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Effect of Mycorrhiza and Phosphorus Fertilizer on some Characteristics of Black Cumin

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ABSTRACT: Approximately 80% of the world population depends on medicinal plants for their health and healing. *Nigella sativa* is an annual flowering plant, native to southwest Asia. It grows to 20 to 30 cm (7.9 to 12 inch) tall, with finely divided, linear (but not thread-like) leaves. Phosphorus is essential for the general health and vigorous all in plant some specific factor that have been associated to phosphorus are root development increasing stack and more stem strength ,improve flower formation and seed production more uniform and earlier crop maturity increase nitrogen fixing capacity of legumes ,improve in crop quality and resistant to plant disease. The field experiment was laid out in randomized complete block design with factorial design with three replications. Treatments included phosphorus fertilizer (0, 30, 60 and 90kg) and mycorrhiza (No mycorrhiza, *Glomus intraradices* and *Glomus mosseae*). Analysis of variance showed that the effect of mycorrhiza and phosphorus on all characteristic was significant.

Key words: *Nigella sativa*, Plant height, Seed yield, Biological yield, Oil percent

INTRODUCTION

Medicinal plants are used to cure many ailments that are either non-curable or seldomly cured through modern systems of medicine. Approximately 80% of the world population depends on medicinal plants for their health and healing (Aliyu, 2003). Societal motivations to use herbs are increasing due to concern about the side effects of synthetic drugs. Many botanicals and some dietary supplements are good sources of antioxidants and anti-inflammatory compounds (Balasubramanian and Palaniappan, 2001). Quality in medicinal plants is more important than other plant products. Environmental factors have an important role on plant growth. Some of these factors such as irrigation and manure can be controlled by human. Both of them are essential to increase yield and quality of plants (Singh and Goswami, 2000). Because the need of increasing the medicinal plant production all over the world, its production became an ultimate goal to meet the great increase of population to avoid chemical therapy side effects on human health through utilization of the medical herbs. However, the use of the most suitable and recommended agricultural practices in growing such crops could provide the producers with higher income, in comparison with many other traditional crops (Hassan *et al.* 2012). Black cumin, *Nigella sativa* L. plant belongs to Ranunculaceae family, common known as black cumin is cultivated for seed yield and oil production. The whole seeds contain 30-35 % of oil which has several uses for pharmaceutical and food industries (Ustun *et al.* 1990). The black cumin seed cake is a by-product obtained from the black cumin seeds with cold pressing and it is used in the production of bio-oil (Sen and Kar 2012). *Nigella sativa* is an annual flowering plant, native to southwest Asia. It grows to 20 to 30 cm (7.9 to 12 inch) tall, with finely divided, linear (but not thread-like) leaves. The flowers are delicate, and usually coloured pale blue and white, with 5 to 10 petals. The fruit is a large and inflated capsule composed of 3 to 7 united follicles, each containing numerous seeds. The seed is used as a spice. Origian Black cumin is rarely available so *N. sativa* is widely used instead, in India *Carum carvi* is the substitute. {cumins are from Apiaceae or Umbelliferae (both names are allowed by the ICBN) family but *N. sativa* is from Ranunculaceae family} Black cumin (not *N. sativa*) seeds come as paired or separate carpels, and are 3 to 4 mm long. They have a striped pattern of nine ridges and oil canals, and are fragrant (Ayurveda says "Kaala jaaji sugandhaa cha" =Black cumin seed is fragrant itself), blackish in colour, boat-shaped, tapering at each extremity, with tiny stalks attached; has been used for medicinal purposes for centuries, both as a herb and pressed into oil, in Asia, Middle East, and Africa.

