Vegetable Science (2019) 46 (1&2) : 114-119

Impact of biofertilizer and mulch on growth, yield and soil health parameters in pea (*Pisum sativum* L.)

Talwinder Singh[1], Harish Chandra Raturi*[2], Lila Bora[3] and YR Shukla[4]

Received: July 2019 / Accepted: January 2020

Abstract

The present investigation entitled "Effect of biofertilizer and mulch on growth, yield and soil health parameters in pea (*Pisum sativum* L.)" was conducted during *Rabi* season 2017-18 at the Experimental farm, Department of Agriculture, Mata Gujri College, Fatehgarh Sahib, Punjab, India. The experiment was laid out in factorial randomized block design (FRBD) with three replications. The treatments consisted of four mulches, M_0-No mulch, M_1-Paddy straw@5t/ha, M_2-Maize stubbles@4t/ha, M_3-Saw dust@10t/ha and four *Rhizobium* doses, B_0-No *Rhizobium*, B_1-*Rhizobium*@20g/kg of seeds, B_2-*Rhizobium*@25g/kg of seeds, B_3-*Rhizobium*@30g/kg of seeds and their combinations. In most of the parameters individually best results were obtained with application of *Rhizobium*@30g/kg of seeds in case of biofertilizer, while in case of mulch best results were obtained with saw dust@10t/ha. In interaction best results were obtained with application of *Rhizobium*@30g/kg of seeds and saw dust@10t/ha.

Keywords: Pea, *Rhizobium*, mulch, growth, yield, soil.

Introduction

Pea (*Pisum sativum* L.) belongs to family Fabaceae. This crop was grown by *Greeks* and *Romans* as an important vegetable crop in 11th century (Khan et al. 2013). It is herbaceous, annual in habit and self-pollinated vegetable crop. The crop is grown for its green pods and seeds. In India pea was cultivated on an area of 5,54,000 Hectares with production of 55,24,000 MT (Anonymous 2019). Biofertilizer is a natural product carrying living microorganisms derived from root or cultivated soil. These preparations in strict terms are called as microbial inoculants. Biofertilizer application has shown bright results in case of leguminous crops especially exclusive results have been obtained in case of pea (Rao et al. 2014). *Rhizobium* belongs to family *Rhizobiaceae* and is symbiotic in nature. *Rhizobium* has ability to fix atmospheric nitrogen in symbiotic association with legumes and certain non-legumes like *Parasponia* (Mishra et al. 2013). Any material used at surface or vertically in soil to assist soil and water conservation and soil productivity is called mulch. Application of high input technology such as chemical fertilizers, pesticides, herbicides have improved the production but there is growing concern over the adverse use of chemicals on soil productivity and environmental quality. Adoption of mulch not only conserves soil, water and energy but also increase crop yield. It is necessary to cover the soil surface as much as possible. Thus, it has become an important strategy to use bio fertilizer and mulch to bring out improvement in soil fertility and protecting environment.

[1]Research Scholar, Department of Agriculture,
Mata Gujri College, Fatehgarh Sahib, Punjab
[2]Assistant Professor, Vegetable Science,
Department of Agriculture, Mata Gujri College,
Fatehgarh Sahib, Affiliated to Punjabi University Patiala, Punjab
[3]Assistant Scientist, Vegetable Science,
CCS HAU Regional Research Station, Uchani, Karnal, Haryana
[4]Senior Extension Specialist, Vegetable Crops,
Department of Vegetable Science, COH, YSPUHF, Solan, HP
*Corresponding author; Email: raturi15@gmail.com

Materials and Methods

A field experiment was conducted during *Rabi* season 2017-18 at the Experimental farm, Department of Agriculture, Mata Gujri College, Fatehgarh Sahib, Punjab with pea cultivar Matar Ageta-7, an early maturing variety of pea. Seeds were sown during first week of November. The treatments comprised of two main treatments with four levels each i.e. first main treatment *Rhizobium*(B), B_0=*Rhizobium*@0g/kg of seeds, B_1= *Rhizobium*@20g/kg of seeds, B_2= *Rhizobium*@25g/kg of seeds, B_3= *Rhizobium*@30g/kg of seeds and second main treatment Mulch (M), M_0= No mulch, M_1= Paddy straw@5t/ha, M_2= Maize stubbles@4t/ha, M_3= Saw dust@10t/ha and their combinations were replicated thrice. In order to apply *Rhizobium*, slurry was prepared with the help of

