ISSN: 2230-9926

*Available online at http://www.journalijdr.com*

IJDR

International Journal of DEVELOPMENT RESEARCH

*International Journal of Development Research*
*Vol. 3, Issue, 9, pp.046-050, September, 2013*

## *Full Length Research Article*

# EFFECT OF INOCULATION WITH NPK FERTILIZER AND ARBUSCULAR MYCORRHIZAL FUNGI ON GROWTH AND YIELD OF CASSAVA

**[1,*]Sridevi, S. and [2]Ramakrishnan, K.**

[1]Research and Development Centre, Bharathiar University, Coimbatore-641046
[2]Department of Botany, Annamalai University, Annamalainagar – 608 002

**ARTICLE INFO**

***Article History:***

Received 15th June, 2013
Received in revised form
10th July, 2013
Accepted 28th August, 2013
Published online 19th September, 2013

***Key words:***
Cassava,
Arbuscular mycorrhiza,
NPK.

**ABSTRACT**

The present investigation was undertaken to study the effect of inoculation with NPK fertilizer and Arbuscular mycorrhizal fungi on growth and yield of cassava (*Manihot esculenta* Crantz). The growth attributes like shoot length, total number of leaves, number of roots per plant and root length and yield attributes, like number of tubers, tuber yield and starch content were noticed maximum under increased 100 per cent NPK with AM fungi inoculated plants. The application of 50 per cent of recommended dose of NPK fertilizer with AM fungi inoculation will results in improved growth and yield of cassava.



## INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is one of the major tuber crop. It is grown in more than 80 countries of the humid tropics of the world and forms the most subsistence crops for farmers. Cassava possesses a high potential for yielding large amounts of food per unit area and also it is an efficient producer of calorie (135 calorie/100 g fresh tuber) compared with other cereal crops. In India, cassava ranks first in area (2.35 lakh ha) and production (5.4 million tonnes of fresh tubers) followed by sweet potato. Its average productivity is 23 tonnes/ha, the highest in the world (Department of Economics and Statistics, Season and Crop Report, 2005). A special type of root, resulting from a mutuality association between a plant and a fungus, is called mycorrhizae. The term mycorrhizae were first coined by Frank (1885) to describe plant root fungus association. It can be classified broadly into ectomycorrhizae and endomycorrhizae. A diverse group of soil fungi spanning the Zygomycetes, Asycomycetes and Basidiomycetes from mycorrhizae (Harley and Smith, 1983). Arbuscular mycorrhizae are formed by non-septate phycomycetous fungi belonging to the genera Glomus, Gigaspora, Acaulospora and Sclerocystics in the family Endogonaceae of the order Mucorales. These fungi are none specialized in host range. Yet are apparently obligate symbionts (Gerdemann, 1968). They depend on their host plants for deriving energy source viz., carbohydrate. They can be recognized by the irregular coenocytic hyphae which ramify within the cells of the root cortex. The latter are finally branched to help in the absorption of nutrients. The fungal hyphae produce spores. It is well documented that the increase in plant growth resulting from arbuscular mycorrhizal symbiosis is usually associated with increased nutrient uptake by the hyphae from the soil (Rhodes and Gerdemann, 1980). The increased ability of plants to absorb phosphates (Mosse, 1973) and possibly other elements such as nitrogen, potassium, calcium, zinc, iron and manganese (Gray and Gerdemann, 1973) are the instances to cite. The other beneficial effects are their role in reducing the disease incidence (Schenck and Kellam, 1978), enhancing biological nitrogen fixation (Sivaprasad and Rai, 1987), protecting plants from stress condition (Aldon, 1975), as well as increasing phytochrome production and photosynthetic rates (Allen *et al*., 1981). Cassava crop responds to mycorrhiza and increase in growth can be obtained by mycorrhizal inoculation in low nutrient soils. This mycorrhizal infection can lead to increase the nutrient content of cassava plants and as well as shoot and root dry weights (Howeler, 1982). The present investigations was therefore undertaken with study the

***Corresponding author:** Sridevi, S.*
*Lecturer in Botany, KNC, Cuddalore – 607 001*

inoculation effect of AM fungi on the growth and yield of cassava as influenced by NPK application.

