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Effect of Different Seed Inoculation on Agronomic Characteristics of Wheat

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ABSTRACT

Combined use of Bio-fertilizers and chemical fertilizers not only increase crop productivity but also lessens the harm posed to environment and helps in sustaining soil health. In this study, an experiment was conducted at the farm of Ch. Nathuram Siag, V.P.O. Jhumianwali, Fazilka, Punjab, India to evaluate the effects of Wheat seed inoculation by N-fixing Azotobacter chroococcum and P-solubilizing Pseudomonas fluorescens on yield and yield attributing characters of wheat. Recommended dose of chemical fertilizer was applied in all the treatments along with different bacterial seed inoculations in two treatments and no inoculation in third treatments. On comparing, Azotobacter and Pseudomonas gave 34.89 % and 15.10 % more dry matter weight as compared to control, 7.69 % and 7.69 % more effective tillers as compared to control, 5.61 % and 4.86 % more grains per spike as compared to control, 11.83 % and 1.69 % more test weight, 7.61 % and 5.58 % more yield and 2.91 % and 0.79 % more harvest index.

Keywords: *Azotobacter, Chemical fertilizer, Pseudomonas, Seed inoculation, Wheat.*

I. INTRODUCTION

Wheat is India's one of the most consumed cereal crops placed second to rice. It is largely consumed in North and North-west parts of India. Being rich in Carbohydrates, Proteins, Vitamins and Minerals it serves as a balanced food to millions of people each day. The conditions required for wheat cultivation are flexible as compared to that of rice which is a Kharif crop. Wheat requires less water usually 3-4 irrigations during its whole period thus making it cultivable even in arid and semi-arid regions of India. Among the leading producers of Wheat in India are Uttar Pradesh, Punjab and Haryana successively. Uttar Pradesh produced the most amount of Wheat due to its large area under wheat cultivation but the highest wheat productivity per hectare is given by Punjab at 4714 Kgs/ha of average yield in 2016-17. The total area under Wheat cultivation in Punjab is 35,00,000 hectares and total production is 1,65,00,000 tonnes in year 2016-17. Out of 22 districts in Punjab the highest average wheat yield was given by Ferozepur, Barnala and Sangrur at 4920 kg/ha, 4905 kg/ha and 4806 kg/ha respectively in 2015-16.

With increasing cost and use of chemical fertilizers, a need has arisen for shifting towards biological fertilizers due to their eco-friendly nature and other benefits. Bacteria used in the experiment for inoculating wheat seed are *Azotobacter chroococcum* and *Pseudomonas fluorescens*. When these bacteria are applied as seed inoculants, they rapidly multiply in the rhizosphere. Not only they increase the crop yield but are also Cost-effective and Eco-friendly. *Azotobacter* is a gram negative, aerobic, free-living, heterotrophic, nitrogen-fixing plant growth promoting rhizobacteria (PGPR) which survive in soil for longer period forming cyst and are

known to stimulate plant growth either by facilitating the plant's uptake of certain nutrients from the environment or by production of phytohormones (auxins, gibberellins, cytokinins) (Joseph *et al.*) [1]. Wheat plants arising from the seeds inoculated with the engineered *Azotobacter* strain exhibited far superior overall performance, had much higher dry weight and nitrogen content, and assimilated molecular ^{15}N much better[2]. Certain *Pseudomonas* strains have been characterized of having beneficial effects on wheat by acting as phosphorous solubilizers with the ability to produce organic acids such as Oxalic acid, Fumaric acid and Citric acid and Phosphatases that help in solubilising phosphorous and other nutrients. After nitrogen, phosphorus is second in terms of importance for growth in plants. Phosphorous is 0.2% of the dry weight in plants. Phosphorus is obtained by the plant as phosphate anions. Phosphate solubilizing bacteria possess capability to convert phosphorus from insoluble to soluble form (Keneni *et al.*, 2010) [3].

