PLANT GROWTH PROMOTING EFFECT OF *Trichoderma* ON GROUNDNUT

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ABSTRACT

The study was conducted to evaluate the growth promoting influence of Trichoderma on groundnut, a major crop of Saurashtra region. The genus Trichoderma is an important asexual form of Ascomycota under Deuteromycotina belongs to a class of free living fungi beneficial to plants that are common in the soil and root ecosystems. Among various species of Trichoderma, T. harzianum and T. viride arisen as the most prominent species of the genus for crop diseases management. Application of 'Sawaj Trichoderma' (T. harzianum), the biocontrol product of Department of Plant Pathology, Junagadh Agriculturral University by the groundnut growers for the management of stem rot disease has been proved most successful since last 5-6 years. Treatment of Sawaj Trichoderma not only managed the disease but also increased pod yield in groundnut resulted in additional economic gain. These observations triggered to study the characters of Trichoderma beyond biocontrol agent in groundnut and this study was design to find out the growth promoting effect of two Trichoderma spp. on groundnut. It has been speculated that the seed application of T. harzianum + T. viride increased seed germination, chlorophyll content, shoot and root length and dry weight of leaves, shoot and root in groundnut. The other treatments of bioagents also influenced positively on said characters, although highest results were obtained in the seed treatment T. harzianum + T. viride. The positive effects on the different characters also reflected in the yield related characters of groundnut. The seed treatment of T. harzianum + T. viride either alone or in combinations performed well to increase number and weight of pods as well as test weight of kernels in groundnut. From this results, seed treatment of T. harzianum or T. viride or T. harzianum + T. viride are advocated in groundnut for better growth and higher outcome of pods.

KEY WORDS: Groundnut, Trichoderma harzianum, Trichoderma viride

INTRODUCTION

Groundnut is an annual legume crop and a major oilseed of tropical and subtropical countries, which is also known as 'peanut', 'earthnut', 'monkey nut' and 'goobers'. It is the 13th most important food crop and 4th most important oilseed crop of the world. It is commercially popular due to its superior edible oil quality and protein in the meal.

Trichoderma is an important genus of asexual ascomycota belongs to Deuteromycotina, class: Hyphomycetes, order: Monilliales and family: Moniliaceae, belongs toa class of free living fungi beneficial to plants that are common in the soil and root ecosystems. Large number of *Trichoderma* spp. are reported regarding for the management of plant diseases/pathogens by their various mechanisms includes competition, antibiosis, mycoparasitism, hyphal interactions, and enzyme secretion. Antifungal ability of two species of *Trichoderma*, *T. harzianum*a and *T. viride* arisen as the most prominent species of the genus. Along with the diverse antifungal mechanisms of *Trichoderma*, the ability to promote plant growth, to increase plant height, leaf area and dry weight, stronger root growth and nutrient uptake, secretion of plant growth regulatory factors and faster germination are reported in various crops. It has been reported in the literature that positive effect of *Trichoderma* on plant growth is independent ability and equally remarkable and significant as its antifungal ability because growth development has been observed in the absence of any detectable disease and in sterile soil. Therefore, now it is considered that the direct effects of this fungus on plant growth and development are crucially important for agricultural uses and for understanding the role of *Trichoderma* in natural and managed ecosystems (Windham *et al*., 1986; Chang *et al*., 1986; Baker, 1988; Ousley *et al*., 1993; Inbar *et al*., 1994; Ousley *et al*., 1994; Gupta and Sharma, 1995; Koch, 2001; Celar and Valic, 2005).

