Research and Reviews: Journal of Agriculture and Allied Sciences
e-ISSN:2347-226X
p-ISSN:2319-9857

Minimizing Allelopathic Effect of Grewia Optiva on Germination and Growth of Finger Millet Using Plant Growth Promoting Rhizobacteria

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Research Article

Received: 05/08/2021
Accepted: 19/08/2021
Published: 26/08/2021

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Keywords: Allelopathy; Biotic stress; PGPR; Grewia optiva; Finger millet; Germination; Vigour

ABSTRACT

Inter specific interaction between plant species is one of the factor responsible for the growth and development of plant species. Interaction between the plants has both beneficial and harmful effect on one or both the species. Grewia optiva is a widely grown fodder tree usually grown on boundaries of crop field. The plant having allelopathic effect on crop growth but its importance as a fodder tree cannot be ignored. The present investigation is carried out with PGPR Strains (Pseudomonas FP-11 and Bacillus BS-217/56) in alleviating allelochemical (biotic) stress of Grewia optiva (Bhimal) on Finger millet. Due to presence of Grewia optiva leaf extract there was inhibition in germination%, seedling fresh and dry weight, root length & shoot length and seedling length, of finger millet respectively as compared to control. This inhibition was recovered with PGPR treatment individual and combined of Pseudomonas FP-11 and Bacillus BS-217/56. The results indicated that the seeds inoculation with PGPR strains under Allelochemical (Biotic) stress (Grewia optaiva leaf extract) significantly improved Germination, plant growth, vigour and chlorophyll contents of leaf. The root length, shoot length, seedling length, seedling fresh weight, and seedling dry weight were also significantly increased by seeds treated with PGPR. The Plant-Growth Promoting Rhizobacteria (PGPR) (Pseudomonas FP-11 strain and Bacillus BS-217/56 strain combination) could alleviate allelopathic effect of Grewia optiva (Bhimal) on finger millet. Plant growth-promoting Rhizobacteria (PGPR) was observed replacing the use of chemicals in agriculture, horticulture practices. This is due to the emerging

demand for minimizing harmful impacts and utilization of chemical products to the growing necessity of sustainable agriculture within a holistic apparition of development and to emphasize environmental protection.

INTRODUCTION

Allelopathy is the interaction of plant species in which one produces biochemical (Alleochemicals) which restricts the growth of other plants around them. Allelopathy is of significant importance for agro-forestry systems. It involves ecological compatibility of trees with crops for higher productivity. Allelochemical inhibits the plant growth by affecting cellular functions and metabolic process.

Several previous studies have been conducted regarding the allelopathic effect of one plant upon another one. However, little attention has been paid to the role that beneficial soil microbes might play in these allelopathic interactions. Therefore, it was of interest to work on the beneficial role of bacteria where bacteria can provide protection to sensitive plants against toxic effect of an invasive weed and also help in withstanding and flourishing of sensitive plants. Finger millet (*Eleusine coracana L*) belongs to family Poaceae is an annual plant grown as cereal in the arid areas of Africa and Asia. Finger millet is an important cereal crop. Although having an economical importance due to nutritional and alternative cereal its production is quite low in the country. It is mostly confined to the hilly and arid regions. It is millet is good source of nutrients especially of calcium, other minerals and fiber. Grewia optiva is common and one of the most important fodder, fiber and fuel wood trees of hills. The plant is also known for its allelopathic effect on agricultural crops. Keeping in view the importance of both the plant species for the hilly reason study was carried out to minimize the allelopathic effect of Grewia optiva on neighboring crops/plants in natural ecosystem and to provide protection to crop using eco-friendly plant growth promoting rhizobacteria without having any harmful effect on non-target plants as well as soil microbial community structure [1].

MATERIALS AND METHODS

The Experiment was conducted in pot culture during kharif season 2019 at Department of Seed Science and Technology, HNB Garhwal University, Srinagar, Uttarakhand. The seeds were collected from Local farmers of Srinagar Garhwal. The PGPR bacterial strains (chalk powder) were procured from Microbiology laboratory, Department of Basic Science, College of Forestry (VCSG UUHF), Ranichauri, Tehri Garhwal.

