Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

**E-ISSN:** 2278-4136
**P-ISSN:** 2349-8234
JPP 2018; 7(1): 1479-1492
Received: 28-11-2017
Accepted: 30-12-2017

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# Role of phosphorus, zinc and rhizobium on growth and yield of field pea (*Pisum sativum* L) var Rachna

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**Abstract**
The field experiment was carried out at Crop research farm Department of Soil Science SHIATS-DU Allahabad India during *season* of November to March 2014-15. The experiment was laid out in 3×3 factorial randomized block design with 9 treatments in three replications. It was observed that the best yield attributes characters in treatment $T_8$ ($P_{60}$+$ZnSo_{4\ 20}$+Rhizobium100g10kg$^{-1}$ of seed) in respect to different days intervals i.e. 30, 60, and 90 days after sowing (DAS). Plant height was 20.24, 50.28, 109.53 and 132.87 cm found to be significant at 60, 90 & 120 DAS but non-significant at 30 DAS. Observed that the Best yield attributes characters in treatment $T_8$($P_{60}$+$ZnSo_{4\ 20}$+Rhizobium100g10kg$^{-1}$ of seed) in respect to different days intervals i.e. 30, 60, and 90 days after sowing (DAS) no. of leaves plant$^{-1}$ were 21.81, 47.77, and 98.00 found to be non-significant at 30 DAS but significant at 60, and 90 DAS, nodules plant$^{-1}$ were 21.30, and 23.27 found to be significant at 30,60 & 90 DAS, It was observed that the best attributes characters in treatment $T_8$($P_{60}$+$ZnSo_{4\ 20}$+Rhizobium100g10kg$^{-1}$ of seed) in respect to different days intervals i.e.30, 60 and 90 days after sowing (DAS), Pod plant$^{-1}$ was 4.53,15.77,18.97 found to be significant at 60,90 & 120 DAS number of flower plant$^{-1}$ at 60 DAS best attributes characters in treatment $T_8$($P_{60}$+$ZnSo_{4\ 20}$+Rhizobium100g10kg$^{-1}$ of seed) at 21.33 found to be significant, found highest seed yield (qn ha$^{-1}$),number of seeds pod$^{-1}$, number of 100g weight pea, Harvest index, and Protein(%) found in $T_8$($P_{60}$+$ZnSo_{4\ 20}$+Rhizobium100g10kg$^{-1}$ of seed) which was 12.73, 6.53, 19.00, 48.67, & 20.63 found to be significant.

**Keywords:** Phosphorus, Zinc, Growth, Yield, Pea

## 1. Introduction
The potential of vegetables in contributing to the national economy has been well recognized in recent years. India is the second largest producer of vegetables, with a production of 40 million tonnes from four million hectares of land area. In spite of that, this see mingly high level of production can provide only 208 g of vegetables 238 g Agricultural Economics Research Review Vol. 19 October-March 2013-2014 per capita (Sharma, 2001-3), as against the suggested dietary intake of 275g and 250g per capita per day for adult male and female, respectively for undertaking moderate work (Swaminathan, 2002). In India the area under field pea continuously from 328.7 milloin hectares in 2013-2014. The percentage of area under peas in India to global area under peas has also risen from 4.1 per cent in 2012-13. The production of green peas has increased from 1.30 million tonnes in 2012-2013 to 3.20 million tones in 2013-14 (www.fao.org). However, the productivity of green peas has shown an irregular trend, it declined from 14,326 kg / ha in 2012-13 to 10,000 kg per ha in 2010-11 and further to 9143 kg / ha in 2007-08 (www.fao.org). The area under green peas in Punjab was 13.2 thousand hectares in 1995-96 which, increased to 13.5 thousand hectares in 2001-02. The production and productivity of green peas were 79.7 thousand tonnes and 6040 kg / ha in 1995-96, respectively, while the corresponding figures for 2001-02 were 86.3 thousand tonnes and 6000 kg/ha, respectively (Anonymous, 2002). Green peas cultivation is highly labour-intensive like all other vegetable crops (Rao and Tripathi, 1979 and Khunt and Desai, 1996) and requires high dosages of manures and fertilizers. The main constituent of the cost of cultivation of peas is manures and fertilizers, followed by cost on bullock / human labour / tractor and pesticides/chemicals. At the same time, the income per hectare from vegetable crops has been almost four-times, as compared to that from food crops (Thakur *et al*, 1994). Thus, the farmers should have to be motivated to diversify to more remunerative cropping patterns like vegetable cultivation instead of the traditional, less profitable ones (Singh,1995). Similar types of results were reported by Maurya *et al*. (2001) and Sharma *et al*. (2000).