MATERIALS AND METHODS

The present investigation was undertaken to study the plant growth promoting effect of *Trichoderma* on groundnut. The study was conducted during *kharif* 2013 at the Research Farm, Department of Plant Pathology, Junagadh Agricultural University, Junagadh. Geographically Junagadh is situated at 21.50 ºN latitude and 70 ºE longitude with an altitude of 60 meters above the mean sea level. The soil of experimental site was medium black, alluvial in origin and poor in organic matter. The climate of the area represents tropical condition with semi-arid nature. The experimental materials consisted of semi-spreading type cultivar GG 20 of groundnut. The experimental trial was conducted in randomized block design replicated thrice. *T. harzianum* and *T. viride* (Sorghum isolates) was obtained from the Pathology laboratory, Department of Plant Pathology, JAU, Junagadh. Mass culture of *T. harzianum* and *T. viride* was prepared on sorghum grains were boiled up to two whistle in a pressure cooker. The mixture was cooled up to room temperature, filled in an autoclave at 15 psi for 30 minutes. After cooling at room temperature, the flasks were inoculated with mycelium discs of culture of *T. harzianum* and *T. viride* and incubated in a BOD incubator at 28 ± 1ºc for 15 days. Seed treatment of groundnut involves seed bio-priming with fungal bioagent viz. *T. harzianum, T. viride* (10 g / kg of seeds) alone and in combination in between and with bacterial bioagent viz. *Pseudomonas fluorescence* (10 ml/kg of seed) as prescribed in Table 1 and Table 2. The observations recorded for various characters are showed in Table 1 and Table 2.

RESULTS AND DISCUSSION

Character wise effect of different treatments are presented and discussed in Table 1 and Table 2.

Germination

The mean data pertaining to the effect of different treatments on germination of groundnut were recorded at 30 DAS are presented in Table 1. The results indicated that in all the treatments the germination was higher than control. Maximum germination in groundnut was 86 per cent in the treatment of *T. harzianum* + *T. viride*, which is 6.5 per cent higher than control (80.7%). This was followed by the treatment of *T. harzianum* + *P. fluorescence* (84.6%) and *T. harzianum* (84.5 %). In present investigation, it has been speculated that the seed application of *T. harzianum* and *T. viride* increased seed germination in groundnut. This finding was supported by Mukhtar (2008), in which he demonstrated that seed treatment of *T. harzianum* produced highest germination index in okra. On the same line, Asaduzzaman *et al*. (2010) in chili, Kaveh *et al*. (2011) in muskmelon and Sheilla *et al*. (2011) in maize, also reported better germination with seed treatment of *T. harzianum*. Seed and soil application of *Trichoderma* spp and *P. fluorescence* increased germination in chickpea (Dubey *et al*., 2012) and in black pepper (Shivakumar *et al*., 2012). They reported that application of *T. harzianum*, *T. viride* and *P. fluorescence* as seed treatment or as soil application helps to produce metabolites such as phytohormones, antibiotics and siderophores which further improves the imbibitions of water inside the seeds and activate the metabolic processes required for establishment of heathy and better seed germination.

Chlorophyll content

The data of chlorophyll content was measured by chlorophyll content meter (CCM 200 plus) for three times at 30 days interval and mean is presented in Table 1. The results indicated that the maximum chlorophyll content 15.4 mg/cm^2 was recorded in the treatment of *T. harzianum* + *T. viride*, which is 13.2 per cent higher than control (13.6 mg/cm^2). This was followed by the *T. harzianum* (15.3 mg/cm^2) and *T. viride* + *P. fluorescence* (15.2 mg/cm^2). Soil application of *Trichoderma* is reported to increase in chlorophyll content in cucumber (Chaur-Tsuen and Chien-Yih, 2002). Samia and Salwa (2012) also noticed increase in chlorophyll in maize with seed as well as soil application of *T. harzianum*. Recently, Entesari *et al*. (2014) reported 206 per cent increase in chlorophyll content in soyabean by biopriming of *T. harzianum*. The most probably reason for increase chlorophyll is that *Trichoderma* spp. helps to increase in the uptake of nutrients like Zn, Mn, Fe etc. from the soil. These nutrients play important role to increase chlorophyll contenT. It is worth mentioning that these parameters are closely related to the photosynthesis processes in plants. From this background, it is logical to appreciate its contribution in improving chlorophyll contenT. Although nutrient analysis was not carried out in the present investigation but in number of research findings, uptake of nutrient and chlorophyll content are correlated positively (Farooq *et al*. 2006; Cakmak, 2008).

