



Field Evaluation of Arbuscular Mycorrhizal Fungal Formulations on Production Performance of Potato (*Solanum tuberosum* L.) cv. Kufri Sindhuri

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Authors' contributions

This work was carried out in collaboration between all authors. Authors NK and DPM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript.

Author AKS guided the author NK during the whole research period and edited the manuscript. Authors Amrita Kumari and Anand Kumar managed the analyses of the study. Authors MKG and HK managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Arbuscular mycorrhizal fungal symbiosis has notable impact on sustainable growth and development of various plants as they provide assistance to acclimatize with the biotic and abiotic conditions. In this concern, a field experiment was conducted during *Rabi* season of 2015-16 at Vegetable Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi in order to evaluate the effect of various mycorrhizal products at different concentrations on growth and yield parameters of potato. The field experiment consisted of 13 treatments involving different mycorrhizal products including Untreated (Control). The treatment T₁₁- NZBBA9050 @ 250 g/ha showed very promising result for almost all the characters under investigation viz., plant stand count at 30 DAP (92%), plant stand count at 60 DAP (90%),

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Plant height at 30 DAP (68.93 cm), Plant height at 60 DAP (112.00 cm), root length (32.63 cm), number of haulms/plant (5.33), number of tubers/plant (16.87), weight of tubers/plant (524.00 g), length of tuber (6.28 cm), width of tuber (4.80 cm), tubers yield/plot (24.67 kg) and tuber yield (27411.11 kg/ha) as compared to other treatments followed by T₈ - NZBBA9049 @ 250 g/ha, T₂ - Soil drench with Bolt SP @ 250 g/ha and T₅ - NZBBA9048 @ 250 g/ha in potato. At much higher concentration, the mycorrhizal products imposed adverse effect on all the growth and yield parameters. As a conclusion, it can be stated that mycorrhiza can perform the role of a remarkable supplement for increasing growth and yield of potato along with commonly used fertilizers.

Keywords: *Solanum tuberosum* L.; mycorrhization; soil drenching; production.

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) has a greater significance among various vegetable crops. It is an annual plant of herbaceous nature belonging to solanaceae, the family that includes pepper and tomato. The edible part of potato is called tuber which is the modified form of underground stem. It was originated in South America and introduced to India in 1600s by the Portuguese. The probable ancestor of all cultivated potatoes is *Solanum stenotomum*. Potato (*Solanum tuberosum* L.) is the most important non-grain food crop in the world, ranking 3rd in terms of total production with over 365 million tonnes per year after rice and wheat [1]. It is grown in around 150 countries spread across both temperate and tropical regions and at elevations from sea level to 4000 m.

Mycorrhizae are known to carry out many ecosystem functions such as improvement of plant establishment, growth enhancement of nutrient uptake, and plant protection against biotic and abiotic stresses [2]. The mutualistic association of roots and AM fungi provides the fungus with relatively constant and direct access to mono or dimeric carbohydrates, such as glucose and sucrose produced by the plant during photosynthesis and then translocation of these solutes to the roots [3].

Among various vegetable crops, potato has got a heavy demand for nutrients especially the NPK requirement. The presence of mycorrhizal infection mainly attribute towards the enhancement in the plant growth due to the improvement in the nutrient uptake especially phosphorous. Although various studies have been conducted regarding the effects of VAM in potato, still intensive investigations are needed to get further refined information regarding the beneficial effects of mycorrhizal inoculation on potato with respect to growth, yield, and quality parameters.

Keeping in view the above facts, the present investigation was carried out with various mycorrhizae-based products (as a soil drench) to study their effects on growth, yield, and yield components of potato as well as to find out the preferential association between the arbuscular mycorrhizal fungi and potato with respect to various parameters under investigation.