## Materials and Methods

The experiment was conducted during *November to March* of 2014-15 at Crop research farm Department of Soil Science Allahabad School of Agriculture SHIATS-DU Allahabad. The experimental site is located in the sub – tropical region with $25^0$ $27^1$ N *latitude* $81^0$ $51^1$ E longitudes and 98 meter the sea level *altitudes.* The experiment was laid out in a $3^2$ Factorial R.B.D factorial design with three levels of Phosphorus and three level of Zinc with nine treatments, each consisting of three replicates. The total number of plots was 27. Field pea (*Pisum sativum* L.) Cv Rachna was sown in Rabi season plots of size 2 x 2 m with row spacing 30 cm and plant to plant distance 10 cm. The Soil of experimental area falls in order of Inseptisol. The soil of the Experimental field is alluvial in nature, both the mechanical and chemical analysis of soil was done before the starting the experiment to ascertain the initial fertility of the soil. The soil samples were randomly collected from 0-15cm depths at randomly prior to tillage operations. The samples were mixed depth viz. and its weight was reducing by air drying, conning, quartering and passing it through 2mm sieve. To obtain composite soil sample in respective to different depth viz. the soil was stored for mechanical chemical analyze. The treatment consisted of nine combination of inorganic source of fertilizers $T_0$ (Control), $T_1$ ($P_0$ + $ZnSo_{410}$ + Rhizobium100g 10kg$^{-1}$ of seed), $T_2$ ($P_0$+$ZnSo_{420}$ + Rhizobium100g 10kg$^{-1}$ of seed), $T_3$ ($P_{30}$ + $ZnSo_{40}$ + Rhizobium100g 10kg$^{-1}$ of seed), $T_4$ ($P_{30}$ + $ZnSo_{410}$ + Rhizobium100g 10kg$^{-1}$ of seed), $T_5$ ($P_{30}$ + $ZnSo_{420}$ + Rhizobium 100g 10kg$^{-1}$ of seed), $T_6$ ($P_{60}$ + $ZnSo_{40}$ + Rhizobium 100g 10 kg$^{-1}$ of seed), $T_7$ ($P_{60}$ + $ZnSo_{410}$ + Rhizobium 100g 10kg$^{-1}$ of seed), $T_8$ ($P_{60}$ + $ZnSo_{420}$ + Rhizobium100g10kg$^{-1}$ of seed). The source of Phosphorus and Zinc as SSP and Zinc sulphate respectively.

### Soil Sampling

The Soil of experimental area falls in order of Inseptisol. The soil of the Experimental field is alluvial in nature, both the mechanical and chemical analysis of soil was done before the starting the experiment to ascertain the initial fertility of the soil. The soil samples were randomly collected from0-15cm depths at randomly prior to tillage operations. The samples were mixed depth viz. and its weight was reducing by air drying, conning, quartering and passing it through 2mm sieve. To obtain composite soil sample in respective to different depth viz. the soil was stored for mechanical chemical analyze.

### Physical and chemical analysis of soil samples (pre-sowing)

**Table 1:** Physical analysis of soil

| Particulars | Method employed | Results |
|---|---|---|
| Sand (%) | Bouyoucous Hydrometer | 68.00 |
| Silt (%) | method **Bouyoucous (1927)** | 17.50 |
| Clay (%) | | 14.50 |
| Textural class | | Sandy loam |
| Bulk density (Mg m$^{-3}$) | Graduated measuring cylinder Black (1965) | 1.63 |
| Particle density (Mg m$^{-3}$) | Graduated measuring cylinder Black (1965) | 2.69 |
| Pore Space (%) | Graduated measuring cylinder Black (1965) | 53.2 |

**Table 2:** Chemical analysis of soil

| Particulars | Method employed | Results |
|---|---|---|
| Soil pH (1:2) | Digital pH meter | 7.24 |
| | (Jackson, 1958) | |
| Soil EC (dS m$^{-1}$) | EC meter (Digital Conductivity Meter ) | 0.32 |
| | (Wilcox, 1950) | |
| Organic Carbon (%) | (Walkley and Black's method 1947) | 0.49 |
| Available Nitrogen (kg ha$^{-1}$) | Alkaline potassium permanganate method | |
| | (Subbaih and Asija (1956). | 280.70 |
| Available Phosphorus (kg ha$^{-1}$) | Colorimetric method | |
| | (Olsen *et al*. 1954) | 17.96 |
| Available Potassium (kg ha$^{-1}$) | Flame photometric method | 258.00 |
| | (Toth and Prince, 1949) | |
| Available Zinc (kg ha$^{-1}$) | Spectrophotometer | 2.25 |
| | (Shaw and Dean1952) | |

