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CORRELATION BETWEEN VAM SPORE DENSITY IN SOIL AND VAM INFECTION IN ROOTS OF WHEAT

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ABSTRACT

Results of three successive years' studies under experimental plot condition showed a significant correlation between VAM infection in roots of six wheat varieties viz., Blue silver, Maxi-Pak, Pak-70, Pavon, Sindh-83, and ZA-77 and density of VAM spores in their rhizospheric regions. VAM infections in roots of all the six varieties initially established then progressed in sigmoid fashion till harvesting stage. While the density of VAM spores reduced significantly ($P<0.01$) in rhizospheric regions on sowing seeds of wheat varieties then increased exponentially and reached the highest at harvesting stage. The regression line showed the dependency of Y-variable on X-variable with 38 to 68 % variation.

Key words: VAM, spore, infection, wheat root, wheat varieties

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the principal diet of the people of Pakistan (Hafiz, 1986) and nearly 40 % of the world (Wiese, 1977). The better growth of wheat is our basic need to compensate its shortage and to boost the economy of Pakistan. Vesicular-arbuscular mycorrhizal fungi-VAM is the most important symbiotic microorganisms ubiquitously present in soil which increases the growth and yield of plants in many ways (Sujan, 1997). The VAM in association with plants roots carried out the exchange of nutrients between autobiont and symbiont (Cook, 1977). It has already been described that VAM fungi enhance the uptake of various nutrients including Cu, Ca, Mn, Mg, S, Al, Fe, K, and Zn in general but phosphorus in particular (Bagyaraj, 1986; Wild, 1988; Lynch, 1987). Therefore, VAM theoratically increases the growth and yield of plants by increasing the uptake of phosphorus along with various other minerals (Nicolson, 1967; Gerdeman, 1968; Hall, 1988; Reena and Bagyaraj, 1990; Verma and Jamaluddin, 1995).

The present study deals with complete and thorough statistical analysis on correlation ship between VAM spores density in soil and their infection in roots of six wheat varieties (Blue silver, Maxi-Pak, Pak-70, Pavon, Sindh-83, and ZA-77). However, yet now such studies have not been carried out in Sindh, Pakistan and even in various parts of the world. The available data would help us to understand the activities of VAM fungi in soil / roots and to carry out the researches on its inoculation process to increase the growth and yield of wheat varieties of Sindh, Pakistan.

MATERIALS AND METHODS

Design of experimental plots and collection of soil samples:

To study the density of VAM spores in soil and their infection in wheat roots; experimental plots of size 120 m^2 were established in blocks at Karachi University Campus by randomized complete block design. The soil samples were collected from experimental plots by a stratified random sampling plan before and after sowing the wheat seeds. Each soil sample consists of three replicas each of 100 g weight.

Before sowing the wheat seeds; soils samples were collected from each plot by small shovel from the area of 15 cm diam. of 10 cm depth after elimination of organic debris and humus particles from the site of collection. Each sample was collected in transparent polyethylene bags of 30 cm^2 size. The collected samples were brought to the laboratory for further processing. The VAM spores were extracted from soil samples by wet sieving and decanting method (Gerdemann and Nicholson, 1963) followed by sucrose centrifugation method (Jenkins, 1964) and quantified on a counting dish (Southy, 1985).

After sowing the seeds of six wheat varieties soils samples were collected at 10 days interval from rhizospheric regions of each var. During sampling the whole root system of each var. was dug out carefully so as not to lose its lateral and fine feeder roots. The whole excavated root system was then shaken off gently to discard its excess compact mass of soil associated with roots. However, the soil closely adhering to root system was retained and

collected in polyethylene bags of same size as described above. The weight and replicas for each sample of each var. was also kept same as above.

