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JS Rawat
Assistant Professor,
Department of Agriculture Sciences, IES University, Bhopal, Madhya Pradesh, India

BK Sharma
Associate Professor,
Department of Agronomy, RAK College, Sehore, Madhya Pradesh, India

Omprakash Kumar
Assistant Professor,
Department of Management, IES University, Bhopal, Madhya Pradesh, India

Corresponding Author:
JS Rawat
Assistant Professor,
Department of Agriculture Sciences, IES University, Bhopal, Madhya Pradesh, India

Effect of growth and yield parameter of lentil (*Lens culinaris* M.) by the iron and zinc application

JS Rawat, BK Sharma and Omprakash Kumar

Abstract
The experiment was conduct during *rabi* session 2022 at Agriculture research farm IES University, Bhopal (M.P.). The experiment was laid out in randomized block Design with 07 treatments and 3 replication. The soil of the experiment field was medium black fairly deep having a slight slope from west to east, which provides good drainage. To access the initial fertility status of the soil of experimental field. The result is significantly. Plant population/m^2 It is evident from the facts; Maximum number of plants viz. (38.25 /m^2) was recorded in application of RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha which was found significantly superior to control. The maximum plant height viz. (46.00) was recorded in application of RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha. Number of Branches plant^{-1} the data indicated that the maximum number of branches plant^{-1}viz. (8.56) were recorded with the application of RDF 100% +soil application of $ZnSO_4$ 20 kg/ha. Dry weight plant^{-1}(g) the maximum dry weight plant^{-1} (12.11) was found in application of RDF 100%+seed treatment with 0.05% $ZnSO_4$ solution.

Keywords: Zn, SO_4, lentil

Introduction
The botanical name of lentil is *"Lens culinaris*" in 1787 and this belong to the Leguminosae family. Lentil is important leguminous crop it is also known as known as "Masoor" is lentil (*Lens culinaris*). Some important nutrients present in lentil like 24-26% protein, 1.3% ash, 1.8% oils, 3.2% fiber, and 57% carbohydrates. Asia, accounts for 75% of global output and 80% of the world's land area, is where it is primarily farmed. Millions of people eat lentils because they are a good source of energy, a source of protein, fibre, minerals, vitamins, and antioxidant compounds. Lentils have also included a variety of micronutrient, pre-biotic and carbohydrates (Migliozzi *et al*., 2015) [9]. Especially for iron (Fe) and zinc (Zn), which are needed in acceptable amounts in the diet, lentil is thought to be rich in micronutrient content, providing 3.7–4.5 mg Fe and 2.2–2.7 mg Zn in a serving of 50 g. (Thavarajah, 2011) [14]. In India, 16.2 lakh tones of lentils were produced of 16 lakh hectares area and productivity is 1037 kg ha^{-1} In state of Madhya Pradesh, 5.96 lakh hectares of lentils were harvested, yielding 6.8 lakh tones at a productivity of 1145 kg ha^{-1}. An excellent source of fibre and high-quality protein is lentil seeds (Tickoo *et al*., 2005) [15]. Micronutrients play important role in the growth and developments of all crops. In terms of micronutrients, zinc is crucial during the reproductive process, such as fertilisation. To achieve a good production of lentils, fertilisation is essential. But a Zn deficit in the plant reduces yield and results in substantial financial loss. Plants with a Zn deficit exhibit a lack of growth since Zn is necessary for cell extension, division, and differentiation (akmak *et al*., 1989) [2]. Zn find lacuna is prevalent in arid climates and in soils with little organic matter, and it is present in 30% of agricultural areas worldwide (Ahmad *et al*., 2012) [1]. In addition, Zn insufficiency is brought on by circumstances such excessive P, pH, lime, and clay (Marschner, 2011) [8].