It has been traditionally used for a variety of conditions and treatments related to respiratory health, stomach and intestinal health, kidney and liver function, circulatory and immune system support, as analgesic, anti-inflammatory, antiallergic, antioxidants, anticancer, antiviral and for general well-being. *N. sativa* oil (not Black cumin seed oil) contains nigellone, which protects guinea pigs from histamine-induced bronchial spasms (Oxford Uni, 2000). It has branches, leaves and soft blue flowers and its seed is black and small. Black seed is cultivated throughout the Mediterranean region, in Pakistan and India. This plant can withstand salt and is regarded as having a sweet flavor (Akram Khan 1999). Black seed's leaf color is gray/green. Its capsule fruit has five parts and its seeds are usually small (1-5 Mg) in dark gray or black color. The ripe seed of Black seed contains 7 % moisture, 4.34 % ash, 23 % protein, 0.39 % fat, 4.99 % starch and 5.44 % raw fiber (Zargari 1990). Phosphorus is essential for the general health and vigorous all in plant some specific factor that have been associated to phosphorus are root development increasing stack and more stem strength ,improve flower formation and seed production more uniform and earlier crop maturity increase nitrogen fixing capacity of legumes ,improve in crop quality and resistant to plant disease. The early supply of P to the crop is influenced by soil P and P application as well as by soil and environmental conditions that affect P phytoavailability and root growth. Roots absorb P ions from the soil solution. The ability of the plant to absorb P will depend on the concentration of P ions in the soil solution at the root surface and the area of absorbing surface in contact with the solution. Mass flow and diffusion govern the movement of P ions in soil, with diffusion being of primary importance (Barber *et al.* 1963; Barber 1984). Therefore, the rate of P uptake is related to the rate of water uptake and P concentration in soil solution. The P ions near the root hairs are absorbed quickly, resulting in a depletion zone with a decreasing P concentration gradient near the root surface (Walker and Barber 1962; Bagshaw *et al.* 1972). Diffusion occurs in the depletion zone down the concentration gradient (Barber 1984). In highly P fertilized soils, the P concentration in soil solution is high (>1 ppm) and the depletion zone is readily replenished, but the replenishment is slow when soil solution P is low especially for soil solid phase with a low buffer capacity (Morel 2002). Ecosystems by encouraging eutrophication (Schindler 1977). Therefore it is important that P management balances the goal of providing sufficient P to the crop to optimize crop yield with the goal of avoiding excess P and environmental risk. Where plant-available P in the soil is low, efficient applications of fertilizer P or manure and/or improved mycorrhizal association may improve crop P levels. The reserves of P in the world are finite and are gradually being depleted (Tiessen 1995). Thus there is a need to develop agricultural systems based on meeting minimum P requirements for crops. Management of the cropping system to improve the availability of P to the crop early in the growing season may improve P nutrition while reducing the potential for excess accumulation of P in soils and risk of movement of P into water systems. This will require a detailed understanding of the processes governing soil P cycling and availability in which mycorrhizal symbiosis may play a significant role. This paper discusses P dynamics in agricultural systems and outlines the potential for improving P nutrition of crops by enhancing mycorrhizal associations and improving P fertilizer use efficiency for sustainable crop production. The importance of adequate tissue P concentrations during early-season growth has been reported in many different crop species (Grant *et al.* 2001). Studies in Ontario have shown that corn grain yield was strongly affected by P supply and tissue P concentration in the L4 to L5 stage, rather than by P concentration later in growth (Barry and Miller 1989; Lauzon and Miller 1997). Gavito and Miller (1998a) reported that enhanced early-season P nutrition in corn increased the dry matter partitioning to the grain at later development stages. Similarly, in wheat (Gericke 1924, 1925; Boatwright and Viets 1966) and barley (Brenchley 1929), P supply prior to 6 wk of growth had a much greater effect on final grain yield than P supply in later growth. Intermediate wheatgrass (Boatwright and Viets 1966), broadleaved willow (Atkinson and Davidson 1971), radish and lettuce (Avnimelech and Scherzer 1971) and a variety of other crops (Crafts-Brandner 1992; Elliott *et al.* 1997) also showed persistent reductions in growth after early-season P deficiencies. In contrast, studies by Plénet *et al.* (2000) reported the maximum difference in biomass production of corn under P deficiency in field conditions at 400 to 600 growing degree days (°C) after sowing. The aboveground biomass accumulation was severely reduced (–60%) during early stages of corn growth although only slight differences were observed on biomass accumulation at harvest and grain yield. The spectacular effect of P deprivation on early reduction in shoot growth is explained by a slight although rapid stimulation of root growth, which has often been reported (Mollier and Pellerin 1999). A major impediment to exploiting mycorrhizal association in agricultural systems is that mycorrhizal association tends to decline as P concentration in the plant increases (Menge *et al.* 1978; Lu *et al.* 1994; Valentine *et al.* 2001). Higher tissue P in the plant reduces the production of spores (De Miranda and Harris 1994) and of secondary external hyphae (Bruce *et al.* 1994).

Exudation from host plant roots of signal molecules that encourage hyphal branching is enhanced by P limitation in host roots (Nagahashi *et al.* 1996; Nagahashi and Douds 2000). Therefore, increasing P status of the root may reduce the secretion of these signal molecules, thus reducing hyphal branching and mycorrhizal association. Phosphorus status of the root may affect membrane phospholipids, thus influencing membrane permeability and the release from the roots of carbohydrates that nourish the fungi (Graham *et al.* 1981; Schwab *et al.* 1991). Therefore, where P concentration in the plant is low, carbohydrate exudation will encourage mycorrhizal association, which then enhances the uptake of P from the soil. Muthukumar and Udaiyan (2000) reported that concentration of soluble carbon in cowpea root increased with decreasing tissue P levels. As root carbohydrate concentration increased, mycorrhizal association was enhanced, although cause and effect was not necessarily proven. In this study, the percentage root length with arbuscules and vesicles and sporulation was more closely associated with carbohydrate concentration than was the total percentage mycorrhizal colonization, indicating that carbohydrates may influence the nature of the association.

