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Performance of Micronutrients and NPK on Growth and Yield of Field Pea (*Pisum sativum* L.) Var. Arkel

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ABSTRACT:

A field experiment was conducted during the Rabi seasons of 2021-2022 under Dehradun valley to investigate the effects of interaction of both inorganic fertilizers along with micronutrients (sulphur and Iron) on field pea (*Pisum sativum* L). The field experiment comprised of 7 treatments combinations with triplicate replications and perform in Randomized Block Design (RBD) of each sub treatment plots. Higher fertility levels with the application of sulphur@40kg/ha and Iron along with recommended dose of NPK in Treatment **7 ($N_{30}P_{60}K_{80}$ + S_{40} kg/ha + Fe @20 kg/ha soil application)** influences significant higher performance in parameters of growth attributes and yield attributes. Application of integration of micronutrients sulphur and iron, which takes part in increasing the metabolic regulation and enzymatic activities including photosynthesis, respiration, and symbiotic nitrogen fixation aided in the rise in growth and growth-related characteristics of the field pea crop.

KEYWORDS: Pea, RDF, Sulphur, Iron

INTRODUCTION:

Pea (*Pisum sativum* L.) is a leguminous crop that belongs to family Fabaceae and cultivated widely all over the world. It may be classified in to two classes firstly Garden or table pea (*Pisum sativum* var. *hortense* L.) which is used for vegetable purpose and for canning and Field pea (*Pisum sativum* L. var. *arvense*) which is consumed as vegetable, fresh, frozen or canned and also grown to produce dry peas like the split pea. It may thrive on a variety of soil types, including clay and sandy loam. It performs best when planted in soil that drains well and has a pH range of 6 to 7.5. Lysine and tryptophan, two amino acids that are generally scarce in cereal grains, are present in significant concentrations in field pea. Protein content in field peas ranges from 21 to 25 percent. Field pea is grown over more than 25 million acres worldwide (**FAO, 2020**). In India the area of production of pea according to 2020-2021 estimate is 573 thousand hectares with total productivity of 5823 thousand Million tonnes (**NHB 2020-2021 second estimates**). Uttar Pradesh being the highest pea producing state during 2021-22 followed by Madhya Pradesh, Punjab, Jharkhand, Himachal Pradesh, WB, Chattisgarh, Haryana, Uttarakhand, Manipur, etc. In Uttarakhand for 2021-2022, pea production is 102.98 thousand tonnes according to **APEDA Indian Production of PEAS (HSCODE-1082)**.

Sulphur, phosphorus, nitrogen, and zinc deficit have all been documented, along with iron, magnesium, and boron shortage. Pulses include protein that is more biologically valuable, substantially less expensive, and easily digested. Pulses are known as "poor man's protein" because of their high lysine content, which is thought to make up for the lack of this amino acid in grain diets. **Ramamurthi *et al.* (2012).** With peas, symbiotic nitrogen-fixing mechanism it has impact on plant, and the efficient use of main and secondary nutrients, micronutrients play a significant role in improving legume output. For the development of Rhizobium and nitrogen fixation, the micronutrients cobalt, boron, molybdenum, and zinc are crucial. Sulphur encourages the growth of nodules on the roots of legumes and enhances the production of seeds. Based on the rising reports of S insufficiency and crops need of Sulphur in equivalent levels consideration on sulphur supplementation is necessary. Sulphur requirements for pea crops are adequately high. Sulphur helps in production of protein. Sulphur is found in three amino acids that include the letter S (cysteine, cystine, and methionine), which are the building blocks of protein. Sulfur application is favourably connected to symbiotic nitrogen fixation (SNF) in nodulated legumes. Sulphur deficiency results in three additional significant effects: decreased nodulation, suppression of SNF, and slowed nodule metabolism.

Legumes have a higher need for iron because they form a symbiotic relationship with bacteria that fix nitrogen. Iron is necessary for the production of nitrogenase and cytochromes for electron transport pathway in bacteroids, as well as proteins in the host with iron, such as the highly prevalent leghaemoglobin. Iron deficiency can impact the nodule's beginning and growth. Iron is involved in the synthesis of chlorophyll in plants and is required for the proper structure and function of chloroplasts. Due to the limited

solubility of the oxidised ferric form in aerobic settings, iron is the third most limiting nutrient for plant growth and metabolism (**Zuo and Zhang, 2011; Samaranayke *et al.*, 2012**). The improvement of the growth, productivity, and quality of legume crops has been greatly aided by micronutrients.

