International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(6): 236-240

Received: 12-09-2018
Accepted: 13-10-2018

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Influence of bio-agents and botanicals on the growth and yield attributing traits of groundnut [(*Arachis hypogaea* L.) cv. GG-20]

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Abstract
The present investigation was conducted to examine the 7 treatments along with control to study about their effects on the growth and yield attributing traits of groundnut. The experiment was conducted at Field Experimentation Center, Department of Genetics and Plant Breeding, Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad during *Kharif*, 2015 in a Randomized Block Design with three replications. Analysis of variance showed highly significant differences from the control plot were studied. Available biocontrol agents were evaluated either alone or in combinations for finding out their efficacy in suppressing the damages by insect-pest and promoting nutrient uptake, plant growth, yield and quality of groundnut under field condition. Treatment containing combination of *T. viride* + *P. fluorescence* (1:1) reduced the insect-pest damage and promote the growth and yield significantly. Highest per plant yield was also recorded from the same combination and it was followed by combination of *T. viride* + *T. harzianum* (1:1), the individual application of *T. viride*, *T. harzianum and P. fluorescence*, Neem leaf extract and turmeric powder solution were gave best performance respectively in decreasing order. All of the treatments found were significantly increased the growth and yield attributing traits of groundnut under field condition as compared to control plot. These results emphasize the need for the use of bio-agents and botanicals for ensuring sustainable production, better growth and improved productivity of this important oil yielding plant.

Keywords: *Arachis hypogea*, bio-agents, botanicals, yield

Introduction
Groundnut (*Arachis hypogea* L.), belong to family Leguminosae is an important crop among oilseeds which is a self pollinated having chromosome no. (2n=40) grown in tropical and a sub-tropical regions of the world. Groundnut is believed to be the native of Brazil. Groundnut is the important oilseed in India in terms of production. The term *Arachis* is derived from the Greek word "arachos", meaning a weed, and *hypogaea*, meaning underground chamber, i.e. in botanical terms, a weed with fruits produced below the soil surface. There are two most common names used for this crop i.e. groundnut or peanut. The term groundnut is used in most countries of Asia, Africa, Europe and Australia, while in North and South America it is commonly referred to as peanut. The term groundnut refers to the pods with seeds that mature underground; the connotation of peanut is because this crop belongs to the leguminous family which includes also other crops such as peas and beans. It is a legume crop and not related to other nuts (e.g. walnut, hazelnut or cashews). Groundnut seeds are valued for oil (40- 48%) and protein (22- 26%) also contain carbohydrate (26%) fat (3%) and high calcium, thiamine and niacin contents which makes a substantial protein contribution for human and animal nutrition (Maiti *et al.*, 1991) [11].

Peanuts are consumed in many forms such as boiled peanuts, peanut oil, peanut butter, roasted peanuts, and added peanut meal in snack food, energy bars and candies (Settaluri *et al*., 2012) [21]. Peanuts also have potassium, phytosterols, resveratrol and healthy fats, all of which may benefit health and help prevent chronic disease. Daily peanut consumption decreases blood pressure, cholesterol and triglyceride levels (Kris-Etherton *et al.*, 1999) [8].

Groundnut being a oilseed crop, the seeds deteriorate at a faster rate as. The overall productivity of this crop in India is *qui*te low. Usually, farmers are using their own seeds without any treatments that ensure poor crop establishment and ultimately the decreased yield. As a seed treatment chemical is hazardous to our ecology, serious threat to our terrestrial and

aquatic species of animal, use of plant extract is essential for maintaining sustainable environmental condition. At present, when human population is crossing its limit, the destruction caused by different pathogens of crops is possing serious problem. The imbalance between populations arises and agricultural production creates shortage of food. Under this situation it is essential that we should aim at obtaining maximum production from our limited area. In these efforts, there is a need for matching the production technology with protection technology. If we continue putting our efforts only to production of crops without protecting them, the self-sufficiency in food will remain only a dream. So, we should practice seed treatment before sowing as a routine practice to achieve sustainable agricultural production. But the study of only laboratory experiment is not sufficiently enough. This emphasizes the need of undertaking further comprehensive research with more varieties, bio-control agents, botanical extracts and field study for its confirmation.

Biological control of plant diseases is cost effective and environmentally safe compared to fungicides. Also, the biocontrol agent once established persists in the soil for longer periods and offers disease protection even in the consecutive crop seasons (Mew and Rosales 1986) [14]. *Trichoderma* is a genus which include species of free-living soil fungi, opportunistic, avirulent plant symbionts *Trichoderma* is recognized primarily as an antagonist against pathogenic fungi, it also has been reported to be antagonistic to certain bacterial pathogens. The antagonistic activity of the genus *Trichoderma spp.* is well documented as effective biological control agents of plant diseases caused by soil borne fungi (Mclean *et al.*, 2004) [13].