## MATERIALS AND METHODS

The present research work has been carried out to find the effect of arbuscular mycorrhizal fungi and NPK fertilizers on the growth and yield of cassava (Manihot esculenta Crantz). Screening experiments (polyethylene bags) and field experiments were conducted in Nellikuppam, Cuddalore district. The pure culture of Glomus species obtained from Department of Agriculture Microbiology, Annamalai University were used in the present study. The culture consists of the live AM fungal spores maintained at 5°C. Cassava (*Manihot esculenta* Crantz) variety H165, which comes to maturity in about 9 month was utilized for the present study. Stem cuttings of 15 cm length were used as planting material. The survey was conducted at ten different field locations at Cuddalore and Villupuram districts of Tamil Nadu state, India. The experiment was conducted to find out the effect of AM fungi (Glomus fasciculatum) on the growth and yield of cassava as influenced by NPK. The experimental farm situated at Nellikuppam, Cuddalore district. The field was prepared as per the recommended agronomic practices.

**Field experimental design and details**

Crop : Cassava
Cultivar : H 165
Plot size : 3.0 m ×2.2 m
Spacing : 75 cm × 90 cm (uniform row)
Design : RBD
Replication: Three
Duration : 270 days

**Fertilizer application**

The recommended fertilizer schedule of 100:100:160 kg N, P2O5 and K2O was followed for the cassava crop. The phosphorus was applied as a single basal dose, whereas nitrogen and potassium were applied in two split doses i.e., 50% basal and 50% top dress on 90 days after planting. The fertilizers, urea, superphosphate and muriate potash were used for the above manorial schedule.

**Treatments and fertilizer levels**

| Treatment | | Notations |
|---|---|---|
| Absolute control | : | T1 |
| AM alone | : | T2 |
| 25% NPK/ha | : | T3 |
| 50% NPK/ha | : | T4 |
| 75% NPK/ha | : | T5 |
| 100% NPK/ha | : | T6 |
| AM + 25% NPK/ha | : | T7 |
| AM + 50% NPK/ha | : | T8 |
| AM + 75% NPK/ha | : | T9 |
| AM + 100% NPK/ha | : | T10 |

**AM application in field soil**

The method of inoculation of AM fungus was placement method at 25 g of inoculums per plant. The inoculums contains about 150 infective propagates per g was placed 5 cm below the soil surface before sowing the cuttings.

**Plant sampling**

The cassava plants were sampled at regular intervals (30, 60, 90, 120 and 150days) and the morphological and biochemical activities of the plants were analyzed. Five plants from each treatment of a plot were taken and were analyzed for various parameters and the average was calculated. The mean values were used for statistical analysis. The morphological characters such as the shoot length, total number of leaves per plant, number of roots per plant, root length, number of tubers and tuber yield per plant and starch content were determined for every sample at regular intervals (30, 60, 90, 120 and 150days).

## RESULTS AND DISCUSSION

Arbuscular mycorrhizae are ubiquitous in soils that colonize the root and increase the growth and yield of agriculturally important plant species (Jefferies *et al.,* 1989). Mycorrhizal infection may affect the mineral nutrition of the host plant directly by enhancing plant growth through nutrient acquisition by fungus, or indirectly by modifying transpiration rates and the composition of rhizosphere microflora (Marschner and Dell, 1994). The capacity of external hyphae for uptake and transport of nutrients viz., nitrogen, phosphorus and potassium has been well demonstrated (George *et al.,* 1992). Cassava is a highly mycotrophic crop. The effect of AM fungal inoculation in both sterile and natural soils on cotton significantly enhanced to growth and yield (Bagyaraj, 1980). In the present investigation, the response of cassava to Glomus fasciculatum inoculation at graded levels of NPK viz., 25, 50, 75 and 100 per cent NPK/ha was studied. AM inoculation induced maximum plant height and biomass of shoot in maize and soybean (Thangaraju *et al*., 1986). Inoculation with mycorrhizae enhanced shoot length in Capsicum annum (Suvercha and Mukerji, 1988). There was substantial increase in number of leaves per plant and plant height due to potassium application of 60 and 120 kg K2O/ha levels in cassava (Ashokan *et al*., 1988).