Number of leaves

The mean data about the effect of different treatments on number of leaves per plant were influenced by different treatments are presented in Table 1. A perusal of data revealed that the maximum number of leaves (176.6) was observed under the treatment of *T. harzianum* + *T. viride*, which is 9.9 per cent higher than control (160.6). This was followed by the treatments of *T. harzianum* (169.4) and *T. harzianum* + *P. fluorescence* (168.4).

Number of branches

The mean regarding the effect of different treatments on number of branches was influenced by different treatments are presented in Table 1.The resulted data revealed that the maximum number of branches were recorded in the treatment of *T. harzianum*+*T. viride* (7.6), which is 16.9 per cent higher than control (6.5). This was closely followed by the treatments, viz. *T. harzianum* + *P. fluorescence* (7.3) and *T. harzianum* (7.2).

Shoot length

The mean data from the Table 1 observed that the maximum shoot length 33.5 cm was observed in the treatment of *T. harzianum* + *T. viride*, which is 18.3 per cent higher than control (28.3 cm). This was followed by treatments *T. harzianum* (32.2 cm), *T. viride* + *P. fluorescence* (31.0 cm).

Root length

The data about the effect of different treatments on root length are presented in Table 1. The highest mean root length (13.6 cm) was recorded in the treatment of *T. hazrianum* + *T. viride*, which is 25.9 per cent higher than control (10.8 cm). This was followed by the treatments *T. harzianum* (12.5 cm) and *T. harzianum* + *P. fluorescence* (12.5 cm).

In the present investigation, it has been found that seed treatment of *T. harzianum* and *T. viride* also increased shoot and root length in groundnut. These findings are in agreement with the reports of Bjorkman *et al*. (1998) in sweet corn; Omar *et al*. (2007) in tomato and Shanmugaiah *et al*. (2009) in cotton, where they found that seed treatment of *T. viride* increases shoot and root length in the respective crop. Soil application of *Trichoderma* is also reported to increase shoot and root length in cucumber (Chaur-Tsuen and Chien-Yih, 2002); in groundnut (Ganesan *et al*., 2007) and in chili (Bhuvaneswari *et al*., 2014). The results of present investigation also supporting the literature coated earlier (Chang *et al*., 1986; Windham *et al*., 1986, Yedidia *et al*., 2001; Adams *et al*., 2007).

Days to 50 per cent flowering

The mean data regarding the effect of different treatments on days to 50 per cent flowering are presented in the Table 1. There was little difference among the treatments. It ranged from 25.8 days (*P. fluorescence*) to 28.6 days (*T. harzianum* + *T. viride*). In control treatment, days to 50 per cent flowering was reported at 26.7 days.

Number of pods

The data pertaining to the effect of different treatments on number of pods per plant was influenced by different treatments are presented in Table 1. The mean data showed that the maximum number of pods (18.7) was recorded in the treatment of *T. harzianum* + *T. viride*, which is 28.9 per cent higher than control (14.5). This was followed by the treatments of *T. hazrianum* + *P. fluorescence* (17.9), *T. harzianum* (17.6) and *T. viride* + *P. fluorescence* (17.4) with marginal difference. These findings are supported by results of Snjezana *et al*. (2013). They have reported yield increased in cabbage and red beet by the soil application of *T. viride*. In the present study, seed treatment of bioagents increased many physiological and subsequent biochemical traits resulted in higher number of pods in groundnut.

Shelling per cent

The data about shelling percentage are presented in Table 1. There was little difference among the treatments except control. Highest shelling percentage (74.6 %) was recorded in the treatment of *T. harzianum* + *T. viride*, which is 4.1 per cent higher than control (71.6 %). This was closely followed by the treatments of *T. viride* + *P. fluorescence* (73.6%), *T. harzianum* (73.2%) and *T. viride* (73.0 %), respectively.

