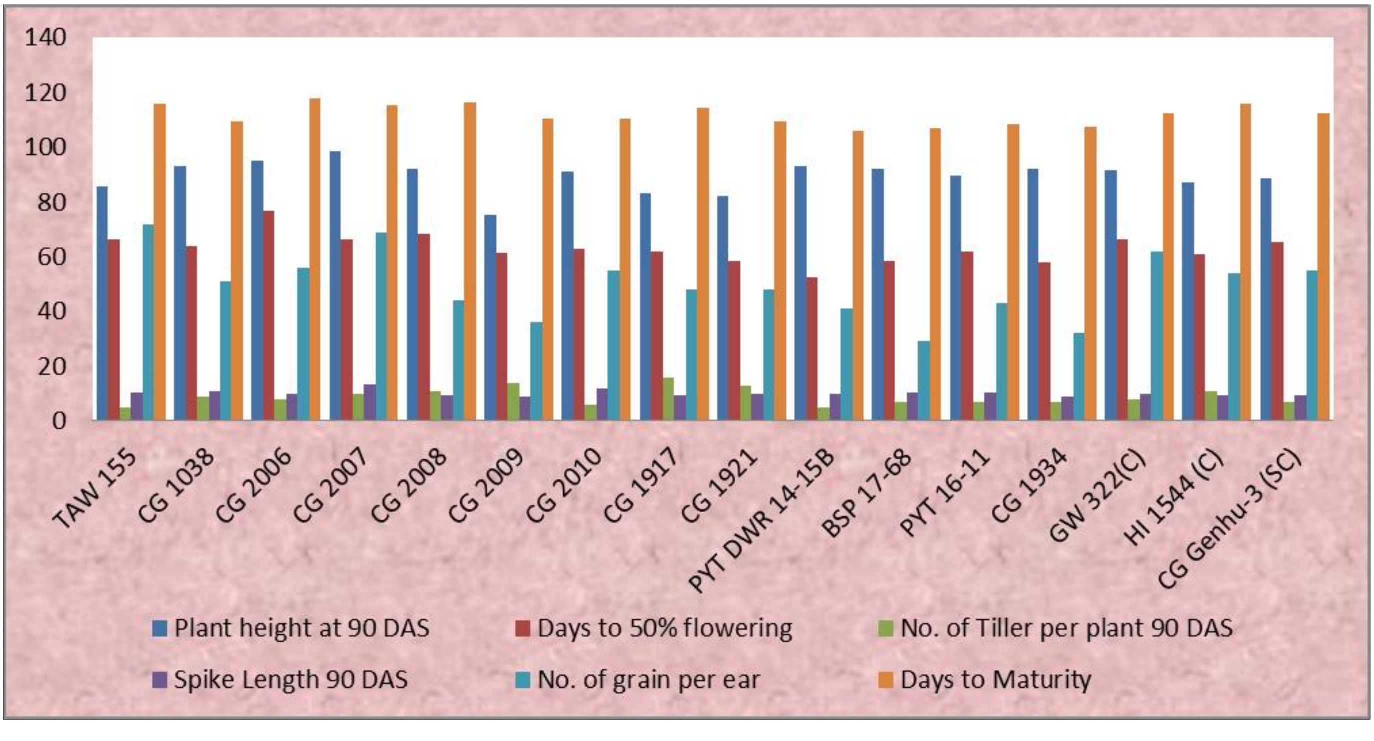

Fig 1: Growth and yield attributes of wheat (*Triticum eastivum L.*) cultivar as influence by *Azotobacter* and PSB