## Results and Discussion

**Table 3:** Plant growth parameter

| Treatment | Plant height (cm) | | | Number of leaves | | | Number of branches | | |
|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS |
| $T_0$ | 17.58 | 35.23 | 71.43 | 17.53 | 29.55 | 86.44 | 3.09 | 3.07 | 9.30 |
| $T_1$ | 18.61 | 35.42 | 73.37 | 18.78 | 30.66 | 88.22 | 3.09 | 3.22 | 9.86 |
| $T_2$ | 19.04 | 36.56 | 88.37 | 18.92 | 38.44 | 88.44 | 3.09 | 3.43 | 11.22 |
| $T_3$ | 19.49 | 37.02 | 96.23 | 19.06 | 41.55 | 89.55 | 3.22 | 3.93 | 12.20 |
| $T_4$ | 19.98 | 37.04 | 99.50 | 19.43 | 41.77 | 91.55 | 3.33 | 4.10 | 14.63 |
| $T_5$ | 20.24 | 41.80 | 103.2 | 19.44 | 41.78 | 91.66 | 3.33 | 4.83 | 18.07 |
| $T_6$ | 20.40 | 43.05 | 104.7 | 20.48 | 42.66 | 95.77 | 3.33 | 4.87 | 18.20 |
| $T_7$ | 21.01 | 45.19 | 109.2 | 20.56 | 47.77 | 97.22 | 3.42 | 4.97 | 19.99 |
| $T_8$ | 21.20 | 50.28 | 109.5 | 21.81 | 41.78 | 98.00 | 3.55 | 5.27 | 21.22 |

| F-test | NS | S | S | NS | S | S | NS | S | S |
|---|---|---|---|---|---|---|---|---|---|
| S.Ed. (±) | 1.409 | 1.775 | 1.299 | 2.240 | 1.486 | 1.599 | 0.430 | 0.274 | 0.46 |
| C.D. (at 05%) | 2.987 | 3.763 | 2.753 | 4.750 | 3.150 | 3.389 | 0.912 | 0.581 | 1.40 |

**Table 4:** Plant yield attribute parameters

| Treatment | Pod plant$^{-1}$ | Dry Weight (g) | Test Weight (g/ 100seed) | Total Seed yield (q ha$^{-1}$) | Total Seeds Pod$^{-1}$ | Protein content (%) | B:C Ratio |
|---|---|---|---|---|---|---|---|
| $T_0$ | 15.10 | 30.35 | 16.83 | 8.20 | 5.30 | 17.07 | 1.93 |
| $T_1$ | 15.87 | 33.36 | 17.97 | 8.43 | 5.77 | 17.77 | 2.06 |
| $T_2$ | 16.63 | 33.55 | 18.30 | 8.73 | 5.77 | 17.83 | 2.10 |
| $T_3$ | 17.20 | 36.33 | 18.50 | 9.73 | 5.77 | 18.20 | 2.12 |
| $T_4$ | 17.97 | 37.70 | 18.50 | 10.73 | 6.30 | 18.88 | 2.22 |
| $T_5$ | 17.97 | 40.27 | 18.53 | 10.87 | 6.47 | 19.60 | 2.24 |
| $T_6$ | 18.33 | 40.85 | 18.84 | 12.17 | 6.52 | 19.87 | 2.32 |
| $T_7$ | 18.63 | 47.54 | 18.87 | 12.53 | 6.53 | 19.97 | 2.49 |
| $T_8$ | 18.97 | 50.43 | 19.00 | 12.73 | 6.80 | 20.63 | 2.55 |
| F-test | S | NS | S | S | S | S | - |
| S.Ed. (±) | 0.680 | 6.641 | 0.315 | 0.266 | 0.130 | 0.318 | - |
| C.D. (at 5%) | 1.441 | 14.079 | 0.667 | 0.479 | 0.275 | 0.674 | - |

**Growth parameters**

**Table 3. Shows the interaction effect of different doses of Phosphorus and Zinc with Rhizobium the important growth parameters of Pea crop.**

**Plant height (cm)**

Increase in plant height due to increasing of Phosphorus and Zinc with Rhizobium may be due to adequate nutrients which are turns help in vigorous vegetative growth of plants and subsequently increase the plant height through cell elongation cell division photosynthesis and turbidity of plant cell. The maximum height recorded as 21.20, 50.28, and 109.53 respectively at 30, 60 and 90 DAS in treatment $T_8$.