Ahmed *et al.* and Amara and Dahdoh reported that, treatments with different genera (*Azotobacter, Azospirilllum, Pseudomonas and Rhizobium*) individually or in mixtures improved grain yield and total plant dry weight. Inoculation with *Rhizobium* showed the highest value of grain yield representing 106.1% over control, while inoculation with mixture of *Azotobacter and Azospirillum* showed the highest value of straw yield representing 157.0% over control and increased the uptake of N, P, K, Na, Fe, Zn, Mn and Cu. On the other hand, inoculation with mixtures of *Pseudomonas* and *Rhizobium* increased the uptake of N, Na, Fe and Cu, while inoculation with *Rhizobium* increased the uptake of N, K, Na, Zn, Fe, and Cu, but inoculation with *Azotobacter* increased the uptake of Mn [1]. The objectives undertaken for the study were to study the effect of seed inoculation by *Azotobacter chroococcum* and *Pseudomonas fluorescens* on morphological, yield and yield contributing characters of wheat.

II. MATERIAL AND METHODS

The Experiment was carried out at the field of Ch. Nathuram Siag, V.P.O. Jhumianwali, District Fazilka, Punjab, India. The location coordinates are 30.254154^{O} N and 74.198558^{O} E. The crop was grown in Rabi season of 2016-17. The experiment was conducted in three plots with each plot having dimensions of 3m x 2m, length and breadth respectively. Treatments were as follows: -

T_1 = *Azotobacter chroococcum* @ 20mL/kg of seed

T_2 = *Pseudomonas fluorescens* @ 20gm/kg of seed

T_3 = Control (No Inoculation)

A Pre-sowing irrigation or *rauni* was given followed by field preparation with disc harrow followed by two ploughings with a cultivator to loosen the soil and uproot the weeds. After ploughing, planker was used for planking to break the clods and level the soil. Seeds for Treatment 1(T_1) and Treatment 2(T_2) were inoculated with *Azotobacter chroococcum* and *Pseudomonas fluorescens*, respectively. 66 gm of Wheat seed was inoculated with 20mL of *A. chroococcum* in a small tub before sowing in Plot number 1. 66 gm of Wheat seed was inoculated with *P. fluorescens* on a pucca floor before sowing in Plot number 2. Seed in Plot number 3 was uninoculated. Wheat variety DBW 17 was sown at the rate of 45 kg/acre in 6 rows with spacing of 30 cm at a

depth of 4-5 cm. Each row measured about 3 metres in length per plot and for each row 11 gms of seed was used. 66 gms of seed was used per plot. Sowing was done using Single-hand seed drill on December 16, 2016. Nitrogen (50 kg/acre) was applied in form of Urea and P_2O_5 (25 kg/acre) in form of D.A.P was applied. Half of urea was applied at time of sowing, $1/4^{th}$ during 1^{st} irrigation and remaining $1/4^{th}$ during 2^{nd} irrigation; full dose of Phosphate was applied at time of sowing. 32.5 kg of urea (15 kg N) + 55 kg of D.A.P (10 kg N + 25 kg P_2O_5) was applied during sowing; 27.2 kg of urea during 1^{st} irrigation and remaining 27.2 kg during 2^{nd} irrigation. The observations recorded for the experiment were dry matter weight, effective tillers, grains/spike, test weight, yield and harvest index. Water was supplied by flood irrigation. 1^{st} irrigation after 21 days of sowing at CRI (Crown Root Initiation) stage.

Irrigation	Date of Irrigation	Days after Sowing
1^{st}	January 6, 2017	21
2^{nd}	January 27, 2017	42
3^{rd}	February 17, 2017	63
4^{th}	March 10, 2017	84
5^{th}	March 31, 2017	105

III. RESULTS AND DISCUSSION

3.1 Dry matter accumulation (30 days interval)

In terms of dry matter accumulation, it fluctuated among the three treatments and by time of harvesting, there was a significant difference among the three treatments. Maximum dry matter accumulation was observed in T_1 (25.9 gms) followed by T_2 (22.1 gms) and minimum in T_3 (19.2 gms) [Fig. 4.1].