Test weight

The data regarding 100 kernels weight of groundnut are presented in Table 1. Scrutiny of the data showed that variations in test weight due to different treatments were found narrow among seed treatments. Highest test weight (50.5 g) was observed in the treatment of *T. hazrianum* + *T. viride*, which is 7.4 per cent higher than control. This was closely followed by *T. harzianum* + *P. fluorescence* (50.0 g) and *T. harzianum* (49.9 g). The lowest mean test weight (47.0 g) was recorded in control treatment. These findings are supported by results of Snjezana *et al*. (2013). They have reported yield increased in cabbage and red beet by the soil application of *T. viride*. In the present study, seed treatment of bioagents increased many physiological and subsequent biochemical traits resulted in higher number of pods as well as test weight in groundnut.

Oil content

The data pertaining to oil content in groundnut kernel is outlined in Table 1. A perusal of data revealed that there was no much difference among the treatments in oil contenT. It ranged between 49.9 per cent (*T.* hazianum) to 50.3 per cent (*T. harzianum* + *T. viride*). Control treatment yielded 50 per cent oil content.

Dry weight of leaves

The results about the effect of different treatments on dry weight of leaves are presented in Table 2. Maximum dry weight of groundnut leaves was recovered in the treatment of *T. harzianum* + *T. viride* (31.6 g), which is 22.9 per cent higher than control (25.7 g). This was followed by the treatments of *T. harzianum* + *P. fluorescence* (29.4 g) and *T. harzianum* (29.2 g), respectively.

Dry weight of pods

The data about the effect of diff erent treatments on dry weight of pods are presented in Table 2. Scrutiny of the data showed that variations in dry weight of pods were less than 2.0 g in different seed treatments. Maximum mean dry weight of pods (21.5 g) was recorded in the treatment of *T. harzianum* + *T. viride*, which is 14.3 per cent higher than control (18.8 g). This was followed by the treatments of *T. harzianum* (20.8 g), *T. harzianum* + *P. fluorescence* (19.9 g) and *T. viride* + *P. fluorescence* (19.8 g) and *T. viride* (19.7 g), respectively.

Dry weight of shoot

The data about the effect of different treatments on dry weight of shoot are presented in Table 2. The data showed variation in dry weight of shoot due to different treatments. Maximum mean dry weight of shoot (10.9 g/plant) was observed in the treatment of of *T. harzianum* + *T. viride*, which is 32.9 per cent higher than than control (8.2 g/plant). This was followed by *T. harzianum* (9.7 g/plant) and *T. harzianum* + *P. fluorescence* (9.6 g/plant).

Dry weight of root

The mean observations regarding the effect of different treatments on dry weight of groundnut root at harvest are presented in Table 2. Scrutiny of the data showed the variation in dry weight of root due to different treatments. Maximum mean dry weight of root (2.5 g/plant was observed in in the treatment of *T. harzianum* + *T. viride*, which is 56.2 per cent higher than control (1.6 g/plant). This was followed by *T. harzianum* + *P. fluorescence* (2.3 g/plant) and *T. viride* (2.2 g/plant), respectively.

In the present investigation, application of *T. harzianum* and *T. viride* increased dry weight of leaves, shoot and root in groundnut. These findings are consonance with the research of Rabeendran *et al*. (2000). They reported increase in dry weight of shoot and root in cabbage and lettuce by root dipping of seedlings in suspension of *T.* virens before transplanting under glasshouse condition. Shanmugaiah *et al*. (2009) also observed highest dry weight of shoot and root in cotton by seed treatment of *T. viride*. Entesari *et al*. (2014) have reported increase in dry weight of shoot and root in soyabean by bio-priming of various isolates of *T. harzianum* and *T.* virens as well as *P. fluorescence*. Logically increase in shoot and root length will also find with their higher dry weight and the biochemical reasons are discussed further. The higher number of leaves in inoculated plants may be attributed to the positive effect of *Trichoderma* and phosphate solubilizing bacteria i.e. *Pseudomonas* spp. on cotton, soyabean and tomato (Domsch and Gams 1972; Kloepper *et al*., 1980; Baker 1988; Lynch *et al*., 1991), which increase availability of nutrients like macro (N, P, K) as well as micro-nutrient (Mo, Zn and Mn) to the roots of cotton, soyabean and tomato and which helps in turns to increase in photosynthetic activity of plants that later enhances the vegetative growth thus the number of leaves per plant, number of branches, plant height and root length .