Frequently, zinc-deficient soils are sandy, low in organic matter, and/or have an alkaline pH. Divalent zinc (Zn+2) is absorbed by plants (Singh *et al* (2015). The first signs of a lentil crop shortage appear five to six weeks after the crop is sown and include mature leaves going from green to a yellowish white colour, leaflets turning brown and eventually falling to the ground, and plants growing slowly with poor pod development (Chaney, 1993) [3]. A lack of zinc in the soil can lower agricultural output and the amount of zinc in agricultural products. Zinc is essential for a number of plant metabolic activities (Dobermann and Fairhurst, 2000) [6]. Although, a large number of studies are available on the role of soil and foliar applied Zn fertilizers in correction of Zn deficiency and increasing plant growth and yield (Rengel *et al*. 1999) [10]. As a result, plants cannot manufacture and stabilise chlorophyll at high pH levels, which causes leaf yellowing, poor development, and decreased yield. (Cesco *et al.*, 2010) [4]. We can micronutrients directly apply into the soil. (solid form or dissolved in water) Darwesh, (2011) [5] also reported the effectiveness of foliar application of micronutrient that it supplies nutrients to higher plants better than any other means.

Material and Methods

The experiment was conduct during *rabi* session 2022 at Agriculture research farm IES University, Bhopal (M.P.). The experiment was laid out in RBD with 07 treatments and 3replication.The soil of the experiment field was medium black fairly deep having a slight slope which provides good drainage. To access the initial fertility status of the soil of experimental field, soil samples were collected randomly from different places of the field at 0 to 15 cm depth with the help of a screw type soil auger. After this a composite sample was prepared for the analysis of available nitrogen, phosphorous and potassium, pH and electrical conductivity.

Treatment Details

Treatment	Treatments
T1	RDF 100% (N:P:K:S –20:17:16:20 kg/ha + PSB + *Rhizobium* culture) (Control)
T2	RDF 100% + 0.5% ZnSO4 at pre-flowering & pod initiation
T3	RDF 100% + 0.5% FeSO4 at pre-flowering & pod initiation
T4	RDF 100% +0.5% ZnSO4 + 0.5% FeSO4
T5	RDF 100% +seed treatment with 0.05% ZnSO4 solution (socked for 3-4 hours)
T6	RDF 100% + seed treatment with 0.05% FeSO4 solution (socked for 3-4 hours)
T7	RDF 100% +soil application of ZnSO4 – 20 kg/ha

Plant height plant^{-1} (cm) varying in same rows of same plant so height of the three randomly selected plants in each plot was measured from the soil surface to the main apical bud and the average was taken for analysis. Numbers of branches plant-1The branches emerging from the base of three-tagged plants were recorded and the average was taken for analysis.
Dry weight plant^{-1} (g) it is the most important part for yield attributing characters. Three randomly selected plants were uprooted from each plot and oven dried at 70 °C for 48 hours. Number of root nodules plant^{-} Plants were uprooted carefully and after washing root nodules was separated from the roots of the plants. The dark pink colored root nodules of plants were counted and the number was recorded and the average was taken for analysis. Dry weight of root nodules plant^{-1} (mg) the dry weight of root nodules of 3 randomly selected plants was recorded in each plot at 45 and 60 days after sowing. Isolated root nodules were kept in an oven for 48 hours at 70 °C the dry weight of nodules was recorded and the average was taken for analysis.