10% jaggery and then seeds were soaked in this solution to form uniform coating on surface of seeds. Biofertilizer (*Rhizobium*) was applied over the seeds and was mixed thoroughly as per different treatments. The treated seeds were dried in shade and then sown in the field. The seeds were sown at a spacing of 10cm on ridges made 30 cm apart. Mulch was applied on the surface of soil after the seed germination. The mulching material like Paddy straw, Maize stubbles and Saw dust were applied as per the treatments. Various growth parameters like days to emergence, germination percentage, days to first flower appearance, days to 50% flowering, days to pod setting, days to first picking, plant height, root length, number of primary branches, number of leaves, leaf area, leaf area index, shoot fresh weight, shoot dry weight, harvest index and yield parameters like pod length, number of pods, weight of seeds, pod yield per plant and per hectare and soil parameters like soil pH, soil EC, soil organic carbon, available nitrogen, phosphorus and potassium were estimated. The initial fertility status of soil is given in Table 1.

Table 1: Initial fertility status of soil

Particulars	Value obtained
Soil pH	8.18
Soil EC (dS m^{-1})	0.30
Soil Organic carbon (%)	0.33
Available nitrogen (kg ha^{-1})	290.8
Available phosphorus (kg ha^{-1})	15.63
Available potassium (kg ha^{-1})	127.12

Results and Discussion

Growth Parameters: Biofertilizer and mulch significantly affected the growth parameters (Table 2). Days to emergence were significantly affected by the treatments. The application of *Rhizobium*@30g/kg of seeds and sawdust@10t/ha resulted in minimum days to emergence (7.11) followed by *Rhizobium*@25g/kg of seed and Saw dust @ 10t/ha. The decrease in days to emergence was due to typical gibberellins like responses. They mimic the effect of exogenous GA_3 application (Bachelard 1968). Initially, inoculated plants showed earlier emergence which might be due to the production of phytohormone as it influences seed germination. Maximum germination percentage (88.52%) was obtained with *Rhizobium*@30g/kg of seed and Paddy straw @ 5 t/ha. The significant results of *Rhizobium* and their interaction with mulch were due to optimum temperature for better germination of seeds provided by mulch. Similar results also have been reported by Bejandi et al. (2012) in chick pea. Minimum days to first flower appearance (40.17) were observed with application of *Rhizobium*@30g/kg of seeds and saw dust@10t/ha. Earlier attainment of flowering was observed with *Rhizobium*inoculation as compared to the uninoculated treatment. Similar results were found by Zaman et al. (2011) which states early flowering in inoculated plants than in uninoculated ones in chick pea.

Days to 50% flowering were significantly affected by *Rhizobium* and mulch. Minimum days (51.13) to 50%flowering were taken in plots where T_{16} was applied. This may be due to easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinins to the axillary buds resulting in breakage of apical dominance. Eventually, they resulted in better sink for faster mobilization of photosynthates and early transformation of plant parts from vegetative to reproductive phase (Pandeyet al., 2017). These results are in conformity with Khan et al. (2017). In individual effect of *Rhizobium*, minimum days to pod setting were obtained in B_3 while in mulch were obtained with M_3. In interaction, minimum days to pod setting (55.60) were taken on application of T_{16}. In individual effect of *Rhizobium*, minimum days to first picking were obtained in B_3 while in mulch were taken with M_2. In interaction, minimum days to first picking (64.53) were recorded with *Rhizobium*@30g/kg of seeds and saw dust@10t/ha. Similar results were obtained by Agba et al. (2013).

Plant height was significantly increased due to various *Rhizobium* doses and mulches. Maximum plant height (86.73 cm) was recorded with B_3M_2. Qureshi et al. (2015) stated that higher growth attributes with *Rhizobium* inoculation may be due to increased nodulation and nitrogen fixation and production of secondary metabolites by the bacteria. Mulches change the soil temperature and soil moisture content which may favour vigorous growth and result in taller plants (Awal et al. 2016). The different mulches and doses of *Rhizobium* were found to be significantly influence the root length. Maximum root length (26.17 cm) was obtained with application of T_{16}. The differential effects on the root length may be due to the fact that application of nutrients along with the *Rhizobium* inoculation caused more enhancement of nutrient availability than nutrient application alone and subsequently uptake by plants which further improved metabolic activities in plants (Das et al. 2015).Mulch helps in maintaining optimum soil moisture, aids seed establishment and promotes excellent crop growth throughout the season (Pandiaraj et al. 2018). Maximum number of primary branches (3.01) was recorded with application of T_{16}. The positive relationship of growth parameter with inoculation could be related to nitrogen fixation ability of nodules which consequently increased the number of branches. The increased number of primary branches is due to better moisture conservation by saw dust. These results are

