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Research Article

Influence of Phosphate Solublizing on the Seed Production of Mustard (*Brassica campestris*)

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A B S T R A C T

Phosphate solubilizing bacteria enhanced the plant performance and benefits the plant by various mechanisms. Phosphate solubilizing bacteria is environmental friendly bio fertilizer. In present study influence of Phosphate Solubilizing Bacteria was investigated on growth of Brassica campestris under drought stress. Drought was given at three different stages, with and without Phosphate Solubilizing Bacteria. The PSB was applied to seeds surfaces before sowing in the pots. Drought duration remained for 14 to 21 days. PSB inoculation increased different parameters i.e. number of pods per plant and grains number and weight. So it is concluded that phosphate soluble bacteria should be applied to the seed for better seed production of mustard under water stress condition.

Keywords: Phosphate Soluble Bacteria, Seed production, Mustard

Introduction

Brassica is the member of family Cruciferae. They are mostly used as vegetables, edible oil in the human diet. (Ashraf and Mcneilly, 2004). They are rich source of vitamins, fibres and minerals. (Turner and Gustafon, 2006). It is also useful in treating different type's cancers by using different part of plants such as stem, leaves and seeds (Duke, 1983).

There is shortage of edible oil in Pakistan for the last many years despite development in agricultural sector. Pakistan produces 0.857 million ton of edible oil out of the total domestic requirement of edible in Pakistan is 3.107 million tons. In order to meet the demand of edible, 1.787 million tons of edible was imported at a huge cost of 1.3 billion dollar. Huge bill for import edible oil can be reduced by increasing oil seed production. In Pakistan Rapeseed and Mustard are vital oil seed crops. Its share is 28 and 31 percent among all oil seed crops grown in the country in respect of area and production. The the last ten years area and production has been increased by 300 %. Brassica oil seed cultivation is well entrenched among our cropping system. If made competitive with other field crops, it can narrow the gap between consumption and production. (Regulation of Seed Act 1989).

Phosphorus is the second most important macro nutrient for the plant growth which exist in the soil in abundance as phosphorus organic compound but mostly in insoluble form and not available to the plants (Miller et al., 2010). Availability of phosphate in soil is prominently enhanced by microbial production of metabolites which leads to lower the PH and from organic and inorganic complexes phosphate is released. Soil microorganism involve in a wide range of biological processes such as the transformation of soil phosphorus. The growth of the phosphate solubilizing bacteria frequently bases soil acidification which plays the vital character in phosphorus solubilisation and phosphate solubilizing bacteria are reflected the main solubilizers of insoluble inorganic phosphate (Haque and Dave, 2005).

The soluble phosphates are made available to the plants by the bacteria and in return gain root borne carbon compounds mostly sugars and organic acids which are obligatory for bacterial growth (Khan et al., 2010). Inoculation of the crops with Phosphate solubilizing microbes has the latent to lessen application rates of phosphate fertilizers by 50% without considerably decreasing crop yield (Jilani et al., 2007; yazdani et al., 2009). Phosphate solubilizing microorganisms are ubiquitous in soils and play vital role to stream phosphorus to plants in an environmental friendly and sustainable way. It not only pays compensation for greater rate of manufacturing fertilizers but also activates the fertilizers added to the soil (Rodriguez and Fraga, 1999. Existing nutrients will most likely affect the capacity of an introduced PSB to colonize root and to carry out their positive activity (Vikram and Hamzehzarghani,2008).

There is the crucial need to introduce the application of phosphate solubilizing bacteria in agricultural field so that society may have the alternates in case of any risk as day by day the climatic and other factors are changing. The present study will lead to check the tolerance and resistance of the different food crops and vegetables against different stress like drought, light, temperature and heavy metals.

Material and Methods

Study Area

Research experiment was carried out in Botany Department of Hazara University Mansehra.

Experimental Design

Experiment was conducted at Hazara University during Rabi 2018-2019. 72 pots of plastic were used in the experiment having clay and sand in 2:1. Experiment was laid out in completely randomized design (CRD) having four replications. It consists of nine treatments. There were three controls, two positive and one negative control having no Drought, no PSB and no fertilizers.