MATERIALS AND METHODS:

The present investigation entitled "**Performance of micronutrients and NPK fertilizers on growth and yield of Pea (*Pisum sativum* L.)**" was carried out during the rabi season of 2021-2022, Dehradun. The experiment was done in randomized block design with seven treatments replicated three times. Arkel variety of pea was chosen for the study experiment. The field experiment comprising 7 treatments are: Control T_1($N_{30}P_{60}K_{80}$) RDF, T_2 ($N_{30}P_{60}K_{80}$ kg/ha + S 20kg/ha), T_3 ($N_{30}P_{60}K_{80}$ kg/ha + S @40kg/ha), T_4 ($N_{30}P_{60}K_{80}$ kg/ha + Fe @10kg/ha Soil application), T_5 (N_{30} P_{60} K_{80} + Fe@20kg/ha soil application), T_6 ($N_{30}P_{60}K_{80}$ + S 20 kg/ha + Fe @10kg/ha soil application), T_7 ($N_{30}P_{60}K_{80}$ + S_{40} kg/ha + Fe @20 kg/ha soil application). Seed rate of 60kg/ha of Arkel variety pea was sown and placed at 5-8 cm deep in open furrow with help of auger at the distance of 8-11 cm plant to plant and 22.5 cm row to row and then covered with a thin layer of soil. The pods of the pea crop were harvested at twice pickling within two weeks interval. Thinning operations were done at 30, 45 and 60 DAS with khurpi to remove weeds maintaining the plant distance. The field was irrigated 3 times and data collection of growth attribute parameters and yield attributes were taken and recorded at 30 DAS, 60DAS and 90DAS under the various treatment combinations. Five plants per plot wise was selected and chosen for collection of data for the required parameters. For determination of performance of the crop over various treatments Randomized Block Design (RBD) was applied. Test for significance were recorded based on C.D differences at 1% and 5% level of significance.

RESULTS AND DISCUSSION:

Growth Atttributes

Plant Height (cm):

According to the table 1.1 shown below, there was significant variation in the plant height within the treatment's combinations. When treated with the recommended NPK+ S @ 40 kg/ha with Fe@20 kg/ha treatment, the highest plant height (50.593cm) was observed at Treatment 7 ($N_{30}P_{60}K_{80}$ + S_{40} kg/ha + Fe @20 kg/ha soil application) followed by Treatment 6 (49.47 cm). Sulphur's ability to increase chlorophyll levels and the amount of photosynthates assimilated per unit leaf area and Iron's ability of synthesizing chlorophyll in plants, structure and function of chloroplasts influences in higher plant height. Sulphur and iron fertility levels, which aided in new cell creation and root development. The ferredoxin level was elevated by sulphur application, which causes nodulation activity. Sulphur is abundant in ferredoxin, contains Fe-S clusters that are essential for N_2 fixation. These nodules promote rhizosphere activity, which in turn influences the retention of nutrients in the root zone and enhances nutrient absorption and translocation from roots to shoot, promoting plant height in pea crop Sulphur assisted in the production of chlorophyll and proteins, which supported vegetative development and raised plant height. **Misha et al. (2011) and Singh *et al.* (2015)** both reported findings that were similar.

Number of leaves per plant:

From initial growth stages Treatment 7 which has application of recommended doses of NPK ($N_{30}P_{60}K_{80}$) along with Sulphur and Iron at doses of 40 kg/ha and 20 kg/ha obtained the highest number of leaves bearing per plant (49.467) followed by 48.867 in Treatment 6 ($N_{30}P_{60}K_{80}$ + S @20 kg/ha + Fe @10kg/ha soil application) as shown in Table 1.1. Control (T_1) has the lowest number of leaves being recorded. Iron application promotes proper functioning of metabolic process related to photosynthesis, chlorophyll biosynthesis which induce leaf growth in fresh and iron content is higher in leaf localised in chloroplasts (**Morrissey and Guerinot 2009).**

Number of branches per plant:

