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EFFECT OF DIFFERENT BIO-INOCULANTS ON GROWTH AND YIELD OF POTATO CV. "DESIREE"

Muhammad Ali Khan[1], M. M. Mahmood[2], Sudheer Tariq[2], Muhammad Ashraf [1], S. Riaz[2] and Aasia Ramzan[2]

[1]*National Institute of Organic Agriculture, NARC, Islamabad*
[2]*Horticulture Research Institute, NARC, Islamabad*
Corresponding Author E-mail: alikhan.fos@gmail.com

ABSTRACT

A potato cultivar (Desiree) pot inoculation trial was carried out to evaluate an indigenous formulation comprising *Azospirillum, Azorhizobium* and P-solubilizing *Pseudomonas* in single, dual and triplicate combination as supplement to chemical fertilizers. The effect on growth and yield indices were compared with full recommended dose of Nitrogen (N) and Phosphorus (P) at NARC, HRI green houses pot experiment during 2009-10. The were, un-inoculated control with starter N and P; *Azospirillum* with half N and P; *Azorhizobium* with half N and P; *Pseudomonas* with full N + half P; *Azospirillum* + *Azorhizobium* with half N and half P; *Azorhizobium* + *Pseudomonas* with half N and half P; *Azospirillum* + *Pseudomonas* half N and half P; *Azorhizobium* + *Azospirillum* + *Pseudomonas* with half N and half P; Full recommended dose N+P. All the inoculated treatments produced significantly higher tuber yield, tuber weight than control (un-inoculated). Triplicate inoculation in the presence of half of recommended dose of N and P, brought 66% increase in tuber yield over control, and it did not differ significantly from that where full dose of recommended N and P was given. The triplicate inoculation saved 50% N and P without compromising on tuber yield.

Key words: *Azospirillum, Azorhizobium, Pseudomonas,* potato tuber yield, bio-fertilizer, N and P

INTRODUCTION

Among the tropical and sub-tropical crops, potato is the fourth most important one producing substantially high edible energy and maximum production tuber crop, the potato plant is highly efficient in the use of available nutrients (Struik, 2006). Additionally, the potato tuber is rich in vitamins, minerals, proteins; essential amino acids and carbohydrates (Buckenhuskes, 2005) Bio-fertilizers are eco-friendly and have proved to be effective and economical alternate of chemical fertilizers with lesser input of capital and energy. Fertilization is among the most important soil amendment operations used in modern agricultural production. Research in this area is mostly focused on increasing crop yields, with their cumulative effects (changes in soil biological and chemical properties) being often neglected. Therefore, the judicious efficient use of mineral fertilizers (nitrogenous ones in particular), organic and microbiological fertilizers can be practicable only through the adoption of a complex approach that gives importance to microbiological studies.

The activity of soil microorganisms as important indicators of soil biologically productivity can be indicative of the economic just ability of the use of different types, combinations and rates of fertilizers (Stark *et al.,* 2007). Some microorganisms in the rhizosphere, such as diazotrophic bacteria and mycorrhizal fungus, establish beneficial interactions with plant roots (Jeffries *et al*., 2003, Kennedy *et al*., 2004). The plant–microbe interaction in the rhizosphere is important for plant development and disease control (Jeffries *et al*., 2003, Avis *et al*., 2008). As a rule, microbial processes are enhanced by mineral fertilization, which is a radical method of soil nutrient balance improvement (Fauci and Dick, 1994). However, the long- term use of mineral fertilizers, particularly high rates of nitrogen fertilizers, may be harmful, as it Leeds to increased gaseous nitrogen losses, deteriorating physical, chemical and biological properties of the soil and, eventually, reduce safety of the plant products obtained (Barabasz *et al*., 2002; Ayoola and Adeniyan 2006)