Treatments

- Treatment Drought Stage-I without PSB i.e. leaf stage (T1)
- Treatment Drought Stage-II without PSB i.e. Flowering Stage (T2)
- Treatment Drought Stage-III without PSB i.e. Pod Formation Stage (T3)
- Treatment Drought Stage-I with PSB i.e. Leaf Stage (T4)
- Treatment Drought Stage-II with PSB i.e. Flowering stage (T5)
- Treatment Drought Stage-III with PSB i.e. Pod Formation Stage (T6)
- Control No Drought No PSB but Fertilizer (T7)
- Control No Drought But PSB and Fertilizers (T8)
- Negative Control No Drought No PSB No Fertilizers (T0)

Growth Parameter

Plants were harvested after maturation of pods. The studied parameters were Plant height (cm), root length (cm), shoot Length (cm), Plant weight (gm), Root Weight (gm), Number of branches per plant, Number of Leaves per plant, Leaf length (cm), Leaf Width (cm), Leaf Area, Number of Pods per plant, Pod Length, Weight of Pods per plant, Number of Grains per pod, Weight of grains per plant and also the macro nutrients present in the soil of pot.

Statistical Analysis

Statistical analysis was done by using Analysis of Variance (ANOVA) with Statistix 8.1 software. Two way interaction (ANOVA) results were noted.

Results

Number of Pods per Plant

Highly significant differences ($P \leq 0.01$) were observed among treatments for the number of pods per plant. The highest amount of pods/ plants (42.25) were documented in T8 (No Drought No PSB No Fertilizer) followed by T4 (Drought stage-I with PSB), T5 (Drought stage-II with PSB) and T7 (No Drought but PSB and Fertilizer) i.e. 39.875, 37.375 and 36.250 respectively while the minimum number of pods per plant (16.750) were noticed in T3 (Drought stage-III without PSB) followed by T0 (No Drought No PSB No Fertilizer) i.e. 19.875.

Pods Length (cm)

Well important variations ($P \leq 0.01$) were noticed amongst treatments for pods length. The maximum pod length (7.215) were noticed in T8 (No Drought but PSB and Fertilizer) followed by T4 (Drought stage-I with PSB) and T1 (Drought Stage-I without PSB) i.e. 7.11 and 7.025 while the minimum pod length (5.0875) were recorded in T3 (Drought stage-III without PSB) followed by T0 (No Drought No PSB No Fertilizer) i.e. 5.40.

Number of Grains per Pod

Highly significant differences ($P \leq 0.01$) were observed among treatments for number of grains per pods. The highest number of grains/pods were documented in T4 (Drought stage-I with PSB) followed by T8 (No Drought but PSB and Fertilizer) and T5 (Drought stage-II with PSB) i.e. 13, 12.75 and 11 respectively while the minimum number of grains per pod were noticed in T0 (No Drought No PSB No Fertilizer) followed by T3 (Drought stage-III without PSB) and T6 (Drought stage-III with PSB) i.e. 6.25, 7 and 7.5 respectively.

Weight of Pods per Plants (Grams)

Highly significant differences ($P \leq 0.01$) were observed among treatments for weight of pods per plant. The highest amount of pods/Plants were documented in T8 (No Drought but PSB along with Fertilizer) followed by T7 (No drought No PSB but Fertilizer) i.e. 0.81 and 0.67 respectively while the minimum weight of pods per plant were observed in T1 (Drought Stage-I without PSB) followed by T0 (No Drought No PSB No Fertilizer) and T3 (Drought stage-III without PSB) i.e. 0.22, 0.23 and 0.25 respectively.