Trichoderma spp. produce at least three classes of compounds (viz. peptides, proteins and low molecular weight compounds) that elicit plant defense responses. *Trichoderma species* have long been recognized as agents for the control of plant pathogenic fungi and have the ability of promoting plant growth and development. Moreover, some strains might enhance plant growth and development (Howell *et al.*, 2000) [6].

The beneficial effects of *Pseudomonas fluorescence* are attribute to the production diverse metabolites including siderophores, hydrocyanic acid (HCN), and phytohormones, and other associated activities such as grater phosphate solubilization, and competition in soil and root colonization. Application of *Pseudomonas fluorescens* to seed, seed pieces, and roots has resulted in increased plant growth and yield of over 100 percent. The full potential of rhizobacteria to promote plant growth can be achieved only when there is better understanding of the factor controlling their ecology and establishment on roots. (Bhatia *et al.*, 2008) [2].

Neem (*Azadirachta indica* A. Juss; Meliaceae), is one plant source of botanical pesticide that can be used for pest control. Based on the content of active ingredient, neem seeds87]ok and leaves contained *azadirachtin* as the main active compound, meliantriol, salanin, and Nimbin, which are the result of secondary metabolites from the neem tree (Ascher, 1993; Mordue and Blackwell, 1993) [1, 15], which are concentrated more in the seed and the bark (Vietmeyer, 1992) [24]. The active compounds of neem tree do not kill pests quickly, but the effect on feeding, growth, reproduction power, molting process, disrupt mating, and sexual communication, decrease in eg-g hatchability, and inhibits formation of chitin (Schmutterer & Singh, 1995) [20]. These active compounds of neem had been reported effect on approximately 400 insects (Howatt, 1994) [5]. (Prakash & Rao, 1997) [16] reported that 5% neem leaf extract had strong antifeedant effect against *S. litura* on groundnut. Available reports suggest that exploiting botanicals with antifungal activity offers an economic, safe and easily available alternative method for the management of leaf spot of groundnut (Rahman and Hossain, 1996) [17].

Leaf extract of *A. indica* can successfully be used for eco-friendly management of leaf spot (tikka) disease of groundnut and to obtain higher yield by avoiding fungicidal chemical leaf extract of *A. indica* showed similar effects as Bavistin. Maximum number of lesions leaf-1 was observed under control. The number of lesions leaf-1 was significantly reduced by the treatments with Bavistin, BAU biofungicide seed treatment + spray, extract of neem leaf and BAU-Bio fungicide spray (Hossain and Hossain, 2014) [3, 4].

Excellent insect repellent activity against housefly was showed by rhizome of *Curcuma longa.* Essential oil obtained from rhizome also has fungi toxicity. The dried rhizome of turmeric found as Botanical treating agent and use for seed treatment. The chemical substance or active principle present in this powder induce the protection against insect and pathogens hence the good viability and vigour of crop will be obtained. (Venkatraman *et al.*, 1978) studied the antifungal activity of several plants of the family Zingiberaceae and reported the marked antifungal activity of rhizome extract of *Curcuma longa* and *Curcuma aromatic*. The rhizome powder of turmeric at 1% controle the grain mycoflora of sorghum during storage.

Materials and Methods

Experimental materials: The experimental materials consist of one groundnut variety (GG-20) which was obtained from SHIATS, Allahabad (U.P.).

Treatment particulars: Kernels of above groundnut variety were treated with following particulars before sowing:

Bio- agents

Trichoderma viridae@ 4g/ Kg of seed
Trichoderma harzianum @ 6g/kg of seed
Pseudomonas fluorescence @ 10g/ kg of seed

Botanicals

Neem leaf extract @ 20g/ kg of seed
Turmeric powder @ 10g/ kg of seed

Treatment details

T0 = Control (Water soaked)
T1 = 4% solution of *Trichoderma viridae*
T_2= 6% solution of *Trichoderma harzianum*
T3 = 10% solution of *Pseudomonas fluorescence*
T4 = *Trichoderma viridae* solution + *Pseudomonas fluorescence* solution (1:1)
T_5= *Trichoderma viridae* solution + *Trichoderma harzianum* solution (1:1)
T6 = 20% solution of Neem leaf extract
T7 = 10% solution of Turmeric powder

Observation Recorded: Field emergence percentage, Seed rot percentage, Seedling mortality (%), Days to 50% flowering, Days to maturity, Number of primary branches, Plant height (cm), Number of Pod per plant.