Table 2: Mean performance of different treatments on days to emergence, germination percentage, days to first flower appearance, days to 50% flowering, days to pod setting, days to first picking, plant height, root length, number of primary branches, number of leaves, leaf area, leaf area index, shoot fresh weight, shoot dry weight and harvest index in pea

Treatments	Days to emergence	Germination percentage (%)	Days to first flower appearance	Days to 50% flowering	Days to pod setting	Days to first picking	Plant height (cm) at harvest	Root length (cm) at harvest	Number of primary branches per plant	Number of Leaves per plant	Leaf area (cm^2)	Leaf area index	Shoot fresh weight per plant (g)	Shoot dry weight per plant (g)	Harvest Index (%)
B_0	8.50	60.39 (51.003*)	44.33	54.21	57.70	69.31	68.61	21.80	2.03	162.25	4.43	0.58	50.01	5.79	85.09
B_1	8.0	73.33 (59.514)	43.59	53.87	57.14	68.33	75.72	23.19	2.27	166.94	5.71	0.75	75.08	9.42	84.16
B_2	7.92	76.05 (61.137)	43.78	53.95	56.82	68.80	77.77	24.49	2.29	180.47	5.50	0.77	88.78	9.97	86.72
B_3	7.86	78.20 (62.681)	41.15	52.66	56.70	65.33	81.85	25.47	2.53	181.97	5.65	0.80	96.78	11.41	87.18
SE(m)±	0.12	1.48 (1.150)	0.12	0.21	0.24	0.09	1.55	0.12	0.07	3.03	0.10	0.007	1.03	0.15	0.25
$CD_{0.05}$	0.35	4.28 (3.338)	0.37	0.61	0.70	0.28	4.47	0.35	0.21	8.75	0.30	0.019	2.97	0.43	0.72
M_0	8.69	69.49 (56.604)	44.41	54.28	57.72	69.43	67.57	22.92	2.12	155.64	5.51	0.69	71.68	8.50	83.37
M_1	7.66	80.82 (65.171)	42.80	53.50	57.04	67.14	77.39	24.02	2.43	171.13	5.46	0.74	75.77	8.84	87.16
M_2	8.14	74.18 (59.722)	42.39	53.56	56.84	67.10	80.55	23.61	2.17	178.11	5.26	0.73	76.97	9.05	85.67
M_3	7.55	63.48 (52.838)	43.25	53.34	56.76	68.09	78.44	24.41	2.39	186.75	5.05	0.74	86.22	10.20	86.95
SE(m)±	0.12	1.48 (1.150)	0.12	0.21	0.24	0.09	1.55	0.12	0.07	3.03	0.10	0.007	1.03	0.15	0.25
$CD_{0.05}$	0.35	4.28 (3.338)	0.37	0.61	0.70	0.28	4.47	0.35	0.21	8.75	0.30	0.019	2.97	0.43	0.72
T_1 (B_0M_0)	9.66	58.17 (49.681)	45.97	55.00	58.90	71.40	50.27	21.23	1.01	144.60	3.98	0.49	40.87	4.69	83.28
T_2 (B_0M_1)	7.89	61.88 (51.897)	43.80	53.93	58.23	68.40	75.73	21.87	2.44	185.13	4.18	0.61	50.52	6.22	85.42
T_3 (B_0M_2)	8.44	61.30 (51.543)	43.00	53.83	57.00	67.13	75.70	21.57	2.50	174.10	4.05	0.58	47.37	5.03	86.84
T_4 (B_0M_3)	8.00	60.22 (50.890)	44.57	54.05	56.67	70.30	72.73	22.53	2.16	145.15	5.50	0.63	61.28	7.21	84.81
T_5 (B_1M_0)	8.44	70.83 (57.294)	44.00	53.93	56.43	68.77	68.53	22.93	2.27	179.43	5.16	0.74	68.43	9.15	82.19
T_6 (B_1M_1)	8.00	85.41 (68.722)	44.28	54.00	57.13	69.17	75.23	23.47	2.74	153.23	6.20	0.75	67.97	8.51	86.07
T_7 (B_1M_2)	7.78	75.91 (60.591)	41.33	53.23	57.28	65.60	83.80	22.57	1.95	151.77	6.36	0.77	80.23	10.03	82.61
T_8 (B_1M_3)	7.78	61.17 (51.449)	44.73	54.30	57.70	69.80	75.30	23.80	2.11	183.33	5.10	0.74	83.67	9.99	85.76
T_9 (B_2M_0)	8.66	73.95 (59.346)	45.07	54.50	57.67	70.90	75.67	23.23	2.44	145.00	6.51	0.75	89.60	9.87	84.21
T_{10} (B_2M_1)	8.00	87.47 (69.603)	42.12	53.43	56.37	66.17	75.93	24.90	2.22	173.33	5.70	0.79	90.83	10.15	87.67
T_{11} (B_2M_2)	7.67	77.08 (61.422)	44.40	54.00	56.17	70.40	75.97	24.70	2.22	220.57	4.51	0.79	80.07	8.93	87.48
T_{12} (B_2M_3)	7.33	65.71 (54.176)	45.53	53.87	57.07	67.73	83.52	25.13	2.28	182.97	5.27	0.76	94.60	10.95	87.52
T_{13} (B_3M_0)	8.00	75.00 (60.094)	42.60	53.70	57.87	66.67	75.80	24.47	2.77	153.53	6.38	0.78	87.83	10.30	83.81
T_{14} (B_3M_1)	7.66	88.52 (70.463)	40.98	52.63	56.43	64.83	82.67	25.83	2.33	172.80	5.78	0.79	93.77	10.48	89.49
T_{15} (B_3M_2)	8.66	82.43 (65.330)	40.83	53.17	56.90	65.27	86.73	25.60	2.00	166.00	6.10	0.80	100.20	12.21	85.74
T_{16} (B_3M_3)	7.11	66.83 (54.836)	40.17	51.13	55.60	64.53	82.20	26.17	3.01	235.53	4.35	0.82	105.33	12.67	89.69
SE(m)±	0.24	2.96 (2.301)	0.25	0.42	0.48	0.19	3.10	0.24	0.14	6.06	0.21	0.013	2.06	0.30	0.50
$CD_{0.05}$	0.70	8.56 (6.676)	0.74	1.22	1.40	0.56	8.95	0.70	0.42	17.51	0.61	0.038	5.95	0.87	1.44