In Table 1.1 maximum number of branches (17.667) was obtained at Treatment 7 ($N_{30}P_{60}K_{80}$ + S_{40} kg/ha + Fe @20 kg/ha soil application) and the lowest value (15.933) was found at Control treatment. The increased iron and Sulphur levels have boosted vegetative growth (number of branches per plant) by ensuring a higher number of greener leaves with increased photosynthesis as a result of increased metabolism of the absorbed plant nutrients, such as nitrogen, phosphorus, Sulphur, and zinc, influencing leaf cell membranes, the formation of longer and stronger roots and synthesis of iron containing proteins. Photosynthesis, respiration, and symbiotic nitrogen-fixation are a several of the enzymatic processes that contribute to metabolic control and maximal growth characteristics. Researchers have documented similar results for garden pea and a number of other crops **(Jeevan and Singh, 2009; Kaisher et al., 2010).**

Fresh Root Weight:

The root part and weighted on a standard measuring scale. Maximum root weight (639.5 mg) was found at Treatment 6 ($N_{30}P_{60}K_{80}$ + S @20 kg/ha + Fe @10kg/ha soil application) followed by Treatment 2 (599.033 mg). Treatment 7($N_{30}P_{60}K_{80}$ + S_{40} kg/ha + Fe @20 kg/ha soil application) found to be 592.033 mg in root weight. Considering root weight, except Control other treatments outperformed in higher root weights. Apart from Control the rest of the treatments are found to be significant in analysis. The observed fresh root weight (639.5 mg/plant) at T6, the combined application of Fe and S @ 20 kg/ha along with the recommended dose of NPK was found to be a beneficial interaction. It was also reported that sulphur application accelerated root and shoot growth by field experimented conducted by (**Kasturi and Ahlawat, 2000; Kumawat and Kangarot, 2002**).

Yield attributes

Number of Pod:

At higher fertility levels regarding NPK (30: 60: 80 kg/ha) and Fe @ 20 kg along with sulphur @40 kg/ha (Treatment 7) regarding the number of pods per plant was found to be 11.4. Minimum number of pods (7.933) was observed at Control (T_1). The application of sulphur at higher doses induces more shoot growth and aids in formation of pods per plant hereby increases the number of this parameter. Sulphur improves the overall nutritional environment of the rhizosphere as well as in the plant system, which in turn enhanced the plant metabolism and photosynthetic activity, according to the findings of **Kokani et al. (2014)** who found that application of S @ 20 kg ha-1 had registered a significantly higher number of pods per plant.

Pod Length:

The treatment combinations and interactions plot wise resulted in significant variation in pod length. Highest pod length (9.42) was observed in Treatment 7 (Fe @ 20 kg/ha and S @ 40 kg/ha along with recommended dose NPK) and the lowest (6.92) by Control treatment (T_1). Interaction of recommended dose of NPK and sulphur @40kg/ha in Treatment 3 recorded the second largest pod length (9.02 cm). In comparison to the control, a significantly longer pod length was observed in all the treatments. **Sharma *et al.* (2006)** reported similar findings.

Number of Seeds per pod:

Number of highest grain per pod (8.33) was found at Treatment 7 (Fe @ 20 kg/ha and S @ 40 kg/ha along with recommended dose NPK) and the second largest on Treatment 3 ($N_{30}P_{60}K_{80}$ kg/ha + S 40kg/ha) having 7.93. Control treatment had the lowest number (5.53) of seeds per pod. Comparing to control treatment T1, treatment 4($N_{30}P_{60}K_{80}$ kg/ha + Fe @10kg/ha Soil application) and Treatment 5 **(**N_{30} P_{60} K_{80} + Fe@20kg/ha soil application are found statistically at par to each other. Seeds per pod were influenced by the available and applied doses of fertilizers. According to research by **Vaiyapuri et al. (2010)**, the application of S @ 30 kg ha-1 boosts all yield-related characteristics, including the number of branches, pods, seeds, and 100 seed weight of soybeans, since S improves plant metabolism.