2. MATERIALS AND METHODS

The experiment was conducted at the experimental field of Vegetable Research Farm of Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during Rabi season of 2016-17. The experimental design followed was Randomized Complete Block Design (RCBD) and each line was replicated three times with a spacing of 15 cm between plant to plant and 60 cm between row to row. The field experiment consisted of two applications of 13 treatments involving different mycorrhizal products at 20 and 50 days after planting (DAP). Spray was targeted towards the roots of plants. Both the sprays were done in all the plots except control. The cultivar used in the experiment was Kufri Sindhuri developed at ICAR-Central Potato Research Institute, Shimla. The mycorrhizal products included in the study are T₁ - Control (without mycorrhiza), T₂ - Bolt SP @ 250 g/ha, T₃ - Bolt SP @ 500 g/ha, T₄ - Bolt SP @ 750 g/ha, NZBBA9048 @ 250 g/ha, T₆ - NZBBA9048 @ 500 g/ha, T₇ - NZBBA9048 @ 750 g/ha, T₈ - NZBBA9049 @ 250 g/ha, T₉ - NZBBA9049 @ 500 g/ha, T₁₀ - NZBBA9049 @ 750 g/ha, T₁₁ - NZBBA9050 @ 250 g/ha, T₁₂ - NZBBA9050 @ 500 g/ha, and T₁₃ - NZBBA9050 @ 750 g/ha that are applied through soil drenching. Observations were recorded on five randomly selected plants and the data was subjected to statistical analysis. For statistical analysis, mean of different treatments were analyzed by the method outlined by Cochran and Cox [4].

Table 1. Effect of various formulations of mycorrhiza on growth and yield parameters of potato

Treatment	Plant stand count (%)		Plant height (cm)		Root length (cm)	Number of leaves/plant	Number of haulms/plant	Number of tubers/plant	Weight of tubers/plant (g)	Length of tuber (cm)	Width of tuber (cm)	Tubers yield/plot (kg)	Tuber yield (kg/ha)
	30 DAP	60 DAP	30 DAP	60 DAP									
T ₁ - Untreated (Control)	87.33	85.00	63.13	97.47	20.20	56.60	3.73	10.60	405.00	5.26	3.76	18.50	20559.26
T ₂ - Bolt SP @ 250 g/ha	88.33	89.00	68.13	105.87	30.40	84.40	5.27	15.80	479.33	6.06	4.58	22.00	24440.74
T ₃ - Bolt SP @ 500 g/ha	88.00	86.33	65.00	100.87	28.93	75.00	4.60	13.87	458.73	5.63	4.53	19.95	22166.67
T ₄ - Bolt SP @ 750 g/ha	87.67	85.33	64.67	99.33	26.67	73.73	4.03	11.67	430.33	5.44	4.20	18.90	21000.00
T ₅ - NZBBA9048 @ 250 g/ha	88.33	86.67	65.93	104.40	29.03	76.53	4.67	14.13	474.33	5.75	4.51	21.67	24077.78
T ₆ - NZBBA9048 @ 500 g/ha	88.33	88.00	65.60	101.67	27.80	73.53	3.93	12.53	450.00	5.71	4.45	20.75	23055.56
T ₇ - NZBBA9048 @ 750 g/ha	87.00	86.00	63.73	97.73	25.47	61.80	3.87	12.10	438.67	5.44	4.16	19.43	21588.89
T ₈ - NZBBA9049 @ 250 g/ha	86.33	85.67	67.53	109.07	30.90	77.93	4.87	14.33	501.33	6.16	4.75	22.18	24640.74
T ₉ - NZBBA9049 @ 500 g/ha	91.00	90.00	66.67	100.53	27.20	70.40	4.57	12.60	456.00	5.70	4.38	21.52	23907.41
T ₁₀ - NZBBA9049 @ 750 g/ha	86.67	86.33	63.93	100.13	25.53	65.20	3.97	11.80	417.33	5.50	3.95	18.81	20896.30
T ₁₁ - NZBBA9050 @ 250 g/ha	92.00	90.00	68.93	112.00	32.63	82.67	5.33	16.87	524.00	6.28	4.80	24.67	27411.11
T ₁₂ - NZBBA9050 @ 500 g/ha	88.33	87.00	64.13	99.13	28.07	75.60	3.80	13.47	466.00	5.56	4.01	20.82	23137.04
T ₁₃ - NZBBA9050 @ 750 g/ha	87.00	86.33	64.03	98.03	24.40	60.37	3.77	11.90	424.67	5.48	3.90	19.13	21259.26
SE(d)	2.815302	2.738613	1.415719	4.470997	2.336823	6.454155	0.493664	1.32651	24.11724	0.205571	0.15486	1.362592	1513.992
CD at 5%	5.810498	5.652219	2.9219	9.227684	4.822965	13.32072	1.018871	2.737783	49.77555	0.424277	0.319614	2.812252	3124.725