*Figures in parenthesis represent arc sin transformed values

in conformity with Awal et al. (2016) who reported that straw mulch resulted in increase in number of primary branches.

In individual effect of *Rhizobium* B_3 resulted in maximum number of leaves and in mulch, M_3 resulted in maximum number of leaves. In interaction, maximum numbers of leaves (235.53) were obtained on application of $T_{16.}$ This may be due to greater assimilation of major nutrient and more activity of *Rhizobium*. Das et al. (2015) had similar findings and reported that pea seeds inoculated with *Rhizobium*showed relatively higher number of leaves per plant as compared to non-inoculated seeds. Maximum leaf area (6.51 cm^2) was obtained on application of B_2M_0. This was due to higher amount of *Rhizobium* which has led to more nitrogen fixation and availability to plant leading to more vegetative growth. Maximum leaf area index (0.82) was obtained with application of B_3M_3. Higher leaf area index could be attributed for higher soil temperature and availability of adequate soil water that might enhance leaf growth (Awal et al. 2016).

Individually *Rhizobium*@30g/kg of seeds and saw dust@10t/ha resulted in maximum shoot fresh and dry weight. In interaction, maximum fresh weight of shoot (105.33 g) and dry weight of shoot (12.67 g) were obtained in treatment B_3M_3. The results are in accordance with De *et al.* (2006) which illustrated that inoculation with *Rhizobium* and *Azotobacter* incorporated in pea rhizosphere through seed treatment probably induced more amount of nitrogen fixation in nodules of pea and solubilisation of fixed nitrogen from non- available to exchangeable pool which imparts more vegetative growth. The results are in conformity with (Noufal et al. 2018). Maximum harvest index (89.69) was obtained with B_3M_3. This might be due to the synergetic effect of biofertilizers and zinc which enhanced nitrogenase activity and in turn supplied more nitrogen fixation for better growth and increased yield (Kumar et al. 2014; Singh et al. 2013).