In the present study, inoculation of Glomus fasciculatum in cassava significantly increased the shoot length in all NPK levels. The shoot length were higher at 100 per cent NPK/ha with AM. Due to AM inoculation the shoot length and total number of leaves per plant increased significantly with increasing levels of NPK viz., 25, 50 and 75 per cent NPK/ha. AM inoculation promoted the shoot length at 50 per cent NPK/ha equivalent to the effect produced by the NPK at 100 per cent NPK/ha alone. The principle function of mycorrhiza is to increase the soil volume explored for nutrient uptake and to enhance the efficiency of nutrient absorption. This phenomenon would have increased the shoot length and total number of leaves per plant in cassava (Table 1 and 2). Mycorrhizal fungi induced maximum number of non-tuberous root and root dry matter in cassava (Ganesan and Mahadevan, 1994). Glomus and Gigaspora enhanced root dry weight in barley plants (Champawat *et al.,* 1987). Mycorrhizal inoculation increased the root weight and root volume in maize plants (Sitaramaiah *et al.,* 1997). In the present study, AM inoculation significantly increased the number of roots and root length at all the levels of NPK (Table 3 and 4). Similar results were obtained in the root fresh and dry weight. AM inoculated plants showed higher root fresh and dry weight. The increased root fresh and dry weight at 50 per cent

NPK/ha with AM was on par with values recorded at 100 per cent NPK/ha without AM. High availability of potassium actually enhances root development, producing more branching and lateral roots (Munson, 1980). In view of the nutrient uptake by AM fungi the root as well as root length had increased considerably which resulted in increased root dry weight. Glomus mosseae inoculated with groundnut showed increased yield (Daft and EI-Giahmi, 1976) and increased the grain yield in barley (Saif and Khan, 1977). Cassava plants inoculated with AM fungi showed increased tuber yield (Sivaprasad *et al.,* 1989).

**Table 1. Effect of inoculation of *Glomus fasciculatum* on the shoot length of cassava at graded levels of NPK**

| Treatments | Shoot length (cm/plant) | | | | |
|---|---|---|---|---|---|
| | Sampling period in days | | | | |
| | 30 | 60 | 90 | 120 | 150 |
| Control | 19.65 | 40.18 | 69.82 | 100.73 | 131.93 |
| AM alone | 23.72 | 45.57 | 72.63 | 108.32 | 140.67 |
| 25% NPK (25:25:40)/ha | 26.37 | 49.24 | 78.39 | 115.13 | 149.53 |
| 50% NPK (50:50:80)/ha | 31.24 | 55.37 | 87.11 | 125.34 | 162.95 |
| 75% NPK (75:75:120)/ha | 32.57 | 59.18 | 100.92 | 143.98 | 187.26 |
| 100% NPK (100:100:160)/ha | 32.72 | 60.05 | 104.51 | 149.36 | 192.53 |
| AM+25% NPK/ha | 32.51 | 58.72 | 93.24 | 134.19 | 174.59 |
| AM+50% NPK/ha | 33.14 | 62.94 | 104.39 | 149.23 | 195.31 |
| AM+75% NPK/ha | 34.03 | 63.14 | 104.73 | 150.13 | 196.94 |
| AM+100% NPK/ha | 34.12 | 63.20 | 105.02 | 152.20 | 198.19 |