Sowing of wheat seeds; collection of root samples and study of VAM infection:

Surface disinfected seeds of each of 6 wheat varieties were sown in plots separately in 3 straight rows each of 100 cm length @ 10 seeds / row / plot by leaving an inter-distance of 10 cm between the seeds. The inter-distances between the rows were kept 30 cm. Each var. was replicated three times. The seeds were allowed to grow up to the harvesting stage. During growing period plots were irrigated with normal tap water.

Root samples of 6 wheat varieties were collected from experimental plots at Karachi University Campus by a stratified samplings method. The samplings was performed at 10 days interval by watering the plots 2 h prior to excavation of roots to minimize the damage of lateral and fine feeder roots which are primary sites of VAM infection (Kormanic and McGraw, 1982). Excavated roots were collected in transparent polyethylene bags (40 x 30 cm. size) and brought into the laboratory. VAM infections in the tissues of root samples were determined by the technique of Philips and Hayman (1970) modified by Koske and Gamma (1989). However, the VAM infection was assessed (quantified) in root tissues by slide length method (Giovannettii and Mosse, 1980).

RESULTS

VAM spores in rhizospheric regions of all the 6 wheat varieties was reduced on sowing wheat seeds as compared to the VAM spores population in soil before sowing. The wheat varieties Blue Silver, Pak 70 and Pavon showed reduction in VAM spores population up to 30 days, Mexi-Pak and Sindh-83 up to 40 days whereas var. ZA-77 showed up to 50 days of growth (**Figs. 1A -1F**). Of the six wheat varieties Mexi-Pak showed slight reduction in population of VAM spores during the aforesaid growth periods as compared to other 5 wheat varieties After such reduction VAM spores population exponently increased and reached to maximum at harvesting stage. But differed wheat varieties wise. At such stage highest VAM spores population was observed in the rhizospheric region of var. Blue Silver (1690 spores/ 100 g soil) and lowest in the rhizospheric region of wheat var. Mexi-Pak (1280 spores/100 g soil) (**Figs. 1A and 1B**). The remaining 4 wheat varieties showed VAM spores population in between the two extremes (**Figs. 1 C, D, E and F**).

Table 1. Correlation analysis between VAM spores in soil and VAM infection percentage in roots of wheat vras.

X-variable	Y-Variable	Correl. Coeffi. r	S.E	Slope (b)	S.E.	Y Intercept (a)	S.E.	Prob. Level
B. Silver								
VAM infec.	VAM spore	0.69	±0.07	5.96	±0.67	778.48	±1.69	0.001
VAM spore	VAM infec.	0.69	±0.07	0.08	±0.00	-37.27	±1.69	0.001
Maxi Pak.								
VAM infec.	VAM spore	0.63	±0.08	4.70	±0.62	762.79	±7.19	0.001
VAM spore	VAM infec.	0.63	±0.08	0.08	±0.01	-42.13	±7.19	0.001
Pak-70								
VAM infec.	VAM spore	0.80	±0.06	7.91	±0.64	703.70	±1.30	0.001
VAM spore	VAM infec.	0.80	±0.06	0.08	±0.00	-43.16	±1.30	0.001
Pavon								
VAM infec.	VAM spore	0.68	±0.08	5.99	±0.69	718.97	±4.88	0.001
VAM spore	VAM infec.	0.68	±0.08	0.07	±0.00	-30.33	±4.88	0.001
Sindh-83								
VAM infec.	VAM spore	0.75	±0.07	5.33	±0.51	774.25	±1.30	0.001
VAM spore	VAM infec.	0.75	±0.07	0.10	±0.01	-66.19	±2.01	0.001
ZA-77								
VAM infec.	VAM spore	0.62	±0.08	5.49	±0.76	696.64	±2.37	0.001
VAM spore	VAM infec.	0.62	±0.08	0.07	±0.00	-18.15	±2.37	0.001