Yield parameters: Pod length is directly correlated with the yield. Long pods have more number of seeds. Consumer also prefers long pods which gives more yield. Maximum pod length (11.03 cm) was obtained in plots receiving B_3M_2 (Table 3). Increase in length may be due to greater availability of nitrogen which leads to more vegetative growth. Qureshi et al. (2015) concluded that increase in pod length might be due to the fact that *Rhizobium* inoculation increased root nodulation through better root development and more nutrient availability resulting in vigorous plant growth and dry matter production which result in better pod formation. Availability of soil water significantly improved the various yield attributes in pea (Awal et al. 2016). Mulches retained higher amount of soil water with efficient use of nutrients which might have enhanced plant growth. Number of pods is directly related to yield. It is a major yield contributing character as more the number of pods more the yield. Maximum number of pods per plant (23.15) was obtained highest with application of B_3M_3. Maximum number of pods per plant was observed in saw dust due to maximum soil moisture conservation, nutrient uptake, water holding capacity and increased aeration of soil (Khan et al. 2013). These results are in conformation with Awal et al. (2016). Another reason for the increase in number of pods can be increased nodulation and biological nitrogen fixation (Kumar et al. 2014). Weight of seeds is a parameter which determines yield of plant. Maximum weight of seeds per plant (110.47g) was obtained with application of *Rhizobium* @30g/kg of seeds and saw dust@10t/ha. De et al. (2006) supported the results in which *Rhizobium* incorporated in pea rhizosphere through seed treatment probably induced more amount of nitrogen fixation in nodules of pea and solubilisation of fixed nitrogen from non-available to exchangeable pool which imparts more vegetative growth. The increase in weight of seeds may be due to the mulch cover which increased soil water storage (Awal et al. 2016). These results also bear resemblance with Noufal et al. (2018) who obtained more weight of 1000 dry seeds in plants inoculated with *Rhizobium* than uninoculated plants.

Pod yield varied significantly with application of different treatments. The aim of the experiment was to have maximum yield for better returns. Individually, maximum pod yield was obtained with *Rhizobium*@30g/kg of seeds and saw dust @10t/ha. Maximum pod yield of 209.17g/plant and 16.37 t/ha were obtained with application of *Rhizobium*@30g/kg of seeds and saw dust@10t/ha. Noufal et al. (2018) concluded that fresh pod yield was significantly increased with co-inoculation of *Rhizobium*. Qureshi et al. (2015) reported that increase in yield may be since *Rhizobium* inoculation increased root nodulation through better root development and mere nutrient availability resulting in vigorous plant growth and dry matter production resulting in better flowering, fruiting and pod formation. This may be due to soil moisture conservation under

Table 3: Mean performance of different treatments on pod length, number of pods, weight of seeds, pod yield per plant, pod yield per hectare, pH, EC, Organic carbon, available nitrogen, phosphorus and potassium in soil in pea