Bageshwar *et al* (2017) found that wheat plants arising from the seeds inoculated with the engineered *Azotobacter* strain exhibited far superior overall performance, had much higher dry weight [2].

3.2 Effective tillers

Effective tillers are an important parameter in predicting the yield of crop. However, the numbers of effective tillers were same in T_1 and T_2 i.e. 5.6 and 5.6, respectively and least (5.2) in T_3 [Table 4.1].

Malik *et al* (2012) conducted a study and their results showed that inoculation significantly stimulates number of tillers and spikes (m^{-2}). Maximum number of tillers (391) and spikes (384) were observed with 120-50-00 NPK kg/ha^{-1} + Phosphobacterium inoculums [4]. Malik *et al* (2005) carried out a study and found that the grain yield of the plots inoculated with *Azotobacter spp.* was increased due to increase in tillering capacity and the ear size producing higher number of grains [5].

3.3 Grains per spike

Inoculated wheat differed significantly from non-inoculated seeds (53.4) with respect to number of grains/spike. More number of grains/spike was present in T_1 (56.4) as compared to T_2 (56.0) [Table 4.2].

Soleimanzadeh and Gooshchi (2013) studied the effect of seed inoculation by *Azotobacter* and different levels of nitrogen fertilizer on growth and yield of Wheat and concluded that *Azotobacter* plants had about 8% more number of grains/spike in comparison to non- *Azotobacter* plants [6].

3.4 Test weight

Test weight is a good measure of knowing yield of any crop as it gives a quantitative prediction of crop yield before weighing the whole crop. Highest test weight was observed in T_1 (39.7) which differed significantly from T_2 (36.1) and minimum in T_3 (35.5) [Table 4.3].

Aazadi *et al* (2014) carried out an experiment and their results showed that with application of *Azospirillum* spp. and *Azotobacter* spp. in wheat cultivation can reduce the use of nitrogen fertilizer. Therefore with right combination of chemical fertilizer and biological fertilizer expected yield can be achieved, with lower danger for environment [7].

3.5 Yield

T_1 gave the maximum yield (21.2 qt/acre) followed by T_2 (20.8 qt/acre) and T_3 (19.7 qt/acre) gave least yield of all the treatments [Table 4.4].

Milošević *et al* (2012) studied the interaction effects of wheat seed inoculation with *Azotobacter chroococcum*. Highest yield increase was found in a variety up to 74% when inoculated and given Urea [8].

3.6 Harvest Index

There was slight difference among the Harvest Index of all the three treatments of which T_1 (38.9%) had the highest of them all followed by T_2 (38.1%) and least in T_3 (37.8%) [Table 4.5].

Study by El-Lattief (2013) also concluded that using Biofertilizers viz. *Azospirillum* and *Azotobacter* increased the harvest index of wheat significantly than control [9].

$$\text{H.I.} = \frac{\text{Economic Yield (e.g. grain)}}{\text{Biological yield (e.g. grain + straw)}} \times 100$$