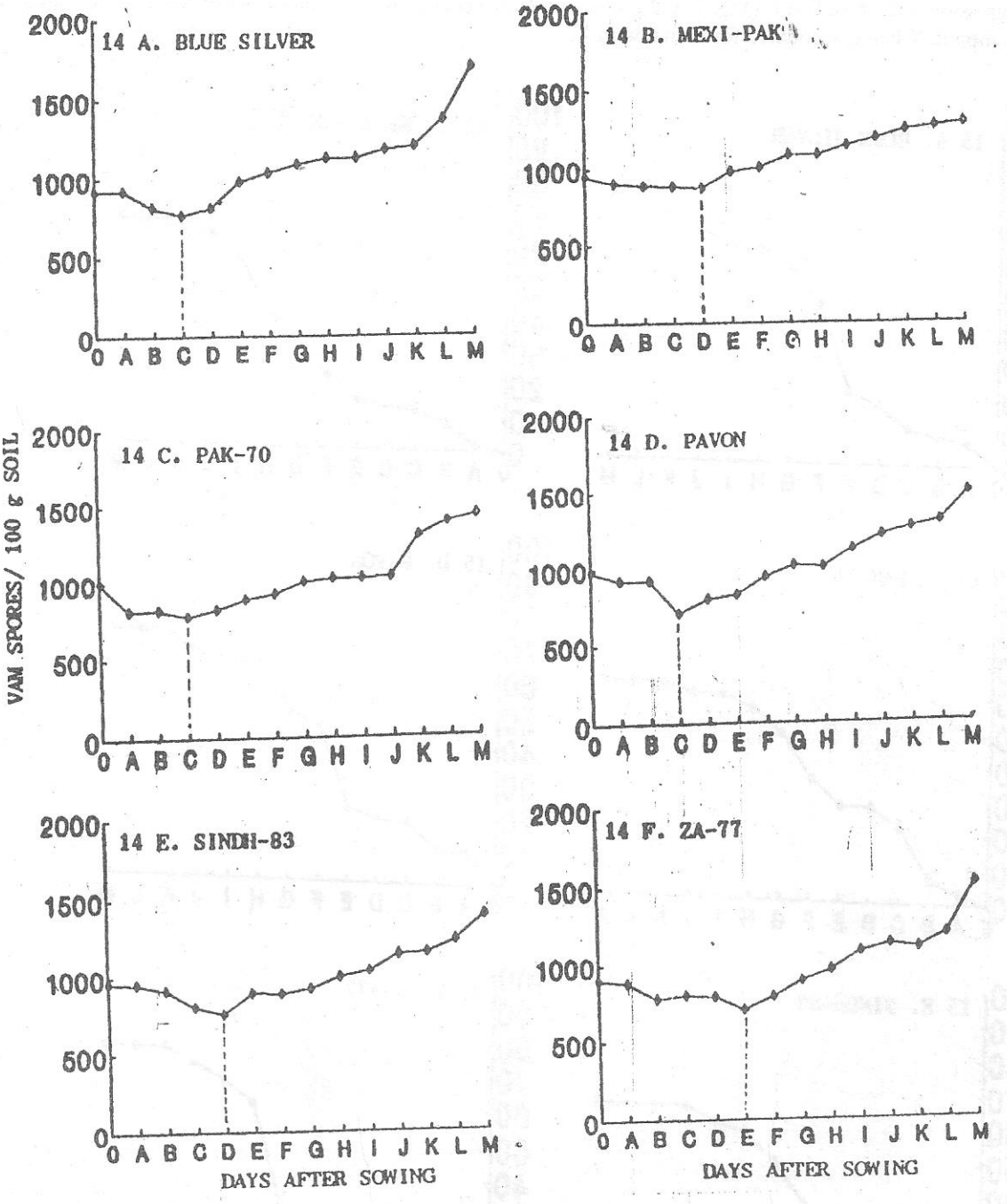

Fig.1 A-F. The pattern of increase of VAM spores population in the rhizospheric regions of 6 wheat varieties. The alphabets on X axis represent the time after sowing seeds at 10 days interval.