Treatments	Pod length (cm)	Number of pods per plant	Weight of seeds per plant (g)	Pod yield per plant (g)	Pod yield per hectare (ton)	pH	Soil EC (dSm^{-1})	Organic carbon (%)	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potassium (kg/ha)
B_0	8.63	17.37	33.30	102.19	8.18	7.88	0.34	0.34	247.63	19.75	143.55
B_1	10.09	19.15	50.68	132.01	10.56	7.73	0.33	0.34	343.04	23.59	146.09
B_2	10.31	19.70	66.04	160.45	12.84	7.72	0.33	0.34	440.68	29.44	149.84
B_3	10.43	20.81	81.71	186.87	14.96	7.73	0.33	0.34	470.93	31.71	152.90
SE(m)±	0.16	0.21	0.21	1.04	0.083	NS	NS	NS	3.19	0.16	0.18
$CD_{0.05}$	0.46	0.63	0.62	3.02	0.24				9.21	0.47	0.52
M_0	9.41	17.79	42.91	123.05	9.85	7.75	0..33	0.34	353.94	24.70	146.95
M_1	10.00	19.74	62.67	154.44	12.37	7.78	0.34	0.34	378.92	26.77	148.64
M_2	9.98	18.71	54.18	143.97	11.52	7.75	0.33	0.34	373.44	26.34	147.83
M_3	10.07	20.79	71.96	160.05	12.80	7.79	0.34	0.34	394.98	26.68	148.96
SE(m)±	0.16	0.21	0.21	1.04	0.083	NS	NS	NS	3.19	0.16	0.18
$CD_{0.05}$	0.46	0.63	0.62	3.02	0.24				9.21	0.47	0.52
T_1 (B_0M_0)	7.73	14.43	23.27	90.30	7.23	7.96	0.33	0.33	195.93	18.27	141.96
T_2 (B_0M_1)	8.83	17.84	36.50	105.37	8.44	7.92	0.33	0.34	260.27	20.55	144.73
T_3 (B_0M_2)	8.73	17.49	33.13	102.49	8.20	7.85	0.34	0.34	250.33	20.40	143.33
T_4 (B_0M_3)	9.23	19.73	40.28	110.62	8.85	7.80	0.35	0.33	284.00	19.77	144.18
T_5 (B_1M_0)	9.67	17.41	42.24	118.83	9.51	7.67	0.33	0.34	324.18	21.91	145.24
T_6 (B_1M_1)	10.17	20.50	52.62	140.09	11.21	7.80	0.34	0.34	339.47	23.66	145.47
T_7 (B_1M_2)	9.90	18.63	47.93	128.10	10.26	7.71	0.34	0.34	331.33	22.95	145.89
T_8 (B_1M_3)	10.63	20.07	60.22	141.00	11.28	7.75	0.33	0.33	377.17	25.85	147.77
T_9 (B_2M_0)	9.83	19.32	52.62	134.57	10.76	7.68	0.33	0.34	434.13	27.31	148.73
T_{10} (B_2M_1)	10.37	20.42	72.16	172.57	13.83	7.67	0.34	0.34	444.73	30.98	150.83
T_{11} (B_2M_2)	10.27	18.86	62.50	155.23	12.42	7.72	0.33	0.34	442.63	30.64	150.14
T_{12} (B_2M_3)	10.77	20.19	106.46	179.43	14.35	7.81	0.33	0.34	441.22	28.81	149.65
T_{13} (B_3M_0)	10.40	20.00	53.50	148.50	11.89	7.69	0.32	0.35	465.53	31.32	151.89
T_{14} (B_3M_1)	10.63	20.20	106.93	199.73	15.97	7.74	0.34	0.34	471.21	31.87	153.52
T_{15} (B_3M_2)	11.03	19.87	73.47	190.07	15.22	7.72	0.32	0.34	469.46	31.37	151.96
T_{16} (B_3M_3)	9.66	23.15	110.47	209.17	16.74	7.79	0.33	0.34	477.53	32.28	154.25
SE(m)±	0.32	0.43	0.43	2.09	0.16	NS	NS	NS	6.37	0.32	0.36
$CD_{0.05}$	0.92	1.26	1.25	6.04	0.48				18.42	0.95	1.04

mulch which lead to optimal transpiration, nutrient uptake and increase in rate of photosynthesis (Khan et al. 2013).

Soil parameters: Soil pH, EC and organic carbon were not influenced significantly by combined application of *Rhizobium* and mulch (Table 3). Maximum soil pH (7.96) was obtained with no *Rhizobium* and no mulch. The soil pH slightly decreased under biofertilizer and mulch treated plots due to decrease in bulk density and increase in organic carbon and altered the soil reaction towards neutral. The decrease in soil pH might be due to addition of organic matter after decomposition of mulches which releases organic acids and dissolve them from their soluble form (Kumar 2014). The organic carbon content in the treated plots is slightly higher due to increased enzymatic and microbial activity which may have led to lower bulk density and subsequently increased the organic carbon content. These results in conformation with Jaipaul et al. (2011) who reported that lower bulk density resulted in increased organic carbon content. However, the effect was statistically non-significant. These results are also in conformation with Manna et al. (2017) who reported that mulch resulted in decrease in pH and increase in EC and Organic carbon in okra. Maximum nitrogen, phosphorus and potassium content (477.53 kg ha^{-1}, 32.28 kg ha^{-1} and 154.25 kg ha^{-1}) was obtained with application of *Rhizobium*@30g/kg of seeds and saw dust@10t/ha. This may be due to atmospheric nitrogen fixation by *Rhizobium* resulting in higher accumulation of nitrogen in the soil, mineralization of native organic matter increased the nitrogen content. According to Kumar (2014) mulch layer caused adjusting soil temperature and maintaining soil moisture that helped better phosphorus absorption condition in soil.