3. RESULTS AND DISCUSSION

A significant increase in the plant growth and yield parameters was recorded after the use of various strains of mycorrhiza and documented in the Table 1. The statistical analysis revealed that the maximum plant stand count (90.00) was recorded similar in both the treatments viz., T₁₁ - NZBBA9050 @ 250 g/ha and T₉ - NZBBA9049 @ 500 g/ha followed by treatment T₂ - Bolt SP @ 250 g/ha (89.00). The increase in plant height may be due to the up surged nutrient uptake as positively influenced by mycorrhiza which made normally unavailable nutrients available to the plants. The maximum plant height both at 30 DAP (68.93 cm) and 60 DAP (112 cm) was recorded with the treatment T₁₁ - NZBBA9050 @ 250 g/ha. These results are in conformity with the findings of Utkhede [5]; El-Haddad and Awad [6]; Oseni et al. [7], and Borca and Puia [8]. The maximum length of roots (32.66 cm) was noticed in the treatment T₁₁ - NZBBA9050 @ 250 g/ha. Increase in root length was due to the greater colonization of mycorrhizal fungus on roots which has resulted in greater accumulation of nutrients. These results were in agreement with the findings of Ryan et al. [9]; Yao et al. [10]; Neumann and George [11]. The treatment effects were found to be statistically significant for number of leaves per plant and the maximum value (84.40) was recorded by the treatment T₂ - Bolt SP @ 250 g/ha. Increased number of leaves was noticed due to the fact that the higher photosynthetic capacity of plant as normal and any disorder free leaves have greater potential for carbohydrate production. This result was in accordance with the work of Rodriguez et al. [12].

A significant increase in the number of haulms per plant was recorded. The increased number of haulms as compared to control was might be due to the increased absorption of nutrient such as phosphorus, copper, iron, zinc, etc. The maximum number of haulms per plant was observed with the treatment T₁₁ - NZBBA9050 @ 250 g/ha (5.33). These results are in accordance with the finding of Ghosh and Das [13]. There was a significant increase in the number of tubers per plant due to the fact that increased phosphorus content in plant had exerted a positive effect on cell division and energy storage and also an increase uptake of nutrients by the plant roots facilitates to sprout more eye buds of the tubers and also due to less attack of insect pests by presence of the mycorrhiza. Maximum number of tuber per plant was found in the

treatment T₁₁ - soil drench with NZBBA9050 @ 250 g/ha (16.86). These results were in agreement with the earlier findings of Ryan et al. [9]; Yao et al. [10]; El-Haddad and Awad [6]; and Hadad et al. [14]. Greater accumulation of photosynthates as well as sufficient carbohydrates to the tubers resulted in the eventual increase in weight of tubers. Observation recorded on weight of tuber revealed that, the maximum tuber weight was observed in the treatment T₁₁ - NZBBA9050 @ 250 g/ha (524.00 g). These results are in accordance with the finding of El-Haddad and Awad [6]; and Hadad et al. [14].

Observations recorded on the tuber length expressed that the maximum tuber length (6.28 cm) was registered with the treatment T₁₁ - NZBBA9050 @ 250 g/ha. The results obtained were in accordance with the previous findings of Buysens et al. [15]. Various mycorrhizal inoculations have significantly increased the tuber width. Maximum tuber width i.e., 4.81 cm, was observed in the treatment T₁₁ - NZBBA9050 @ 250 g/ha. The results obtained were in accordance with the findings of Buysens et al. [15]. The maximum tuber yield per plot (24.67 kg) was found in the treatment T₁₁ - NZBBA9050 @ 250 g/ha. This may be due to increase in the nutrient content that is channelized towards the tubers leading to the rise in the yield per plot. The present findings are in agreement with the work of Gaurav et al. [16]; Ekin et al. [17]; and Buysens et al. [15].

The treatment of arbuscular mycorrhizal products has considerably improved the production and quality. The maximum tuber yield (kg/ha) i.e., 27411.11 kg/ha, was recorded in the treatment T₁₁ - NZBBA9050 @ 250 g/ha. The significant increase in tuber yield per hectare was due to better nutrient absorption of plant which resulted in better vegetative growth and increased plant biomass. These results were in confirmation with the earlier work of El-Haddad and Awad [6]; Gaurav et al. [16]; Ekin et al. [17]; and Buysens et al. [15].

4. CONCLUSION

It can be concluded from the results that all the mycorrhiza-based products have significant potential with respect to superior vegetative growth and enhanced yield performance over the

untreated treatment thus emphasizing the prominence of symbiotic organisms in crop growth and resistance towards the stresses.

From the present findings, it can be corroborated that the treatment T₁₁ - NZBBA9050 @ 250 g/ha showed very promising result for almost all the characters as compared to other treatments followed by T₈ - NZBBA9049 @ 250 g/ha, T₂ - Bolt SP @ 250 g/ha, and T₅ - NZBBA9048 @ 250 g/ha in potato.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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