Preparation of leaf extract

Mature leaves were collected from trees of Grewia optiva established in surrounding of farmer fields in Srinagar Garhwal, Uttarakhand. Aqueous leaf extracts were prepared by soaking 100 g fresh dry leaves powder of G. optiva with 1000 ml distilled water and kept at room temperature for 24 hours. The resulting aqueous extracts were filtered through two layers of Whatmans No.1 filter paper and then some extracts were diluted to generate concentrations of 50, 75 and 100% and stored in conical flasks until required [2].

Seed treatment

Finger millet seeds were surface disinfected by immersing in 1% Sodium hypochlorite for 5 min, and then washed three times in distilled water. Moist Seeds were treated by PGPR @ 10g/kg of seed for single stain and @5g/kg of seed of every strain for multi strain treatment were added to make the mixture and kept for 24 h at room temperature. The trial was conducted in triplicate in a completely randomized design each containing 25 seeds of finger millet were prepared for each extract concentration using Pot culture and Allelochemical were provided by adding 10 ml of the 0, 50, 75 and 100% Grewia optiva leaf extract solution. Pots are filled by Sand, FYM and soil, Seeds were evenly distributed on the Pot and 10 ml of each extract solution was added to each pot. The seeds used as controls were treated with only distilled water of same amount. Moisture in the pot was maintained by adding 5 ml of aqueous extract or distilled water every 2 days. The experiment was carried out for three weeks. The seeds were considered germinated upon the emergence of the radical. Germinated seeds were counted daily and the lengths of the roots and shoots were measured at the end of the experiment.

e-ISSN:2347-226X
p-ISSN:2319-9857

RESULT AND DISCUSSION

Allelochemical effect reduce due to microbial inoculants has become of great interest to plant and soil scientists. In the present study, the germination, and growth of Finger millet seeds under normal and different level of Allelochemical condition were checked. Consequently the effects of selected PGPR strains to mitigate Allelochemical stress at the early germination process of Finger millet seeds were studied in pot culture environment (Table 1) [3].

Table 1. Effect of plant growth promoting rhizobacteria on germination and growth of finger millet (*Eleusine coracana l.*) under allelochemical stress.

Treatment	G %	S.F.W.	S.D.W.	Shoot L.	Root L.	Seedling L.	V. I	V. II	Chlorophyll content
Control	83.67	16.96	2.42	17.02	17.63	34.65	2901.33	201.90	34.20
Grewia optiva - 50%	77.33	16.59	2.19	16.83	17.33	3'4.17	2641.40	224.31	32.60
Grewia optiva-75%	76.67	15.50	2.11	16.10	16.67	32.77	2666.43	226.68	31.47
Grewia optiva-100%	62.33	13.28	2.06	15.80	16.20	32.00	1995.65	190.41	27.25
Pseudomonas FP-11	93.76	20.32	3.43	21.98	20.99	42.97	4029.87	322.60	36.55
Bacillus BS-217/56	96.54	19.20	3.21	21.43	20.21	41.64	4020.93	310.90	36.45
G.O.-50%+Pseudomonas FP-11	87.00	15.57	2.43	19.15	17.27	36.42	3167.18	211.71	31.29
G.O.-50%+Bacillus BS-217/56	97.00	17.27	2.71	18.53	19.82	38.35	3720.42	262.72	33.31
G.O.-75%+Pseudomonas FP-11	87.00	16.56	2.99	19.78	20.10	39.88	3468.51	261.23	32.30
G.O.-75 %+Bacillus BS-217/56	97.33	19.70	2.60	20.10	17.87	37.97	3694.93	253.20	30.67
G.O.-100%+Pseudomonas FP-11	86.00	18.49	3.23	19.67	20.23	39.90	3431.93	277.83	31.53
G.O.-100%+Bacillus BS-217/56	91.00	17.76	2.90	18.17	17.94	36.11	3286.31	263.83	32.74
G.O.-100%+PseudomonasFP-11+ Bacillus BS-217/56	98.67	19.00	3.00	20.60	19.60	40.20	3966.50	296.33	34.73
S.EM	1.05	0.56	0.21	0.30	0.48	0.56	60.52	18.81	0.68
SE.d	1.48	0.79	0.30	0.42	0.68	0.80	85.59	26.61	0.96
CV %	2.11	5.72	13.09	2.80	4.59	2.65	3.30	13.42	3.67
CD 5 %	3.09	1.65	0.63	0.88	1.43	1.66	178.54	55.50	2.01

PGPR Impact on Seed Germination and growth

The Finger millet seeds treated with each of the PGPR strains possessed significantly Greater germination and all growth parameters than non-inoculated (control) seeds. More specifically, the seeds treated with Pseudomonas FP-11 and Bacillus BS-217/56 were 12.6% and 15.39%, higher germination %, 19.82 and 12.21% Seedling fresh weight, 29.15 and 25.92% Shoot length, 19.06 and 14.63% root length increase respectively compared to control.