Conclusion

Rhizobium @30g/kg of seeds was found best in all *Rhizobium* levels while saw dust @10t/ha performed best in all mulch levels. Interaction of *Rhizobium* @30g/kg of seeds and saw dust @10t/ha performed better with respect to growth characters such as days to emergence, days to first flower appearance, days to 50% flowering, days to pod setting, days to first picking, root length, number of primary branches, number of leaves, leaf area index, shoot fresh weight, shoot dry weight, harvest index. Yield and yield contributing characteristics viz. number of pods, weight of seeds, pod yield per plant, pod yield per hectare and soil parameters like available nitrogen, phosphorus and potassium performed best with *Rhizobium*@ 30g/kg of seeds and saw dust @10t/ha. *Rhizobium* @30g/kg of seeds and maize stubbles @4t/ha resulted in maximum plant height and pod length. Whereas, *Rhizobium* and mulch treated plots decreased the pH and increased EC and Organic carbon in soil as compared to initial soil fertility of soil.

lkjka'k

यह अनुसंधान कार्य मटर (पइसम सटाइवम) में पौधे के सर्वोत्तम विकास, उपज एवं मृदा के स्वास्थ्य मापदंडों पर जैव उर्वरक एवं पलवार के उपयोग के प्रभाव की जांच के लिए प्रायोगिक प्रक्षेत्र, कृषि विज्ञान विभाग, माता गुजरी कॉलेज, फतेहगढ़ साहिब, पंजाब भारत में सत्र 2017–18 के दौरान रबी ऋतु में किया गया। इस प्रयोग में चार प्रकार के पलवार जैसे धान की पुआल (05 टन प्रति हेक्टेयर), मक्की के डंठल (04 टन प्रति हेक्टेयर) तथा लकड़ी का बुरादा (10 टन प्रति हेक्टेयर) का प्रयोग किया गया एवं अलग–अलग मात्रा में राइजोबियम जैव उर्वरक (0, 20, 25 एवं 30 ग्राम प्रति किलोग्राम बीज) के द्वारा बीजों को उपचारित कर तथा पलवार एवं राइजोबियम जैव उर्वरक के संयोजन का उपयोग किया गया। यह प्रयोग तीन प्रतिकृति के साथ फैक्टोरियल रेन्डोमाइज्ड ब्लाक डिजाइन में किया गया। इस अनुसंधान कार्य में राइजोबियम 30 ग्राम प्रति किलोग्राम की दर से उपचारित बीजों का पादप वृद्धि में सर्वश्रेष्ठ प्रदर्शन रहा। इस अनुसंधान कार्य में अधिकांश मापदंडों में व्यक्तिगत रूप से राइजोबियम 30 ग्राम प्रति किलोग्राम की दर से उपचारित बीजों का सर्वश्रेष्ठ प्रदर्शन प्राप्त हुआ, जबकि पलवार के मामले में सबसे अच्छे परिणाम लकड़ी के बुरादे (10 टन प्रति हेक्टेयर) के साथ प्राप्त हुए। अतः इस प्रयोग में राइजोबियम 30 ग्राम प्रति किलोग्राम एवं लकड़ी का बुरादा 10 टन प्रति हेक्टेयर ने सर्वश्रेष्ठ प्रदर्शन किया।

References

Agba OA, Mbah BN, Asiegbu JE and Eze SC (2013) Effects of *Rhizobium leguminosarum* inoculation on the growth and yield of *Mucuna flagellipies*. Global Journal of Agricultural Sciences 12: 45-53.

Anonymous (2019) National Horticulture Board http://nhb.gov.in/statistics/State_Level/2018-19(1st%20Adv).pdf

Awal MA, Dhar PC and Sultan MS (2016) Effect of mulching on microclimatic manipulation, weed suppression and growth and yield of pea. J Agri Ecol Res Int 8(2): 1-12.

Bachelard (1968) Effects of seed treatments with gibberellic acid on subsequent growth of some eucalypt seedlings. New Phytologist 67: 595-604.