Diazotrophic bacteria can fix atmospheric nitrogen and convert into ammonium thereby stimulating plant growth (Postgate, 1998). The inoculation of *Alpinia puerperal* K. Sschum, plantlets obtained through micropropagation with native diazotrophic bacteria induced larger stem diameter, root dry mass, number of shoots and increased their survival percentage from 77 to 100% compared to plantlets without inoculation (Ovando-Medina *et al*., 2007). It is for these reasons that food production involving long-lasting environmental prevesation and stable quality yields is advocated within novel integrated agricultural systems. Accordingly, attention has been focused on the use of different organic sub-strates and biofertilizers (microbial inoculants) as an alternative and/or a supplement to costly mineral fertilizers. This results in improved physical, chemical and biological properties of the soil, elevated levels of readily available nutrients, phytohormones, enzymes and useful microorganisms and, hence, increased yields and safety of plant crops (Simek *et al*., 1999). In this respect, the results of Emtsv *et al* (1998) indicate the importance of the use of *Klebsiella planticola* TSHA-91-based bioproducts towards increased yields of vegetable crops, most notably potatoes. The authors report not only their high nitrogenase activity but also their adhesion capacity, the ability to absorb at the plant roots and colonize them throughout the growing season, and growth inhibition of some pathogenic fungi. The ability to fix nitrogen, produce biologically active matter and increase crop yield is also a characteristic of other species of the genus *Klebsiella* (Yasmin *et al.*, 2007).

The objective of this study was to evaluate the effect of bio-inoculants with chemical fertilizers growth parameters and tuber yield of potato.

MATERIALS AND METHODS

The pot experiment was set up as a conducted during 2009-10 at greenhouse Horticultural Research Institute at National Agricultural Research Centre (NARC), Islamabad, Pakistan in a randomized complete block design (RCBD) with three replications having nine treatments, (with un-inoculated control) in the presence and absence of nitrogen and phosphorus. Before sowing potato seeds were inoculated according to standard procedure of seed treatment. The potato cultivar Desiree was selected as test crop. Prior to the application of fertilizers, the composite soil samples were collected from each plastic tub at a depth of 0-30cm and analyzed for physical and chemical characteristics of soil (Table 1). The soil for experiment was thoroughly prepared. Fertilizers were broadcasted into the soil prior to sowing. Data on various morphological and yield traits, i.e., number of leaves/plant, number of tubers/plant, tuber size and tuber yield were recorded. At maturity (115 days after planting), plants were manually harvested from each pot, to estimate tuber yield/ plant. Tubers were taken from each plant, cleaned and weighed. Then, yield and other parameters were computed on per plant basis. The following treatment comparisons were made:

- T1 = Control.
- T2 = *Azospirillum* + 1/2NP (21.73g and 16.30g/pot).
- T3= *Azorhizobium* + 1/2NP (21.73g and 16.30g/pot).
- T4 = *Pseudomonas* full N and 1/2P (43.47g and 16.30g/pot).
- T5 = T2 + T3 + 1/2NP (21.73g and 16.30g/pot).
- T6 = T3 + T4 + 1/2NP (21.73g and 16.30g/pot).
- T7 = T2 + T4+ 1/2NP (21.73g and 16.30g/pot).
- T8 = T2+ T3+ T4+ 1/2NP (21.73g and 16.30g/pot).
- T9= N and P (43.47g and 32.60g/pot).

Characteristics of experimental soil (pre-sowing).

Texture	pH	O.M.%	Olsen-p (mg kg^{-1})	Total Nitrogen %
Sandy loam	7.74	0.97	9.65	1.90

The data were subjected to standard analysis of variance using MSTATC, a computer software package (Bricker, 1991)

RESULTS AND DISCUSSION

Number of leaves

Significant effect of the treatments was recorded on number of leaves but all the treatments performed at par except control (Table 1). Maximum number of leaves were produced (18.40) by T9 treatment, where full N and P (43.47g and 32.60g/pot) chemical fertilizer was applied, while T8 was the next best treatment, where all the bio-inoculants were applied with ½ N and P chemical fertilizers, which produced number of leaves (17.50). It was followed by T7, T6, T5 and T4, which produced significantly best number of leaves (16.70, 15.30, 14.20 and 12.40), and other two treatments T3 and T2 were non significant in producing number of leaves. While control produced less number of leaves which were (8.10).