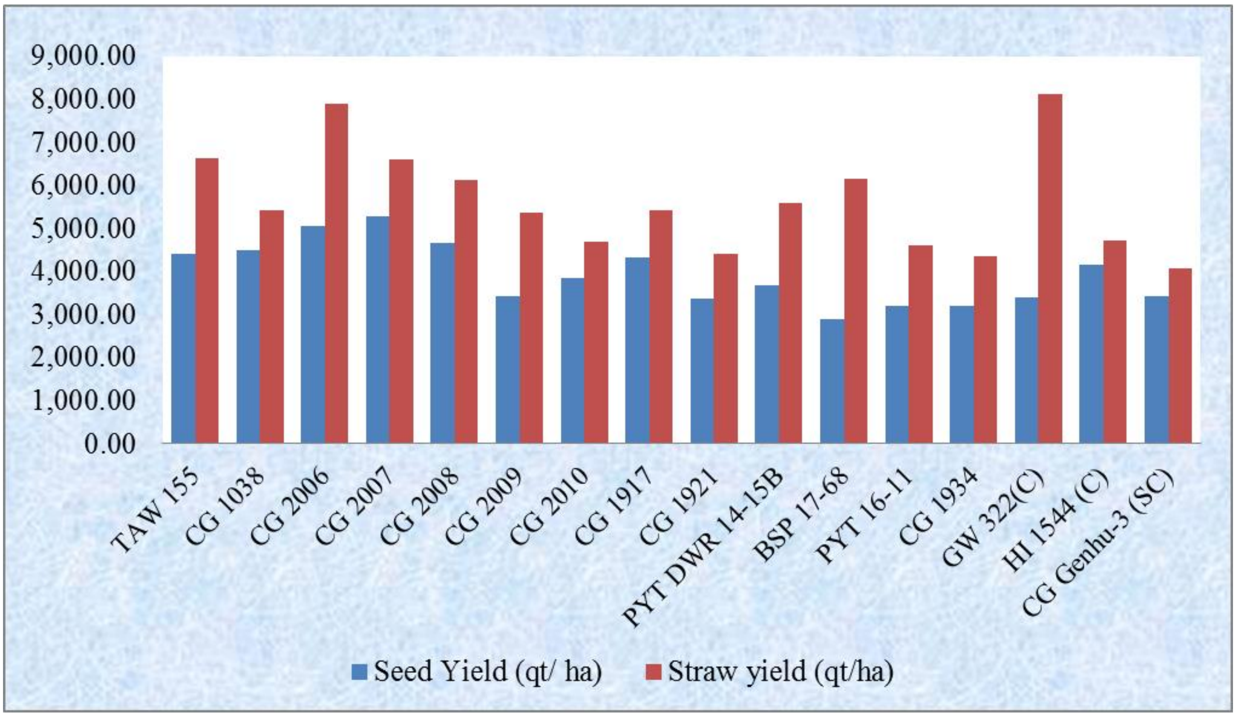

Fig 2: Grain yield and straw yield of wheat (*Triticum eastivum L.*) cultivar as affected by *Azotobacter* and PSB.

Yield (5275.00 qt/ha), respectively. The effects of different liquid biofertilizer treatments (*Azotobacter* and PSB) on yield and yield-attributing factors were found to be variable. The application of biofertilizer treatment resulted in an increase in the number of spikelet's per ear, ear length, total number of tillers per plant, and 1000 grain weight.

Several studies have shown that Azotobacter as a biofertilizer improves growth of crop plants by various mechanisms like nitrogen fixation (Laxminarayana *et al*., 1992), ammonia excretion (Narula *et al*., 1980), plant growth hormone production (Azcon and Barea, 1976) [2], production of antifungal substances, siderophore (Suneja *et al*., 1994) [25] and phosphate solubilization (Kundu and Gaur, 1980) [14], PSB inoculation with Azotobacter might have also favored P availability in soil, resulting in better crop growth. Further, the production of amino acids, vitamins, and growth-promoting substances by Azotobacter and PSB might result in improving plant growth and yield attributes of wheat (Leinhos, 1994) [16].

The application of chemical fertilizers with bio-fertilizers had a stimulatory effect on the survival of Azotobacter and PSB through their direct effect on the growth and proliferation of bacteria or indirectly through changing the growth rate and metabolic activities of the crop plant, resulting in the secretion of more root exudates and thereby creating a favourable habitat for the growth and development of microorganisms. This might have favoured the plant growth and grain and straw yield of wheat as earlier reported by (Gaind and Gaur, 1991: Zahir *et al*., 1996: Kumar *et al*., 2001) [14, 31]. The grain and straw yield is usually in positive correlation with the number of microorganism which plant nutrient in soil (Okon *et al*., 1995; Govedarica *et al*., 2002) [22, 6].

Conclusion

- Performance of liquid biofertilizer *(Azotobacter* and PSB) applied seed treatment was recorded in T3 CG2006, germination percentage, 50% flowering, length of root, dry weight of root, grain yield, and straw yield.
- Then, in T4 CG 2007 more attributing characters variety was recorded, which performed well in plant height, spike length, number of seeds per spike, and grain yield.
- Since the results of the present investigation belong to liquid biofertilizer *Azotobacter* and PSB, this type of experiment using carrier-based biofertilizer (*Azotobacter* and PSB) is recommended to insure the long-term growth and yield performance of wheat in response to inoculation.
- Finally concluded that the treatment T4 (CG 2007) and T3(2006) was better performance in the field trail as compared to cultivar of wheat as well as national check T15 (HI 1544(C)) and state check (CG 1934).

Suggestion

- However, the results are indicative and require further experiments to arrive at more consistent results.
- To confirm the result at farmer field.
- To more level of biofertilizer and application methods was needed to confirm the result.
- Other biofertilizer are compare with this biofertilizer.

Acknowledgement

The authors thank SKCARS, Kawardha for the help and support rendered in carrying out the field trail.

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