Impact of Grewia optiva leaf extract (Allelochemical stress) on Seed Germination and growth of Finger millet due to presence of Grewia optiva leaf extract there was 7.58, 8.37and 25.50% inhibition in germination, 2.19, 8.61 and 21.70 % in seedling fresh weight, 1.12, 5.41 and 7.17 % in shoot length, 1.71, 5.45 and 8.12% in root length of finger millet under Allelochemical stress (leaf extract) 50, 75 and 100 % respectively and all parameters are also inhibited compared to control.This inhibition was recovered when seed treated with Pseudomonas FP-11 and Bacillus BS-217/56 as compared to control and leaf extract. Similarly Melkania and Bhatt was reported that reduction in germination of soybean with aqueous extract of Grewia optiva. Inhibition in germination and growth of wheat and chickpea due to G. optiva extract was also reported by Melkania and Kausha studies in Petridis, leachates of G. optiva and P. deltoides were found to reduce the germination of maize at higher concentration. Reported that aqueous leaf leachates of Grewia optiva, leaves were evaluated for allelopathic effects on germination and growth of five field crops viz. chickpea (Cicer arietinum), wheat (Triticum aestivum), maize (Zea mays), bean (Phaseolus vulgaris) and soybean (Glycine max). Aqueous leachates of Grewia optiva were found to reduce the germination of chickpea, wheat, bean and soybean at all the concentrations. They were finding that Seedling growth parameters were found to reduce drastically at higher concentrations of aqueous leaf leachates. The negative impact of G. optiva on field crop germination and growth can be attributed to the phytotoxic and phenolics inhibitory compounds present in its leaf and soil below its canopy [4].

PGPR impact on seed germination and growth at different allelochemical stress levels

Application of Pseudomonas FP-11and Bacillus BS-217/56 and their mixture increased root length, shoot length, seedling length, seedling fresh and dry weight, vigour index I, vigour index II and chlorophyll content under allelochemical stress (leaf extract) condition. However, Pseudomonas FP-11 significantly increased the germination % of finger millet seeds by 12.51, 13.48, and 37.98, at Allelochemical stress 50, 75 and 100% of Grewia optiva leaf extract respectively, non-significant increase in Seedling fresh weight under 50 % leaf extract, but under 75 and 100 % leaf extract increase seedling fresh weight 7.03 and 39.24 % respectively, shoot length 13.79, 22.86 and 24.49 under leaf extract 50, 75 and 100 % respectively and root length decrease 0.35 % under 50 % leaf extract and increase 20.58, 24.88% under 75 & 100 % leaf extract respectively as shown in Table 1. The Bacillus BS-217/56 also showed significant increase seed germination % of finger millet seeds by 25.44, 26.95 and 46.00% at Allelochemical stress 50, 75 and 100% of Grewia optiva leaf extract respectively, significant increase 4.09, 27.09 and 33.74% in seedling fresh weight, 10.10, 24.85 and 15 % in shoot length and 14.37, 7.20 and 10.75 % in root length at Allelochemical stress 50, 75 and 100% of Grewia optiva leaf extract respectively. Pseudomonas FP-11 and Bacillus BS-217/56 mix seed treatment significant increased the seed germination by 58.31%, seedling fresh 43.08% weight, shoot length 30.38% and root length 21% at Allelochemical stress 100% of Grewia optiva leaf extract. Plant growth promoting rhizobacteria also significantly reduces the allelopathic effect of rosemary in wheat [5].

CONCLUSION

The results show that, there is the adverse effect of leaf extract of Grewia optiva on the germination and primary seedling characters. This also indicates that the overall development and yield of the crop will also affect adversely. So, this should be taken in consideration that the crop should be grown away from the plantation of Grewia optiva. But keeping in view the importance of the tree for hilly regions it is difficult to separate the plant from cultivation system. The study also showed that, seeds treated with PGPR improve seed germination and growth of seedling under Grewia optiva allelopathic stress. This study also indicates toward the need of research in overcoming the effect of these plants on crop growth at field condition by PGPR.

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