Roots of all the 6 wheat varieties were found to be infected with VAM fungi after 10 days of sowing then increased exponentially in sigmoid fashion (**Figs. 2A-2F**). The pattern of increase was almost same in all wheat varieties However, the var. Blue Silver showed maximum VAM infection percentage in its root tissues (83 %) while it was observed lowest in wheat var. Mexi-Pak (61 %) (**Figs. 2A and 2b**). The rest of the 4 wheat varieties showed in between these two extremes (**Figs. 2 C, D, E and F**).

The data on number of VAM spores in rhizospheric region correlated at regular intervals with VAM infection percentage in roots of 6 wheat varieties The Correlation Analysis of the data (Table 1) showed a significant positive correlation-ship between them. The values of correlation coefficient "r" for each wheat varieties are given in Table

1. The regression line of each var. (**Fig. 3 A-F**) showed the dependency of Y-variable on the X-variable, with 38 to 64 % variation in Y being accounted for variation in X.

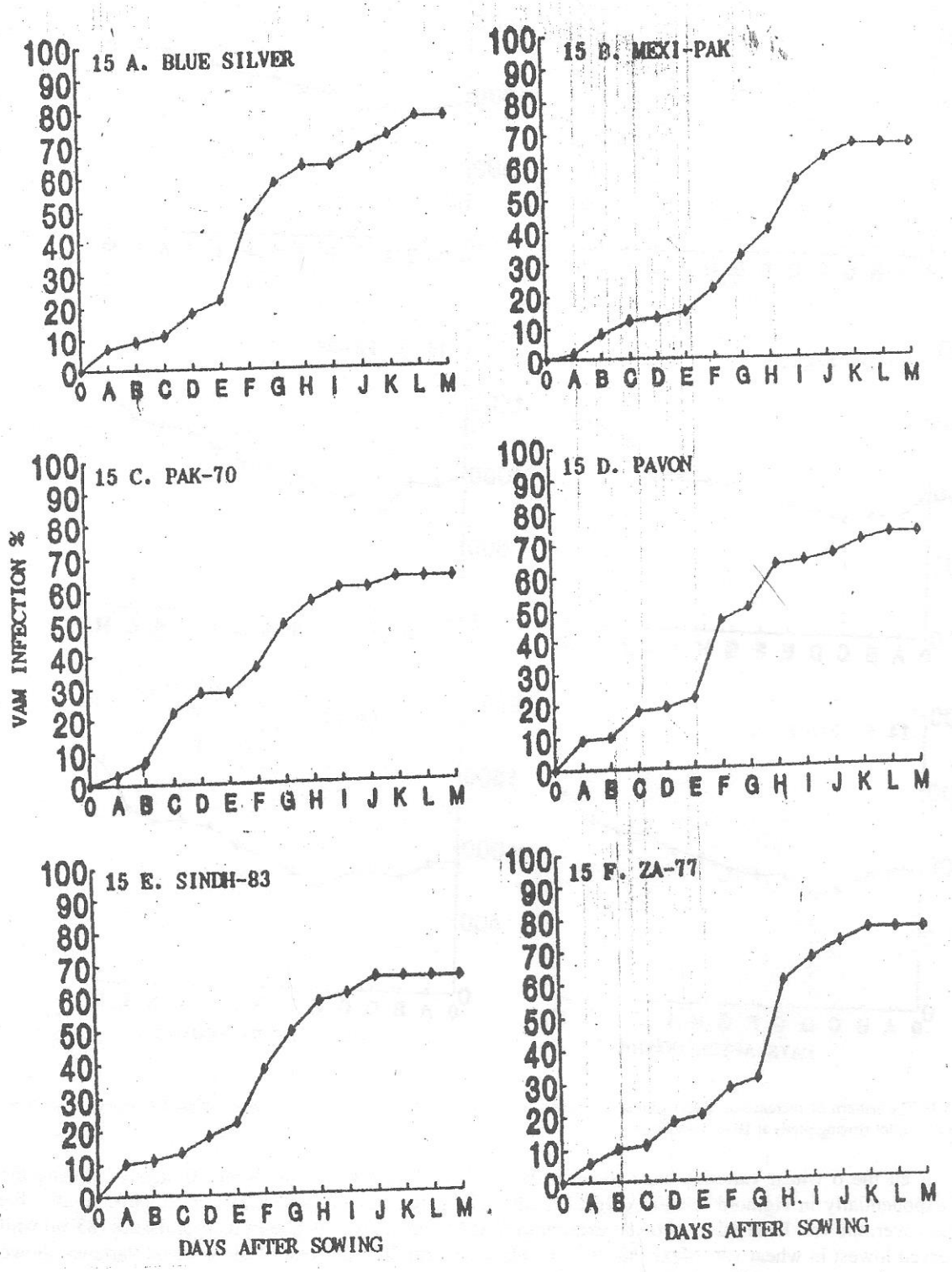

Fig.2 A-F. The pattern of increase of VAM infection percentage in roots of 6 wheat varieties. The alphabets on X axis represent the time after sowing seed at 10 days interval.