Number of Tubers

Data regarding the number of tubers /plant, the plants treated with NP treatment was found to be highest in number of tubers (15.66), which was statistically non significant T8, in which all the bio-inoculants were included with ½ NP, produced (15.00), but these two treatments were statistically significantly higher than in the control and other treatments (Table.1). The lowest number of tubers was found in untreated treatment T1 (8.00) only; while rest of the inoculated treatments T2 to T7 ranged from (10.33 to 14.33), which are at par with Control treatment. Our findings are in consistency to the findings of Duffy and E.M (2000). However, they worked on increase in plant growth by mycorrhizal association is largely due to increased absorption of nutrients.

Tuber size

Data regarding tuber size presenting in table-1, maximum output was achieved with treatment T9 recommended NP (56.0cm) followed by treatment T8 microbial consortium with 1/2 NP was (53.5cm), and it was followed by T7 producing tuber size (51.5cm), all these treatments showed non significant results. The treatments from T2 to T6 also showed non significant results, these treatments were from 41.0cm to 49.0cm, while control showed least tuber size (37.5cm).Our results are in line with Stark et al. (2007), however, they also worked on soil physical and chemical characteristics.

Table 1. Effect of different bio-inoculants on growth and yield of potato cultivar “desiree”.

	Treatments	Number of leaves	Number of tubers	Tuber size(cm)	Potato yield g/plant
T1	Control	08.10 d	08.00 d	37.5 c	356 d
T2	Azospirillum + 1/2NP	10.20 c	10.33 c	41.0 c	416 d
T3	Azorhizobium + 1/2NP	10.90 c	10.66 c	42.5 c	410 c
T4	Pseudomonas full N and 1/2P	10.41 c	12.66 b	49.0 c	470 c
T5	T2 + T3 + 1/2NP	14.20 b	13.33 b	46.2 b	502 c
T6	T3 + T4 + 1/2NP	15.30 b	12.33 c	51.5 c	430 c
T7	T2 + T4+ 1/2NP	15.90 b	14.33 b	51.5 a	560 b
T8	T2+ T3+ T4+ 1/2NP	17.50 a	15.00 a	53.5 b	586 b
T9	Azorhizobium + 1/2NP	18.40 a	15.66 a	56.0 a	752 a
	LSD at 0.05 alpha level	0.793	2.289	1.73	0.031
	COV (%)	5.82	18.35	10.94	12.59

Potato Tuber yield

The results revealed that diazotrophs inoculation associated with the roots increased tuber yield. Mixed microbial cultures allow their components to interact synergistically, thus stimulating physical or bio-chemical activities.

Increase in tuber yield by different treatments was ranged from 356g to 752g as presented in Ttable-1. The effect of treatment T9 where full N and P chemical fertilizer was applied, was found significantly more pronounced 752g/pant followed by treatment T8 microbial consortium with 1/2 NP was 586g. However, in other microbial treatments, there was non significant difference from treatment T2 to treatment T8. On the whole, the increase in potato yield resulting from the treatments was consistent with the results obtained from other authors who reported that, the in the yield of potato minitubers might be due to phytohormone production induced by the two AM fungi (Castro *et al.,* 2000). The use of bio fertilizers and their effect on potato yield and quality are given special importance in organic agriculture systems.

Conclusion

The best over all the performance was revealed by treatment T9, where full N & P was applied and it is concluded from the present investigation that combined application of bio-fertilizers through seed treatment is equally good to attain superior potato growth and yield than application of inorganic fertilizers alone to potato cultivation and bio-fertilizer use thus can save 50% cost of urea as well as phosphorus. Moreover, the triplicate inoculants can thus be used as bio-fertilizer in low fertility soil in low rainfall area for the profit of resource poor farmer.

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