Weight of Grains per Plant (Grams)

Highly significant differences (P≤ 0.01) were observed among treatments for weight of grains per plant. The maximum weight of grains per plant (0.15) were recorded in T8 (No Drought but PSB and Fertilizer) followed by T4 (Drought stage-I with PSB) and T7 (No drought No PSB but Fertilizer) i.e. 0.11 and 0.10 respectively while the minimum weight of grains per plant (0.05) were noticed in T0 (No Drought No PSB No Fertilizer) and T3 (Drought stage-III without PSB) followed by T6 (Drought stage-III with PSB) and T2 (Drought Stage-II without PSB) i.e. 0.06 and 0.07 respectively.

Plant Weight (Gms)

The major variations (P≤0.01) were noticed amongst the treatments for plant weight. The maximum plant weight (2.250) was noticed in T4 (Drought stage-I with PSB) while the minimum plant weight (0.800) were recorded in T0 (No Drought No PSB No fertilizer).

Organic Matter (%age)

Highly significant differences (P≤ 0.01) were observed among treatments for organic matter. The maximum organic matter were observed in T8 (No Drought but PSB and Fertilizer) followed by T4 (Drought stage-I with PSB) i.e. 0.81 and 0.80 respectively while the minimum organic matter were recorded in T0 (No Drought No PSB No Fertilizer) followed by T3 (Drought stage-III without PSB) and T2 (Drought Stage-II without PSB) i.e. 0.63, 0.64 and 0.66 respectively.

Nitrogen (%age)

Highly significant differences (P≤ 0.01) were observed among treatments for nitrogen. The maximum nitrogen were recorded in T8 (No Drought but PSB and Fertilizer) followed by T4 (Drought stage-I with PSB) and T7 (No drought No PSB but Fertilizer) i.e. 0.035, 0.033 and 0.03 respectively while the minimum nitrogen were noticed in T0 (No Drought No PSB No Fertilizer) followed by T3 (Drought stage-III without PSB) i.e. 0.02 and 0.023 respectively.

Phosphorus (mg/kg)

Highly significant differences (P≤ 0.01) were observed among treatments for phosphorus. The maximum phosphorus were recorded in T8 (No Drought but PSB and Fertilizer) followed by T4 (Drought stage-I with PSB) i.e. 41.3 and 41.1 respectively while the minimum phosphorus were observed in T2 (Drought Stage-II without PSB) followed by followed by T3 (Drought stage-III without PSB) and T5 (Drought stage-III with PSB) i.e. 38.2, 39.1 and 39.3 respectively.

Phosphate (mg/kg)

Highly significant differences (P≤ 0.01) were observed among treatments for phosphate (Table-4). The maximum quantity phosphate (284.7 mg/kg) were noticed from T0 (No Drought No PSB No Fertilizer) whereas minimum quantity of phosphate (275.7 mg/kg) were recorded in T3 (Drought stage-III without PSB).

Table 1.No of Pods Per plant and Pods Length (cm) as Effected by Phosphate Soluble Bacteria (PSB) and Drought Stress

Treatments	No of pods per plant	Pods Length (cm)
Negative Control (No Drought No PSB No Fertilizers)	20.00 GH	5.4250 E
T1(Drought Stage-I without PSB)	31.00 CDE	7.0250 AB
T2(Drought Stage-II without PSB)	25.25 EFG	6.7250 ABCD
T3(Drought stage-III without PSB)	16.75 H	4.7500 F
T4 (Drought stage-I with PSB)	39.50 AB	7.2000 A
T5 (Drought stage-II with PSB)	37.50 ABC	6.9500 AB
T6 (Drought stage-III with PSB)	25.75 EFG	6.2500 CD
Control (No Drought No PSB but fertilizers)	37.75 ABC	6.6500 ABCD
Control (No Drought But PSB and Fertilizer)	41.50 AB	7.2500 A
LSD	7.10	0.066

Table 2.No of grains per pods, weight pods per plant, weight of grains per pods (gm) and plant weight (gm) as effected by phosphate soluble bacteria (PSB) and drought stress