Result and Discussion

Analysis of variance

S. No.	Characters	Mean sum of squares		
		Replication (d. f. = 02)	Treatment (d. f.= 07)	Error (d.f. = 14)
1	Field emergence	0.796	156.26**	0.453
2	Seed rot percentage	0.546	5.33**	0.203
3	Seedling mortaility	0.125	4.92**	0.268
4	Days to 50% flowering	0.796	31.13**	1.74
5	Days to maturity	0.296	44.37**	0.332
6	No. of primary branches at 60 DAS	0.105	3.90**	0.114
7	Plant hight	3.618	71.28**	1.336
8	Number of Pod per plant	0.14	97.00**	0.205

Mean performance of variety for different character

Treatments	Field emergence (%)	Seed rot (%)	Seedling Mortaility (%)	Days to 50% flowering	Days to maturity	Primary branches per plant	Plant height (cm)	Number of pod per plant
T_0	74.66	23.33	21.66	35.33	118.66	3.86	25.07	10.20
T_1	91.66	8.33	6.65	27.00	109.33	5.46	36.98	25.06
T_2	93.33	6.66	5.00	28.00	110.66	6.13	36.48	24.86
T_3	90.00	10.00	8.33	27.66	111.33	5.60	36.26	23.86
T_4	96.66	3.33	1.66	24.66	106.00	7.13	41.18	27.06
T_5	95.00	5.00	3.33	26.66	109.00	6.33	38.89	25.46
T_6	86.66	13.33	10.00	28.33	113.00	4.46	33.02	20.40
T_7	83.33	16.66	13.33	30.66	114.33	4.20	33.26	16.86
Grand mean	88.91	10.83	8.74	28.54	111.54	5.39	35.14	21.72
Minimum range	74.66	3.333	1.66	24.66	106.00	3.86	25.07	10.20
Maximum range	96.66	23.33	21.66	35.33	118.66	7.13	41.18	27.06
S. Ed	*0.54*	0.36	0.42	1.07	0.47	0.27	0.94	0.36
CD (0.5%)	1.18	0.79	0.90	2.31	1.02	0.50	2.02	0.79

1. Field emergence (%) at 10 DAS: The range of days to field emergence at 10 days after sowing varied from 74.66 percent to 96.66 percent with over all mean value 88.91 percent. The maximum field emergence percent was recorded for (T_4) 96.66 percent followed by (T_5) 95.00 percent and (T_2) 93.33 percent whereas minimum field emergence percent was for (T_0) 74.66 percent and (T_7) 83.33 percent (T_6) 37.66 percent were found significant.

Similar result also observed in the field trials, seed treatment with a spore suspension of *Trichoderma* completely eliminated the disease while *Trichoderma* and *Pseudomonas fluorescens* reduced the disease incidence significantly. The seed treatments also significantly increased seed germination, seedling growth and seedling vigor. Jegathambigai *et al.* (2009) [7].

Among all the seed treatments, seed were treated with *T. viride* showed higher rate of inhibition of *Pectinolytic* enzymes of *Fusarium oxysporum* followed by *T. harzianum* and *P. fluorescens*. This indicates that culture filtrate of *T. viride* (1%) is the best biocontrol agent in the inhibition of *Fusarium oxysporum* causing *Fusarium* wilt of *Arachis hypogaea.* Rajeswari (2015) [18].

2. Pre- emergence seed rot (%): A range of pre-emergence seed rot (%) 3.33 to 23.33 percent was observed with mean value (10.83) percent for this trait was observed. Maximum seed rot (%) was recorded for (T_0) 23.33 followed by (T_7) 16.66 percent and (T_6) 13.33 percent, whereas minimum seed rot (%) was recorded for (T_4) 3.33 percent and (T_5) 5.00 percent significantly.

Also found effective the two bacterial isolates of *P. fluorescens* with *T. viridae* and Thiram. The integrated use of these two bacterial isolates with *T. viridae* or Thiram improved their biocontrol efficacy. Combined application of bacterial isolates with *T. viride* was significantly effective than that with Thiram in protecting groundnut seedlings from stem rot infection. Manjula *et al.* (2004) [12]. Similar result find that the seed treatment with *Trichoderma harzanium* and *T. viride* along with farm yard manure offered better performance against damping-off disease and seedling growth of cauliflower. Rehman *et al.* (2012) [19].

3. Seedling Mortaility (%): A range of Seedling Mortaility (%) 1.66 to 21.66 percent was observed with mean value (8.74) percent for this trait was observed. Maximum seedling Mortaility percent was recorded for (T_0) 21.66 percent followed by (T_7) 13.33 percent and (T_6) 10.00 percent, whereas minimum seedling Mortaility percent was recorded for (T_4) 1.66 percent and (T_5) 3.33 percent significantly.