**Table 2. Effect of inoculation of *Glomus fasciculatum* on the total number of leaves per plant of cassava at graded levels of NPK**

| Treatments | Total number of leaves per plant | | | | |
|---|---|---|---|---|---|
| | Sampling period in days | | | | |
| | 30 | 60 | 90 | 120 | 150 |
| Control | 20.31 | 33.69 | 47.03 | 61.82 | 84.47 |
| AM alone | 21.67 | 36.19 | 52.21 | 70.95 | 96.24 |
| 25% NPK (25:25:40)/ha | 24.85 | 44.32 | 67.36 | 90.12 | 126.50 |
| 50% NPK (50:50:80)/ha | 26.23 | 45.97 | 68.73 | 96.86 | 133.87 |
| 75% NPK (75:75:120)/ha | 26.38 | 46.17 | 70.54 | 98.91 | 138.03 |
| 100% NPK (100:100:160)/ha | 26.89 | 46.86 | 69.83 | 100.47 | 139.32 |
| AM+25% NPK/ha | 25.97 | 45.96 | 68.43 | 95.93 | 131.79 |
| AM+50% NPK/ha | 27.32 | 47.23 | 70.86 | 100.67 | 140.99 |
| AM+75% NPK/ha | 27.39 | 47.95 | 71.66 | 101.26 | 142.20 |
| AM+100% NPK/ha | 27.45 | 48.33 | 72.13 | 103.86 | 143.46 |

**Table 3. Effect of inoculation of *Glomus fasciculatum* on the total number of roots per plant of cassava at graded levels of NPK**

| Treatments | Total number of roots per plant | | | | |
|---|---|---|---|---|---|
| | Sampling period in days | | | | |
| | 30 | 60 | 90 | 120 | 150 |
| Control | 15.09 | 20.16 | 23.40 | 25.27 | 26.50 |
| AM alone | 16.84 | 21.93 | 27.36 | 30.55 | 32.19 |
| 25% NPK (25:25:40)/ha | 17.00 | 22.29 | 30.67 | 33.47 | 34.09 |
| 50% NPK (50:50:80)/ha | 17.25 | 22.96 | 31.90 | 35.17 | 35.84 |
| 75% NPK (75:75:120)/ha | 17.88 | 23.08 | 31.96 | 35.70 | 36.76 |
| 100% NPK (100:100:160)/ha | 18.72 | 23.13 | 32.84 | 36.89 | 37.13 |
| AM+25% NPK/ha | 17.67 | 22.89 | 31.73 | 34.81 | 35.25 |
| AM+50% NPK/ha | 18.83 | 24.83 | 33.00 | 36.18 | 36.88 |
| AM+75% NPK/ha | 19.08 | 24.90 | 33.20 | 36.72 | 36.99 |
| AM+100% NPK/ha | 19.76 | 25.00 | 33.93 | 37.06 | 37.27 |

**Table 4. Effect of inoculation of *Glomus fasciculatum* on the root length of cassava at graded level of NPK**

| Treatments | Root length (cm) | | | | |
|---|---|---|---|---|---|
| | Sampling period in days | | | | |
| | 30 | 60 | 90 | 120 | 150 |
| Control | 16.79 | 25.19 | 36.48 | 48.06 | 52.10 |
| AM alone | 17.52 | 27.33 | 39.79 | 53.39 | 60.90 |
| 25% NPK (25:25:40)/ha | 18.67 | 28.65 | 40.66 | 55.43 | 62.00 |
| 50% NPK (50:50:80)/ha | 19.23 | 29.10 | 41.85 | 58.00 | 66.10 |
| 75% NPK (75:75:120)/ha | 19.32 | 29.80 | 42.39 | 59.69 | 69.33 |
| 100% NPK (100:100:160)/ha | 19.36 | 29.84 | 43.23 | 60.86 | 70.80 |
| AM+25% NPK/ha | 19.29 | 29.72 | 41.64 | 57.85 | 65.43 |
| AM+50% NPK/ha | 20.21 | 30.33 | 43.64 | 60.62 | 70.06 |
| AM+75% NPK/ha | 20.90 | 30.35 | 43.98 | 61.03 | 72.20 |
| AM+100% NPK/ha | 21.02 | 30.49 | 44.71 | 61.98 | 73.90 |