Results

The Plant population/m^2 it is evident from the facts maximum number of plants viz. (38.25 /m^2) was recorded in application of RDF 100% +soil application of $ZnSO_4$ – 20 kgha^{-1}which was found significantly superior to control. The application of RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha was found with the application of RDF 100% +0.5% $ZnSO_4$+ 0.5% $FeSO_4$ spray viz. (37.35/m^2) followed by the application of RDF 100% +seed treatment with 0.05% ZnSO4 solution (soaked for 3-4 hours) viz. (35.96/m^2) and RDF 100% + 0.5% ZnSO4 spray at pre-flowering & pod initiation viz. (33.55/m^2) at harvest respectively. Plant height (cm) the most significant indicator of plant growth is plant height. It is explicit from data; the plant height was increased greatly with advancement of the crop growth under all the treatments and attends highest plant height at maturity stage. The maximum plant height viz. (46.00) was recorded in application of RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha. The application of RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha was found the application of RDF 100% +0.5% $ZnSO_4$+ 0.5% $FeSO_4$ spray8viz. (44.66), RDF 100% +seed treatment with 0.05% $ZnSO_4$ solution (soaked for 3-4 hours) viz. (43.93),RDF 100% + 0.5% $ZnSO_4$ spray at pre-flowering & pod initiation viz. (43.93), RDF 100% +0.5% $ZnSO_4$+ 0.5% $FeSO_4$ spray (43.13) at harvest respectively.
Number of Branches plant^{-1} the number of branches plant^{-1}at different growth stages of crop is presented in (Table-1). The data indicated that the maximum number of branches plant^{-1}viz. (8.56) were recorded with the application of RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha. The application of RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha was found at par with the application of RDF 100% +0.5% $ZnSO_4$+ 0.5% $FeSO_4$ spray(7.73) and application of RDF 100% +seed treatment with 0.05% $ZnSO_4$ solution (soaked for 3-4 hours) (7.73) at harvest, respectively. The application of RDF 100% +seed treatment with 0.05% $ZnSO_4$ solution (soaked for 3-4 hours) was also found with the application of RDF 100% + 0.5% $ZnSO_4$ spray at pre-flowering & pod initiationviz. (7.73) at maturity, respectively.
The maximum dry weight plant^{-1} (11.72) was found in application of RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha, which was found significantly superior to control at harvest. The application of RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha was found at par with the RDF 100% +0.5% $ZnSO_4$+ 0.5% $FeSO_4$ spray and application of RDF 100% +seed treatment with 0.05% $ZnSO_4$ solution (soaked for 3-4 hours).

Table 1: Effect of different treatments on plant population, Plant height, Number of Branches plant^{-1}, Dry weight plant^{-1}(g) at successive growth stages of lentil

Treatments	Plant Population	Plant height	Number of Branches plant^{-1}	Dry weight plant^{-1}(g)
	At Harvest	At Harvest	At Harvest	At Harvest
RDF 100%(N:P:K:S–20:17:16:20 kg/ha + PSB + *Rhizobium* culture) (Control)	33.55	37.86	5.73	10.33
RDF 100% + 0.5% $ZnSo_4$ spray at pre- flowering and pod initiation	35.22	43.93	7.73	10.88
RDF 100% + 0.5% $FeSO_4$ spray at pre-flowering & pod initiation	35.18	43.13	7.26	10.64
RDF 100% +0.5% $ZnSO_4$+ 0.5% $FeSO_4$ spray	37.35	44.66	8.13	11.15
RDF 100%+seed treatment with 0.05% $ZnSO_4$solution (soaked for 3-4 hours)	35.96	43.93	7.73	12.11
RDF 100%+seed treatment with 0.05%$FeSO_4$ solution (soaked for 3-4 hours)	34.05	39.83	5.80	10.97
RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha	38.25	46.00	8.56	11.72
SE (m) ± 1	0.25	1.58	0.59	0.44
CD at 5%	NS	4.94	1.85	1.23

Discussion

Plant population/m^2 It is evident from the facts; Maximum number of plants *viz*. (38.25 /m^2) was recorded in application of RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha which was found significantly superior to control. Similar results were given by Kumawat *et al*. (2006) [7] and Sadhegi and Noorhosseini (2014) [11]. Plant height (cm) the most significant indicator of plant growth is plant height. Theplant height was increased greatly with advancement of the crop growth under all the treatments and attends highest plant height at maturity stage. The maximum plant height viz. (46.00) was recorded in application of RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha. Similar results were given by Kumawat *et al*. (2006) [7] and Sadhegi and Noorhosseini (2014) [11]. Number of Branches plant^{-1} the data indicated that the maximum number of branches plant^{-1}viz. (8.56) were recorded with the application of RDF 100% +soil application of $ZnSO_4$ – 20 kg/ha which was found significantly superior to all the other treatments at maturity, respectively. Similar results were given by Kumawat *et al*. (2006) [7] and Sadhegi and Noorhosseini (2014) [11]. Dry weight plant^{-1}(g) the periodical observations on dry weight per plant were recorded treatment wise and there after the data were statistically computed. The maximum dry weight plant^{-1}(12.11) was found in application of RDF 100%+seed treatment with 0.05% $ZnSO_4$ solution (soaked for 3-4 hours).

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