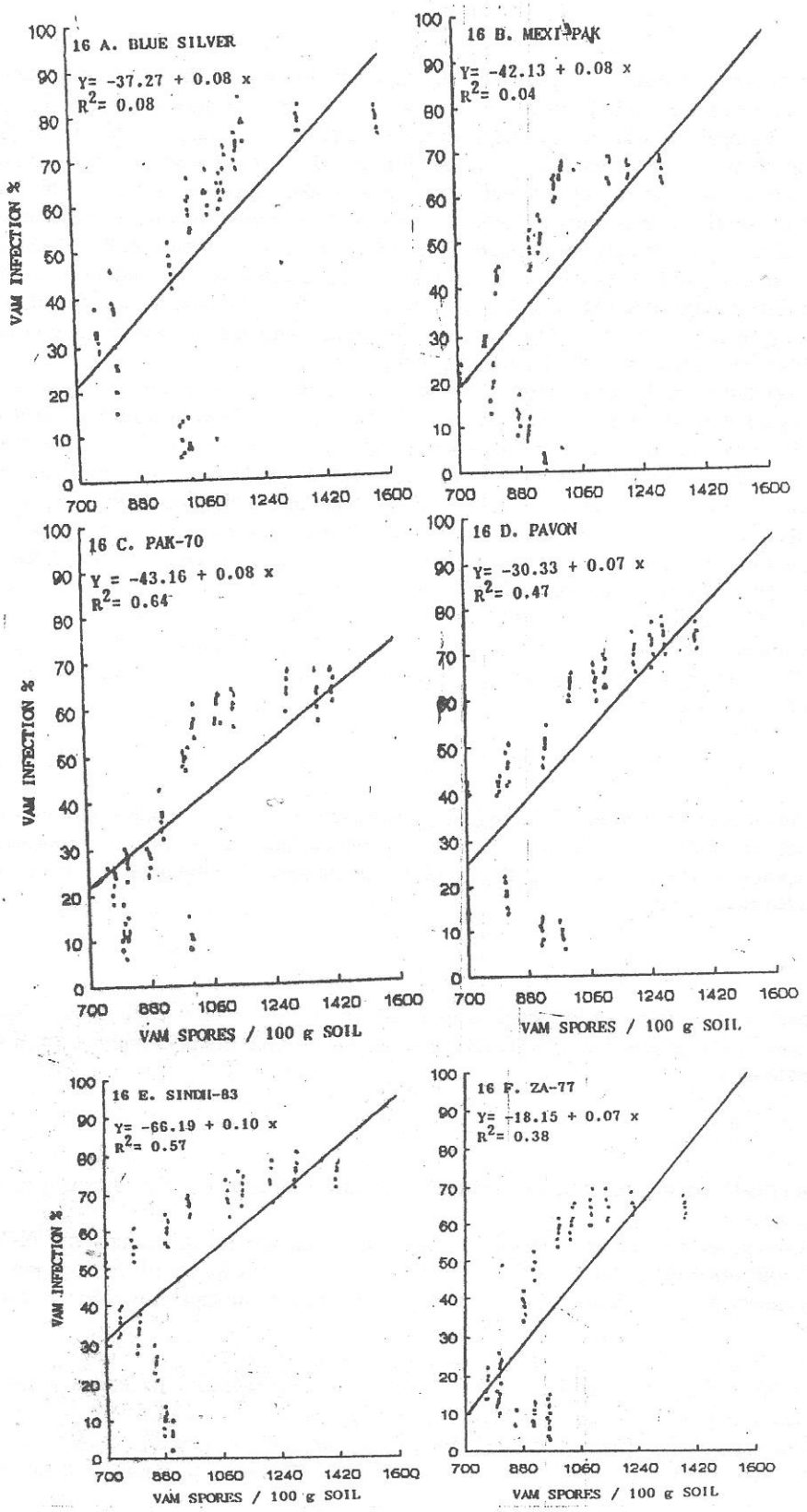

Fig.3 A-F. The regression lines between VAM spores in soil and its infection percentage in root tissues of 6 wheat varieties, alongwith Y and R^2 valus.

DISCUSSION

The data of the experiments were analyzed statistically for the first time to observe the exact correlation-ship between VAM spores in soil and their infection % in roots of wheat varieties at various stages of growth. Since prior to this findings, such type of the analysis was not available to us at least from our part of the world (Sindh, Pakistan). The correlation coefficients "r" of the data (Table 1 and **Fig. 3 A-F**) showed a positive correlation-ship between number of VAM spores in rhizospheric regions and their infection percentage in roots of all the 6 wheat varieties The population of VAM spores in rhizospheric region is found to be decreased initially then progressively increased and reached to the highest level at harvesting stage (**Figs. 1A – 1F**). Such increase in the VAM spores population was similar to the result of Saif (1977) and Baylis (1967) who found a positive correlation between host age and mycorrhizal infection. The pattern of VAM infection % in roots of the 6 wheat varieties was found to be as sigmoid fashion (**Figs. 2A – 2F**). Such pattern of VAM infection in different plants has already been described by many workers (Mosse, 1981; Saif, 1977; Sutton, 1973; Land and Shonbeck, 1991).