**Table 5. Effect of inoculation of *Glomus fasciculatum* on the average number of tubers, tuber yield and starch content of cassava at graded levels of NPK**

| Treatments | Number of tubers/plant | Tuber yield | | Starch content (% dry weight) |
|---|---|---|---|---|
| | | Kg/plant | Tonnes/ha | |
| Control | 4.40 | 1.156 | 16.790 | 66.46 |
| AM alone | 5.60 | 1.420 | 20.571 | 70.78 |
| 25% NPK (25:25:40)/ha | 6.20 | 1.910 | 26.124 | 77.65 |
| 50% NPK (50:50:80)/ha | 6.50 | 2.040 | 29.497 | 80.47 |
| 75% NPK (75:75:120)/ha | 6.50 | 2.205 | 31.973 | 83.91 |
| 100% NPK (100:100:160)/ha | 6.80 | 2.330 | 33.120 | 84.89 |
| AM+25% NPK/ha | 6.70 | 1.970 | 29.154 | 80.30 |
| AM+50% NPK/ha | 6.80 | 2.325 | 32.980 | 84.76 |
| AM+75% NPK/ha | 6.90 | 2.358 | 33.649 | 85.29 |
| AM+100% NPK/ha | 7.00 | 2.360 | 34.152 | 85.89 |

Tomato plants inoculated with AM fungi increased the fruit yield (Arangarasan, 1994). Quality of wheat grains is affected by many factors, like nutrient status. Nitrogen nutrition determined the grain yield, flour protein content and milling quality (Dyke and Stewart, 1992). Different levels of N and P with biofertilizer was found to be significant on number of flowers, flower yield and quality of flower in marigold (Arora and Jaswinder Singh, 1980). In the present study, AM inoculation significantly increased the number of tubers, tuber weight and starch content of cassava at all the levels of NPK. They increased up to 270 DAP. The inoculated plants showed higher number than the uninoculated plants. The tuber yield, tuber weight and starch content of inoculated plants that received 50 per cent NPK/ha was on par with the un inoculated plants supplied with 100 per cent NPK/ha (Table 5).

## REFERENCES


Aldon, E.F., 1975. Endomycorrhizae enhance survival and growth of four wing salt bush on coal mines spoils. VSDA Forest Service Research Note. RM-294.

Allen, M.F., W.K. Smith, T.S. Moore Jr. and M. Christensen, 1981. Comparative water relations and photosynthesis of mycorrhizal and non-mycorrhizal Bouteloua gracilis H.B.K. Lag ex Steud. *New Phytol*., 88: 683-643.

Arangarasan, V., 1994. Studies on VA-mycorrhizal symbiosis in CO3 tomato. M.Sc. (Ag). Thesis, Annamalai University, Annamalainagar.

Arora, J.S. and Jaswinder Singh, 1980. Effect of N and P2O5 on growth and flower production of marigold. National Seminar on Production Technology for commercial flower crops. 29 and 30 Aug., Tamil Nadu Agricultural University, Coimbatore, p. 83-84.

Ashokan, P.K., R. Vikraman Nair, V.L. Geetha Kumari and E.K. Lalithabai, 1988. Response of local and hybrid varieties of cassava to nitrogen and potassium fertilizers. *J. Root Crops*, 14: 17-22.

Bagyaraj, D.J. and A. Manjunath, 1980. Response of crop plants to vesicular-arbuscular mycorrhiza inoculation in an unsterile Indian soil. *New Phytol.,* 85: 33-36.

Champawat, R.S., V.N. Pathak and K.R. Krishna, 1987. Influence of vesicular arbuscular mycorrhizal fungi on growth and nutrient uptake in barley. *Curr. Sci.,* 56: 1294-1295.

Daft, M.J. and A.A. El-Giahmi, 1976. Studies on nodulated and mycorrhizal peanuts. *Annuals of Applied Biology*, 83: 273-276.

Dyke, G.V. and B.A. Stewart, 1992. Grain yield, milling quality and flour protein in relation to variety and nitrogenous fertilizer. *Plant Var. Seeds*, 5: 115-128.

Frank, A.B., 1885. Uber die anf Wurzelsymbiose beruhende

Erahrung gewisser Baume duch. Pilz. Ber. Oxdt. Bot. Ges., 3: 128-145.