**Number of leaves per plant**

The effect of different doses of Phosphorus and zinc with Rhizobium on no. of leaves per plant was found significant at 60, and 90 DAS, whereas found non-significant at 30 DAS. The maximum no. of leaves per plant was recorded as 21.81, 42.88, and 98.00 respectively at 30, 60 and 90 DAS in treatment $T_8$.

**Number of branches per plant**

The effect of different doses of Phosphorus and zinc with Rhizobium on no. of branch per plant was found significant at 60, and 90 DAS, whereas found non-significant at 30 DAS. The maximum no. of branch per plant was recorded as 3.55, 5.27, and 21.22 respectively at 30, 60 and 90 DAS in treatment $T_8$.

**Table 4. shows the interaction effect of different doses of Phosphorus and Zinc with Rhizobium the important plant yield attributes parameters of yellow mustard crop.**

Higher yield response in comparison of phosphorus and zinc with Rhizobium alone was recorded with balanced application of phosphorus, zinc and Rhizobium. The maximum no. of pod per plant was recorded as 18.97 in treatment $T_8$ and minimum no. of pod per plant was recorded as 15.10 in treatment $T_0$ and were found to be significant. The maximum dry weight of plant was recorded as 50.43 in treatment $T_8$ and minimum dry weight of plant was recorded as 30.35 in treatment $T_0$ and were found to be Non-significant. The maximum test weight of seeds 19.00 g was recorded in $T_8$ and minimum test weight of seeds was 16.83g recorded in $T_0$ and were found to be significant. The maximum seed yield 12.73 qn ha$^{-1}$ was recorded in $T_8$ and minimum seed yield 8.20 qn ha$^{-1}$ was recorded in $T_0$ and were found to be significant. The maximum Total seeds pod$^{-1}$ 6.80 was recorded in $T_8$ and minimum seeds pod$^{-1}$ 5.30 was recorded in $T_0$ which were found to be significant. Among the different treatments studied with respect of maximum Protein Content in seeds (%), The maximum Protein Content in seeds (%) was recorded in followed by $T_8$ and the minimum was recorded $T_0$. Among the different treatments studied with respect of maximum B: C ratio, the maximum B:C ratio was recorded in followed by $T_8$ and the minimum was recorded $T_0$.

**Conclusion**

It was observed that the best yield attributes characters in treatment $T_8$ ($P_{60}$+$ZnSo_{4\ 20}$+Rhizobium100g10kg$^{-1}$ of seed) in respect to different days intervals i.e. 30, 60, and 90 days after sowing (DAS). Plant height was 20.24, 50.28, 109.53 and 132.87 cm found to be significant at 60& 90 DAS but non-significant at 30 DAS. Observed that the Best yield attributes characters in treatment $T_8$($P_{60}$+$ZnSo_{4\ 20}$+Rhizobium100g10kg$^{-1}$ of seed) in respect to different days intervals i.e. 30, 60, and 90 days after sowing (DAS) no. of leaves plant$^{-1}$ were 21.81, 47.77, and 98.00 found to be non-significant at 30 DAS but significant at 60, and 90 DAS, nodules plant$^{-1}$ were 21.30, and 23.27 found to be significant at 30,60 & 90 DAS, It was observed that the best attributes characters in treatment $T_8$($P_{60}$+$ZnSo_{4\ 20}$+Rhizobium100g10kg$^{-1}$ of seed) in respect to different days intervals i.e. 60, 90 and 120 days after sowing (DAS), Pod plant$^{-1}$ was 4.53,15.77,18.97 found to be significant at 60,90 & 120 DAS number of flower plant$^{-1}$ at 60 DAS best attributes characters in treatment $T_8$($P_{60}$+$ZnSo_{4\ 20}$+Rhizobium100g10kg$^{-1}$ of seed) at 21.33 found to be significant, found highest seed yield(qn ha$^{-1}$),number of seeds pod$^{-1}$, number of 100g weight pea, Harvest index, & Protein(%) found in $T_8$($P_{60}$+$ZnSo_{4\ 20}$+Rhizobium100g10kg$^{-1}$ of seed) which was 12.73, 6.53, 19.00, 48.67, & 20.63 found to be significant.

**Acknowledgements**

The Authors are thankful to Department of Soil Science, SHIATS, Allahabad School of Agriculture, for taking their keep interest and encouragement to carry out the research work.

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