CONCLUSION

From the present investigation, it can be seen that seed application of *T. harzianum* + *T. viride* increased seed germination, chlorophyll content, shoot and root length and dry weight of leaves, shoot and root in groundnut. The other treatments of bioagents also influenced positively on said characters, although highest results were obtained in the seed treatment *T. harzianum* + *T. viride*. The positive effects on the different characters also reflected in the yield related characters of groundnut. The seed treatment of *T. harzianum* + *T. viride* either alone or in combinations performed well to increase number and weight of pods as well as test weight of kernels in groundnut. From this results, seed treatment of *T. harzianum* or *T. viride* or *T. harzianum* + *T. viride* are advocated in groundnut for better growth and higher outcome of pods.

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Table 1: Effect of different seed treatment on growth parameters of groundnut

Treatments	Germination	• Chlorophyll Content (mg/cm^2)	**Number of Leaves per Plant	**Number of Branches per Plant	** Shoot Length (cm)	**Root Length (cm)	Days to 50 Per Cent Flowering	**Number of Pods per Plant	**Shelling Per Cent	**Test Weight (g)	**Ooil Per Cent
T_1 = *Trichoderma harzianum*	84.5	15.3	169.4	7.2	32.2	12.5	27.8	17.6	73.2	49.9	49.9
T_2 = *Trichoderma viride*	83.4	14.4	166.2	6.9	30.8	11.6	26.9	17.2	73.0	48.2	50.2
T_3 = *Pseudomonas fluorescence*	81.5	14.9	164.5	6.8	30.1	11.3	25.8	16.5	72.5	48.8	50.0
T_4 *Trichoderma harzianum+ Trichoderma viride*	86.0 (6.5%)	15.4 (13.2%)	176.6 (9.9%)	7.6 (16.9%)	33.5 (18.3%)	13.6 (25.9%)	28.6 (7.1%)	18.7 (28.9%)	74.6 (4.1%)	50.5 (7.4%)	50.3 (0.3%)
T_5 = *Trichoderma viride + Pseudomonas fluorescence*	84.2	15.2	165.8	6.9	31.0	11.7	26.5	17.4	73.6	48.3	50.0
T_6 = *Trichoderma harzianum+ Pseudomonas fluorescence*	84.6	14.5	168.4	7.3	30.4	12.5	27.5	17.9	72.8	50.0	50.1
T_7 = Control	80.7	13.6	160.6	6.5	28.3	10.8	26.7	14.5	71.6	47.0	50.1

** Mean of 4 plots*

• Mean 3 observations taken at 30 day interval

*** (Colum 3 to 15 except 7) observation at harvest*

Note: The data given in the parenthesis are per cent increase as compared to untreated control

Table 2: Effect of different seed treatment on growth parameters of groundnut

Treatments	**Dry Weight of Leaves (g/plant)	**Dry Weight of Pods (g/plant)	**Dry Weight of Shoot (g/plant)	**Dry Weight of Root (g/plant)
T_1 = *Trichoderma harzianum*	29.2	20.8	9.7	2.0
T_2 = *Trichoderma viride*	28.5	19.7	9.0	2.2
T_3 = *Pseudomonas fluorescence*	27.4	18.2	8.7	1.8
T_4 = *Trichoderma harzianum+ Trichoderma viride*	31.6 (22.9%)	21.5 (14.3%)	10.9 (32.9%)	2.5 (56.2%)
T_5 = *Trichoderma viride + Pseudomonas fluorescence*	28.8	19.8	9.2	2.1
T_6 = *Trichoderma harzianum+ Pseudomonas fluorescence*	29.4	19.9	9.6	2.3
T_7 = Control	25.7	18.8	8.2	1.6

***** *Mean of 4 plots*

****** Observations recorded at harvest***

Note: The data given in the parenthesis are per cent increase as compared to untreated control

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