Treatments	No of grains per pods	Weight of pods/ plant	Weight of grain per plant	Plant weight (gm)
Negative Control (No Drought No PSB No Fertilizers)	6.50	0.20	0.06	0.775 H
T1(Drought Stage-I without PSB)	9.00	0.21	0.07	1.1500 FG
T2(Drought Stage-II without PSB)	9.50	0.31	0.09	1.4000 EF
T3(Drought stage-III without PSB)	7.00	0.26	0.05	1.1500 FG
T4 (Drought stage-I with PSB)	13.00	0.48	0.10	2.0250 BCD
T5 (Drought stage-II with PSB)	11.00	0.49	0.10	2.0250 BCD
T6 (Drought stage-III with PSB)	8.50	0.54	0.07	1.6750 DE
Control (No Drought No PSB but fertilizers)	9.50	0.62	0.11	1.9500 BCD
Control (No Drought But PSB and Fertilizer)	13.00	0.76	0.16	2.1750 AB
LSD	2.024	0.124	0.038	0.035

Table 3.Organic matter (%), Nitrogen (%), Phosphorus (mg/kg) and Phosphate (mg/kg) as Effected by Phosphate Soluble Bacteria (PSB) and drought stress

Treatments	Organic matter (%)	Nitrogen	Phosphorus (mg/kg)	Phosphate
Negative Control (No Drought No PSB No Fertilizers)	0.6150 J	0.0205 I	40.875 AB	285.20 E
T1(Drought Stage-I without PSB)	0.6750 HI	0.0278 FGH	37.775 CDEF	266.92 H
T2(Drought Stage-II without PSB)	0.6225 J	0.0270 FGH	35.600 F	265.50 I
T3(Drought stage-III without PSB)	0.6150 J	0.0258 H	37.200 DEF	265.00 I (±0.129)
T4 (Drought stage-I with PSB)	0.7225 EF	0.0310 CD	39.400 BCD	267.35 H
T5 (Drought stage-II with PSB)	0.6925 GH	0.0293 DEF	36.475 EF	267.55 GH
T6 (Drought stage-III with PSB)	0.6825 H	0.0263 GH	38.325 CDE	266.97 H
Control (No Drought No PSB but fertilizers)	0.7050 FG	0.0273 FGH	39.050 BCD	266.95 H
Control (No Drought But PSB and Fertilizer)	0.7400 E	0.0330 BC	39.525 BC	268.13 G
LSD	0.02	2.48	2.21	0.73

Discussion

Drought stress impedes crop productivity as limited water supply changes physiological and biological processes that affect the plant growth and yield. To prevail plant growth in such stressful condition's inoculation of plants with PSB can increase productivity of crop (Shiva et al., 2015). PSB used as bio-fertilizers having beneficial effects by producing plant hormones etc and to protect plant from the biotic or abiotic stress (Ullah and Bano,2017). Drought affects the morphological and physiological traits (Rahdari and Hoseini, 2012).

In the present trial, it was noted that there was decreased in the number of pods and pods length due to the adverse effects of drought on the mustard plants and the PSB inoculation have shown the good performance under the drought stress. Increased in more number of pods result is similar to those of (Zaidi et al., 2006) who concluded that production and growth of green gram, Indian mustard and canola was amplified with the inoculation of Bacillus. Results of Influence of PSB on plants under drought stress resembles to (Nadeem et al., 2013) who reported that plant length, pod length, number of grain per pod, number of pots per plants of pee was considerably influence by mean of P2O5 quantity.

During the present research work it was recorded that the plant weight of the Brassica campestris were reduced due to the drought stress and have not performed well under the drought stress. The use of PSB under drought stress has increased the plant weights and these plants have performed better in the droughty conditions. Similar results were reported by (Farooq et al., 2009) who reported increase in weight of mustard plant PSB inoculation under water stress condition.

The number of grains and the grains weight both were decreased in the plant under the drought stress. PSB inoculations have shown good performance by increasing the yield of the plants under the drought stress. Reduce in productivity result are similar to those of (Farooq et al., 2008) who concluded that water stress is the most important abiotic factor that limits the productivity of the crop plants, during the growing season water stress occurred and seed yield is reduced.

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