However, the results of correlation on VAM spores in rhizospheric region and VAM infection in roots have been controversially reported by many workers. Khan (1972) stated that the extent of VAM infection is dependent to its spores in soil. Iqbal *et al.* (1975) found the number of Endogone spores (former name of VAM) and the extent of their infection had no correlation-ship. Giovannetti (1985) however, obtain a good correlation-ship between the extent of mycorrhizal infection and total number of VAM spores in soil. Land and Schonbeck (1991) reported that there was no correlation between myccorrhizal colonization of roots and VAM spores density in any type of soil. Abbot and Robson (1991) stated that the abundance of VAM infection within the roots could be correlated to the number of VAM spores in soil. The correlation between the extent of mycorrhizal infection and number of spores in soil of wheat fields (Hayman, 1970) and maize (Daft and Nicolson, 1972) had been positively related whereas Redhead (1971) stated that number of VAM spores in soil was not significantly correlated with root infections. Jamaluddin and Pratiksha (1996) stated that VAM infection increased with the age of seedlings but the spore population did not show any definite correlation.

CONCLUSION

On the basis of our findings it is concluded that VAM spores present in soil of wheat reduced in number after causing initial infection but later on multiplication in or out root tissues increase the rate of infection, sporulate and showed highest number of spores at maturity of crop that persists till harvesting supported by (Khan, 1972; Giovannetti, 1985; Abbot and Robson, 1981).

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