MATERIAL AND METHODS

The experiment was conducted at the khash (in iran) which is situated between 28° North latitude and 61° East longitude. Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics. The field experiment was laid out in randomized complete block design with factorial design with three replications. Treatments included phosphorus fertilizer (0, 30, 60 and 90kg) and mycorrhiza (No mycorrhiza, Glomus intraradices and Glomus mosseae). Data collected were subjected to statistical analysis by using a computer program MSTATC. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments` means.

RESULTS AND DISCUSSION

A. Plant height

Analysis of variance showed that the effect of mycorrhiza on Plant height was significant (Table 1). The maximum of Plant height (22.61) of treatments glomus mosseae was obtained (Table 2). The minimum of Plant height (20.6) of treatments control was obtained (Table 2). Analysis of variance showed that the effect of phosphorus on plant height was significant (Table 1). The maximum of plant height (23.28) of treatments 90 kg/ha was obtained (Table 2). The minimum of plant height (19.04) of treatments control was obtained (Table 2).

B. Seed yield

Analysis of variance showed that the effect of mycorrhiza on seed yield was significant (Table 1). The maximum of seed yield (492.08) of treatments glomus mosseae was obtained (Table 2). The minimum of seed yield (393.33) of treatments control was obtained (Table 2). Analysis of variance showed that the effect of phosphorus on seed yield was significant (Table 1). The maximum of seed yield (563.33) of treatments 90 kg/ha was obtained (Table 2). The minimum of seed yield (393.33) of treatments control was obtained (Table 2).

Table 1: Anova analysis of the black cumin affected by phosphorus fertilizer and mycorrhiza.

S.O.V	df	Plant height	Seed yield	Biological yield	Oil percent
R	2	8.963^{ns}	6633.3^{ns}	77794.5^{ns}	1.591^{ns}
Mycorrhiza	2	12.195^{*}	33643.7^{**}	293298^{*}	30.86**
Phosphorus	3	39.701^{**}	92272.9^{**}	1123427.3^{**}	398.9**
Mycorrhiza* phosphorus	6	0.272^{ns}	7752^{*}	18018.8^{ns}	12.33*
Error	24	24	2381	70892.5	3.39
CV (%)	-	8.279	10.73	19.43	7
*, **, ns: significant at p<0.05 and p<0.01 and non-significant, respectively.					

C. Biological yield

Analysis of variance showed that the effect of mycorrhiza on biological yield was significant (Table 1). The maximum of biological yield (1545.9) of treatments glomus mosseae was obtained (Table 2). The minimum of biological yield (1247) of treatments control was obtained (Table 2). Analysis of variance showed that the effect of phosphorus on biological yield was significant (Table 1). The maximum of biological yield (1758.9) of treatments 90 kg/ha was obtained (Table 2). The minimum of biological yield (921.9) of treatments control was obtained (Table 2).

D. Oil percent

Analysis of variance showed that the effect of mycorrhiza on oil percent was significant (Table 1). The maximum of oil percent (28.15) of treatments glomus mosseae was obtained (Table 2). The minimum of oil percent (25.36) of treatments control was obtained (Table 2). Analysis of variance showed that the effect of phosphorus on oil percent was significant (Table 1). The maximum of oil percent (35.19) of treatments 90 kg/ha was obtained (Table 2). The minimum of oil percent (19.71) of treatments control was obtained (Table 2).

Table 2: Comparison of different traits affected by phosphorus fertilizer and mycorrhiza.

Treatment	**Plant height**	**Seed yield**	**Biological yield**	**Oil percent**
Phosphorus fertilizer (kg/ha)				
0 (control)	19.04c	330d	921.9c	19.71d
30	20.88b	420c	1297.8b	23.16c
60	23.43a	501.67b	1501.2ab	27.12b
90	23.28a	563.33a	1758.9a	35.19a
Mycorrhiza				
Control (no mycorrhiza)	20.6b	393.33b	1247b	25.36b
Glomus intraradices	21.76ab	475.83a	1316.9b	25.38b
Glomus mosseae	22.61a	492.08a	1545.9a	28.15a
Any two means not sharing a common letter differ significantly from each other at 5% probability				

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