Ganesan, V. and A. Mahadevan, 1994. Effect of mycorrhizal inoculation of cassava, elephant foot yam and taro. *J. Root Crops*, 20: 1-14.

George, E., K.U. Haussler, D. Vetterlein, E. Gorgus and H. Marschner, 1992. Water and nutrient translocation by hyphae of Glomus mosseae. *Can. J. Bot.,* 70: 2130-2173.

Gerdemann, J.W., 1968. Vesicular-arbuscular mycorrhiza and plant growth. *Annu. Rev. Phytopathol*., 6: 397-418.

Gray, L.E. and J.W. Gerdemann, 1973. Uptake of sulphur-35 by vesicular arbuscular mycorrhiza. *Plant Soil*, 39: 687-689.

Harley, J.L. and S.E. Smith, 1983. Mycorrhizal symbiosis. Academic Press, London and New York, p. 483.

Howeler, R.H., 1982. Mycorrhiza project. In: cassava program, CIAT Annual Report, 1981. O2CE (3) 82, Cali, Colombia, pp. 57-67.

Jeffries, P., T. Spyropoulos and E. Vardavaleis, 1989. Vesicular-arbuscular mycorrhizal status of various crops in different agricultural soils of Northern Greece. Prolong Fert. *Soils*, 5: 333-337.

Marschner, H. and B. Dell, 1994. Nutrient uptake in mycorrhizal symbiosis. *Plant Soil*, 159: 89-102.

Mosse, B., 1973. Advances in the study of vesicular arbuscular mycorrhiza. Ann. Rev. *Phytopathol*., 11: 171-176.

Munson, 1980. Potassium for Agriculture - A situation analysis. Potash and Phosphorus Institute, Atlanta.

Rhodes, L.H. and J.W. Gerdemann, 1980. Nutrient translocation in vesicular-arbuscular mycorrhizae. *In:* Cellular interactions in symbiosis and parasitism. (Eds.) C.B. Cook, P.W. Pappas and E.D. Rudolph. The Ohio State University Press, Columbus.

Saif, S.R. and A.G. Khan, 1977. The effect of vesicular-arbuscular mycorrhizal association on the growth of cereals III. Effects on barley growth. *Plant Soil,* 47: 17-26.

Schenck, N.C. and M.K. Kellam, 1978. The influence of vesicular- arbuscular mycorrhizae on disease development. *Fla. Agric. Exp. Stn. Bull.,* 68: 799.

Season and Crop Report, 2005. Department of Economics and Statistics.

Sitaramaiah, K., R. Khanna and R. Khanna, 1997. Effect of Glomus fasciculatum on growth and chemical composition of maize. *J. Mycol. Plant Pathol.,*27: 21-24.

Sivaprasad, P. and P.V. Rai, 1987. Mechanism of enhanced nodulation in vesicular-arbuscular mycorrhizal pigeonpea (*Cajanus cajan* (L.) Mill.). *Agric. Res. J. Kerala,* 25: 99-102.

Sivaprasad, P., A.K. Inasi and U.M. Kunju, 1989. Response of cassava and sweet potato intercropped in the coconut garden to VA mycorrhiza inoculation. *J. Root Crops,* 15: 49-53.

Suvercha, T. and K.G. Mukerji, 1988. Influence of VAM fungi on the growth of two cultivars of *Capsicum annum. In:* Mycorrhiza for Green Asia. Proc. First Asian Conf. On Mycorrhiza held at University of Madras, Madras, India, Jan. 29-31 (Eds. Mahadevan, A., N. Raman, and K. Natarajan) pp. 262-264.

Thangaraju, M., R. Rajamanickam and D. Kandasamy, 1986. Response of maize and soybean to the inoculation of different isolates of VA-mycorrhizal fungi. Paper presented at NaH. Seminar on Microbial Ecology held during Jan. 1986 at Tamil Nadu Agric. Univ., Coimbatore, India, Abst. pp. 24.

*******