Maximum pod yield and dry haulm weight were also recorded under Bavistin. BAU-bio fungicide (seed treatment + spray) produced the second highest pod and dry haulm yield followed by leaf extract of Neem and BAU-biofungicide (spray). Hossain and Hossain (2014) [3, 4].

Similar result found due to fungal bioagents, *T. harzianum* was most effective and recorded maximum mycelial growth inhibition (72.22%), followed by *T. viride* (70.27%). Bacterial antagonist *P. fluorescens* was found comparatively least effective with 48.60% inhibition of the test pathogen. The inhibition rate recorded from botanicals neem (68.88%) in addition to Karanj (63.60%) at 20% concentrations. Waghe *et al.* (2015) [25].

4. Days to 50 percent flowering: The range of days to 50 percent flowering varied from (24.66) days to (35.33) days with an overall mean value of (28.54) days. The earliest days to 50% flowering was depicted by T_4 (24,66) days, T_5 (26.66) days, and T_1 (27) days followed by T_3 (27.66) days and T_2

(25.33) days whereas late flowering was reported in the T_0 (35) days and T_7 (30.66) days, T_6 (28.33) days were significant different from control.

5 Days to maturity: The range of days to maturity varied from 106 days to 118.66 days with an overall mean of 111.54 days. The maximum day to maturity was recorded for T_0 (118.66) days followed by T_7 (114.33) days and T_6 (113) days and, whereas minimum day to maturity was recorded for T_4 (106) days and T_5 (109) days were significant different from control plot.

Also use the combinations with *Trichoderma viridae* on rhizosphere mycoflora, plant biometrics at 75 days of sowing of ground nut. A total of 13 treatments with required dosages in combination with *Trichoderma viridae* were applied as seed treatment to groundnut crop. Vasundara *et al.* (2015) [22].

6. Number of primary branches per plants: The mean number of primary branches per plant ranged from 3.86 to 7.13 with an overall mean value of 5.39 at the time 60 day after sowing. The maximum number of primary branches per plant was recorded for T_4 (7.13) followed by T_5 (6.33) and T_2 (6.13), while minimum number of primary branches per plant was found in T_0 (3.86) and T_7 (4.2) days and T_6 (4.46) days were significant different from control.

Similar result also observed in field condition bio agents and botanicals were used as seed treatment and foliar spray. The seed treatment *Trichoderma viride* @ 4g/kg seed + foliar spray *Pseudomonas fluorescens* @ 10 g/liter water was found effective with less diseasese variety of 34.39% and higher grain yield 68.60 q/ha. *In vitro* condition it was observed dual culture technique, *Trichoderma viride* was most effective inhabiting the growth of *Helminthosporium oryzae* (61.72%). Kumar *et al.* (2015) [9].

7. Plant height (cm) 60 DAS: The variability observed for plant height was high, as reflected by its wide range from 25.07 cm to 41.18 cm with an overall mean value of 35.14 cm at the time 60 day after sowing. The maximum plant height was recorded for T_4 (41.18 cm) followed by T_5 (38.89 cm) and T_1 (36.98 cm), whereas minimum plant height was recorded for T_0 (25.07 cm) and T_6 (33.02 cm) days and T_7 (33.26) were significant different from untreated control. also studied about combination with *Trichoderma viride* and *Pseudomonas fluorescens* on growth enhancement of groundnut under polyhouse conditions. All the treated combinations used significantly influenced the morphological, physiological as well as yield parameters over un inoculated control. Yadav and Aggarwal (2015) [26].

8. Number of pod per plant: A range of number of pod per plant (10.2) to (27.06) was observed with mean value (21.72) for this trait was observed. Maximum number of pod per plant was recorded for T_4 (27.06) followed by T_5 (25.46) and T_1 (25.06), whereas minimum number of pod per plant was recorded for T_0 (10.2), and T_7 (16.86) were found significant from control.

Also find the highest effect in controlling damping off and root rot disease and increased peanut yield. Mixture of *Trichoderma spp.* isolates were the most effective followed by Nemastop compared with control treatment under field conditions. Mahmoud (2015) [10].

Conclusion

It was concluded from the present study that the treatment combination of *Trichoderma viride* + *Pseudomonas fluorescence* was found most significant in all the characters studied followed by the combination of *Trichoderma viride* + *Trichoderma harzianum* with compared to their individual application. *Trichoderma viride* as individual application found suitable treatment among all the treatment followed by *Trichoderma harzianum, Pseudomonas fluorescence.* In botanicals Neem leaf extract and Turmeric powder solution also gave good result at all the characters respectively in descending order with compared to as the untreated control. The result of this study clearly brought out the significant effect of bio inoculants on the growth and yield parameters of selected important oil yielding plants. These combinations can be further tested under field conditions and can be recommended to the farmer after proper confirmation.

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