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IV. FIGURES AND TABLES

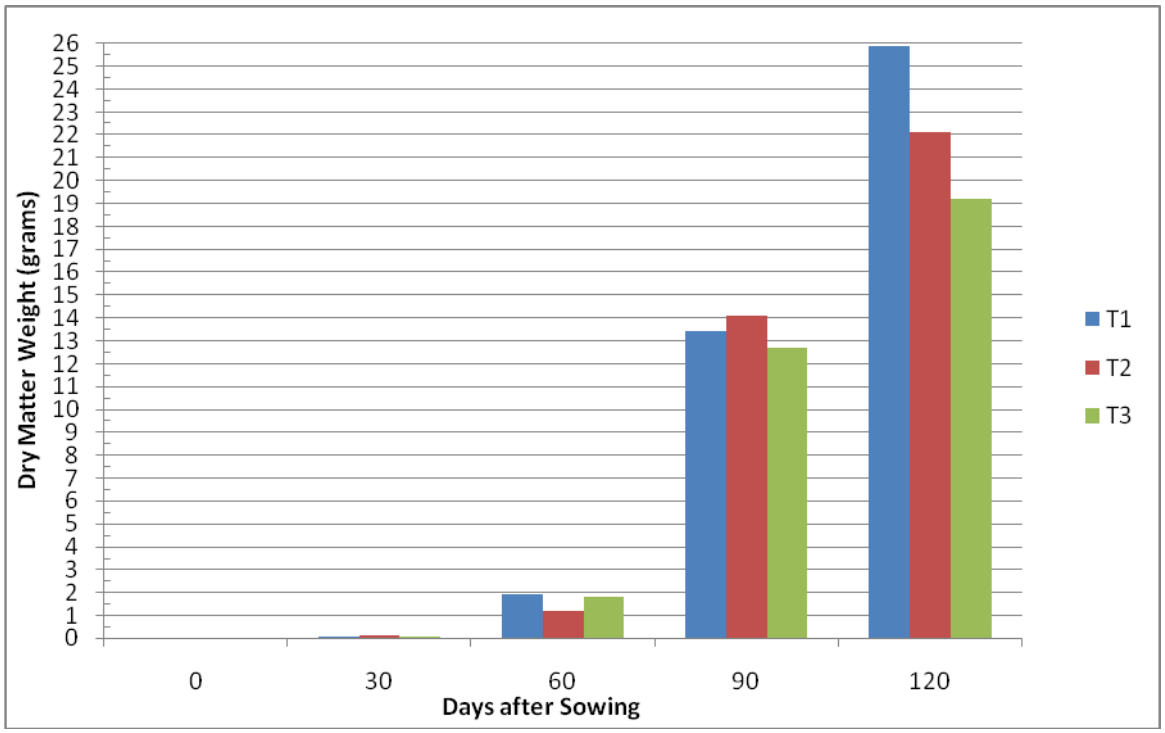

Figure 4.1 Comparison between dry matter of 3 treatments T_1, T_2 and T_3

Table 4.1 Comparison between number of effective tillers/plant of treatments T_1, T_2 and T_3

Treatments	Number of Effective Tillers/ Plant
T_1	5.6
T_2	5.6
T_3	5.2

Table 4.2 Comparison between number of grains per spike of treatments T_1, T_2 and T_3

Treatments	Number of Grains/ Spike
T_1	56.4
T_2	56.0
T_3	53.4

Table 4.3 Comparison between test weight of treatments T_1, T_2 and T_3

Treatments	Test Weight (1000 grains)
T_1	39.7
T_2	36.1
T_3	35.5

Table 4.4 Comparison between Yield of treatments T_1, T_2 and T_3

Treatments	Yield (Qt./acre)
T_1	21.2
T_2	20.8
T_3	19.7

Table 4.5 Comparison between Harvest index of treatments T_1, T_2 and T_3

Treatments	Harvest Index (%)
T_1	38.9
T_2	38.1
T_3	37.8

V. CONCLUSION

The present experiment was conducted to study the effect of different seed inoculation on agronomic characteristics of wheat. The conclusion reached was that, among all the inoculation treatments viz. Azotobacter, Pseudomonas and no inoculation, Azotobacter inoculation performed better in important parameters like dry matter weight, effective tillers, grains/spike, test weight, yield as well as harvest index than Pseudomonas inoculation and control. So, it can be concluded that inoculation with Azotobacter chroococcum in combination with recommended dose of NPK gave better yield in comparison to inoculation with Pseudomonas fluorescens and control.

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