Pod Yield:

Highest pod yield (43.8 q/ha) was observed at Treatment 7(Fe @ 20 kg/ha and S @ 40 kg/ha along with recommended dose NPK) followed by treatment 3 ($N_{30}P_{60}K_{80}$ kg/ha + S 40kg/ha) ranging 40.87 q/ha. According to **Parashar et al. (2020)**, enough sulphur supply aided in the development of floral primordia, or reproductive organs, which led to the production of pods and grains in plants. Maximum pod production is the result of increased chlorophyll synthesis, carbohydrate build up, protein accumulation, and their transport. Similar findings were recorded by **(Dass et al. 2005; Sharma *et al.* 2006; Patel *et al.*2012; Saket *et al.* 2014).** Application of sulphur has been observed to boost the yield and quality of field pea as sulphur is a key component of the S-containing amino acids and proteins.

Table 1.1. Effect of Treatments on crop growth and yield attributes of field pea:

Growth Attributes

Treatments	Plant height (cm)	No. of branches	No. of leafs	Fresh root weight (mg)
T_1 (CONTROL ($N_{30}P_{60}K_{80}$) RDF)	43.24	15.933	41.2	468.567
T_2 ($N_{30}P_{60}K_{80}$ kg/ha + S 20kg/ha)	48.22	17.133	47.80571429	599.033
T_3 ($N_{30}P_{60}K_{80}$ kg/ha + S 40kg/ha)	47.967	16.467	44.533	538.233
T_4 ($N_{30}P_{60}K_{80}$ kg/ha + Fe @10kg/ha (Soil)	45.4	15.933	42.73333333	545.6
T_5 (N_{30} P_{60} K_{80} + Fe@20kg/ha (soil)	45.127	17.133	43.8	510.467
T_6 ($N_{30}P_{60}K_{80}$ + S @20 kg/ha + Fe @10kg/ha (soil)	49.447	17.267	48.867	639.5
T_7 ($N_{30}P_{60}K_{80}$ + S_{40} kg/ha + Fe @20 kg/ha (soil)	50.593	17.667	49.467	592.233
S. Em (±)	0.166	0.274	0.919	0.797
CD (P=0.05)	0.725	0.932	1.706	1.588

Yield Attributes

Treatments	No. of pods	Pod length (cm)	Pod weight (gm)	Pod yield (q/ha)	Number of grain/pods
T_1 (CONTROL ($N_{30}P_{60}K_{80}$) RDF)	7.933	7.133	61.933	12.73	5.533
T_2 ($N_{30}P_{60}K_{80}$ kg/ha + S 20kg/ha)	10.133	7.333	67.267	32.08	7.333
T_3 ($N_{30}P_{60}K_{80}$ kg/ha + S 40kg/ha)	10.6	7.4	70	40.87	7.933
T_4 ($N_{30}P_{60}K_{80}$ kg/ha + Fe @10kg/ha (Soil)	9.733	8.433	64.333	26.05	6.4
T_5 (N_{30} P_{60} K_{80} + Fe@20kg/ha (soil)	9.6	8.433	64.533	31.23	5.867
T_6 ($N_{30}P_{60}K_{80}$ + S @20 kg/ha + Fe @10kg/ha (soil)	10.1	8.633	66.6	37.65	7.867
T_7 ($N_{30}P_{60}K_{80}$ + S_{40} kg/ha + Fe @20 kg/ha (soil)	11.4	9.467	68.2	43.8	8.333
S. Em (±)	0.396	0.053	0.297	0.057	0.121
CD (P=0.05)	1.12	0.411	0.97	0.425	0.618

Conclusion:

The results of the current experiment demonstrated the importance of S and Fe in Pea. Observing of all the parameters taken, data recorded and shown in tables, the beneficial treatment combination for the crop growth attributes and yield attributing quality was found at Treatment 7. The experimental results made it abundantly evident that using sulphur in granular elemental form, i.e., S @ 20 or 40 kg/ha, had a surplus effect on vegetable pea or grain pea production and quality. Sulphur improves the efficiency of other macronutrients such as phosphorus and potassium in plants. Sulphur enhances phosphorus uptake and assimilation of carbohydrate. Iron enhances green pod and grain yield besides its functioning in nitrogenase activity, higher leghemoglobin content and enzyme activity. Integrated application of NPK along with sulphur and iron influences higher performance in growth and yield attributing parameters. An adequate sulphur status is important for the uptake and assimilation of micronutrients such as iron. The investigation suggests that integrated application of recommended dose of NPK and sulphur@40 kg/ha and Iron @20kg/ha proved to be the beneficial treatment combination of all the other remaining six.

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