Bejandi TK, Sharifii RS, Sedghi M and Namvar A (2012) Effects of plant density, *Rhizobium* inoculation and microelements on nodulation, chlorophyll content and yield of chickpea (*Cicer arietinim* L.). Annals of Biological Research 3(2): 951-958.

Das R, Mandal R, Chattopadhayay SB and Thapa U (2015) Synergetic influence of macro nutrient, micro nutrient and biofertilizer on root nodulation, growth and yield of garden pea (*Pisum sativum* L.). The Bioscan 10(1):291-297.

De N, Singh RK, Kumar A and Singh J (2006) Effect of organic inputs and biofertilizers on biomass, quality and yield parameters of vegetable pea (*Pisum sativum* L.). International Journal of Agricultural Science 2(2): 618-620.

Jaipaul, Sharma S, Dixit AK and Sharma AK (2011) Growth and yield of capsicum (*Capsicum annuum* L.) and garden pea (*Pisum sativum* L.) as influenced by organic manures and biofertilizers. Indian Journal of Agricultural Sciences 81(7): 637-642.

Khan IA, Sajid M, Hussain I, Rab A, Jan I, Wahid IF and Shah ST (2013) Influence of organic mulches on growth and yield of Pea's cultivars. Greener Journal of Agricultural Sciences 3(8): 652-657.

Khan I, Singh D and Jat BL (2017) Effects of biofertilizers on plant growth and yield characters of Pea (*Pisum sativum* L.). Advance Research Journal of Crop Improvement 8(1): 99-108.

Kumar R, Deka BC, Kumawat N and Ngachan SV (2014) Effect of integrated nutrition, biofertilizers and zinc application on production potential and profitability of garden pea (*Pisum sativum* L.) in eastern Himalaya, India. Legume Research 37(6): 614-620.

Kumar V (2014) Effect of different mulching materials on soil properties of NA-7 aonla under rainfed condition of Shivalik foothills of Himalayas India. The Bioscan 9(1): 561-564.

Manna A, Tarafder HK, Dasgupta S and Das NC (2017) Influence of different organic mulching materials on soil fertility and performance of okra in new alluvial zone of West Bengal. The Bioscan 12(1): 663-666.

Mishra DJ, Singh R, Mishra UK and Kumar SS (2013) Role of biofertilizers in organic agriculture. Research Journal of Recent Sciences 2: 39-41.

Noufal EHA, Ali MAM and Abd El-al MMM (2018) Effect of *Rhizobium* inoculation and foliar spray with salicylic and ascorbic acid on growth, yield and seed quality of pea plant (*Pisum sativum* L.) grown on salt affected soil, New valley-Egypt. In: 4th International Conference on Biotechnology Applications in Agriculture held during 4-7 April, 2018 at Benha University, Moshtohor and Hurgada, Egypt.pp.573-590.

Pandey V, Dahiya OS, Mor VS, Yadav R, Jitender, Peerzada OH and Brar A (2017) Impact of integrated nutrient management on seed yield and its attributes in field pea (*Pisum sativum* L.). Chemical Science Review and Letters 6(23): 1428-1431.

Pandiaraj T, Bhardwaj K and Chaturvedi S (2018) Tillage, mulching and fertility effects on vegetable pea production under conservation agriculture after rice cultivation in Indo-Gangetic plains. Journal of Pharmacognosy and Phytochemistry 7(1): 188-193.

Qureshi F, Bashir U and Ali T (2015) Effect of integrated nutrient management on growth, yield attributes and yield of field pea (*Pisum sativum* L.) cv. Rachna. Legume Research 38(5): 701-703.

Rao KM, Singh PK, Ryingkhun HBK and Maying B (2014) Use of biofertilizers in vegetable production. Indian Horticulture Journal 4(1): 73-76.

Singh BK, Pathak KA, Ramakrishna Y, Verma VK and Deka BC (2013) Vermicompost, mulching and irrigation level on growth, yield and TSS of tomato (*Solanum lycopersicum* L.). Indian Journal of Hill Farming 26 (2): 105-110.

Zaman S, Mazid MA and Kabir G (2011) Effect of *Rhizobium* inoculant on nodulation, yield and yield traits of chick pea (*Cicer arietinum* L.) in four different soils of greater rajshahi. Journal of Life and Earth Science 6: 45-50.