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Effect of Zinc and Molybdenum on the Growth and Yield of Garden Pea (*Pisum sativum* L.)

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Abstract

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from December 2015 to March 2016 to study the effect of zinc and molybdenum on the growth and yield of garden pea. The variety *BARI Motorshuti-1* was used as the test crop. Two factors experiment as, Factor A: Levels of zinc (3 levels)- Zn_0: 0 kg Zn ha^{-1}, $Zn_{1.5}$: 1.5 kg Zn ha^{-1} $Zn_{3.0}$: 3.0 kg Zn ha^{-1} and Factors B: Levels of molybdenum (3 levels)- Mo_0: 0 kg Mo ha^{-1}, $Mo_{0.3}$: 0.3 kg Mo ha^{-1}, $Mo_{0.6}$: 0.6 kg Mo ha^{-1} was laid out in Randomized Complete Block Design (RCBD) with three replications. In case of different levels of zinc, the tallest plant, maximum number of pods plant^{-1}, the highest green pod yield hectare^{-1} were recorded from $Zn_{3.0}$, whereas the shortest plant, the lowest green pod yield hectare^{-1} were found from Zn_0. For different levels of molybdenum, the tallest plant, the highest green pod yield hectare^{-1}, was found from $Mo_{0.6}$, while the shortest plant, the minimum number of pods plant^{-1}, the lowest green pod yield hectare^{-1}, was recorded from Mo_0. Due to the interaction effect of different levels of zinc and molybdenum, the tallest plant, the highest green pod yield hectare^{-1} were found from $Zn_{3.0}Mo_{0.6}$ and maximum number of pods plant^{-1} found from $Zn_{1.5}Mo_{0.6}$. The shortest plant, the minimum number of pods plant^{-1}, the lowest green pod yield hectare^{-1} were found from Zn_0Mo_0.

Keywords: Growth, yield, zinc, molybdenum, garden pea

1. Introduction

Every year total cultivable land of the country is turning into non-agricultural land at the rate of 0.73% (Molla, 2016), while total population is projected to be 201.3 million by 2051 (El-Saharty et al., 2014). So, meeting food demand by maintaining soil health is a great challenge. Pulses are the second most important group of crops after cereals (Chandra et al., 2020). So, it is the high time to conduct research on pulses. Pulses are rich source of protein and play a significant role in correcting the prevalent malnutrition in the country like Bangladesh and India (Singh et al., 2015). Among the pulses, fieldpea *(Pisum sativum* L.*)* is an important grain legume in the Asia, Europe, North America, Japan and Australia but in Bangladesh, fieldpea is going to be a major pulse crop within a few years (BBS, 2016). It is the second most important legume crop of the world (Pawar et al., 2017). Garden pea (*Pisum sativum L.*) belongs to the family Fabaceae is one of the world's oldest domesticated crops cultivated before 10th and 9th millennia BC (Zohary and Hopf, 2000). It is highly nutritive which contains high proportion of digestive protein

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(20 to 22.5%) (Singh et al., 2015). The garden pea is a legume with great nutritional potential because of its high content of plant protein (27.8%), complex carbohydrates (42.65%), vitamins, minerals, dietary fibre and antioxidant compounds (Urbano et al.., 2003). Garden pea is cultivated in Bangladesh for fresh green seed, boiled green pods and dried seed. The green pods of pea may contribute to a major income sources for small-scale farmers (Musinguzi et al., 2010). The area for pea cultivation in 2013 was 36,132 acres with the production was 11,842 tons but in 2007 it was 37,145 acres with the production was 12,610 tons (BBS, 2013). The yield of pulses in Bangladesh is low due to many reasons : nutrient deficiency (including micronutrient) is one of them (Quddus et.al., 2014). Micronutrients play an important role in increasing yield of pulses and oilseed legumes through their effects on the plant itself and on the nitrogen fixing symbiotic process (Movalia et. al., 2020). The soils of different parts of Bangladesh particularly calcareous soils are more or less deficient in Zn and Boron as well as the population of nitrogen fixing bacteria (*Rhizobium* sp.) is less which are main cause of poor pulse yields (Jahiruddin, 2015; Quddus et al., 2014).

For optimal growth and development, 17 essential elements are required for plants the elements, which required in relatively trace amounts are called micronutrients. When micro-nutrients become limited, water, fertilizers and other high energy production inputs may be wasted (Samreen et.al., 2017). Zinc has been the micronutrient needed by crops especially pulses in sufficiently large quantity (Yashona et al., 2018). Zinc in plants required for biosynthesis of hormone (Kudi et al., 2018). Zinc plays a vital role in metabolism and it is involved in N-fixation through nodule formation (Patel et al., 2011). Zinc is an essential micronutrient involved in a wide variety of physiological processes and it plays an important role in several plant metabolic processes; it activates enzymes and is involved in protein synthesis and carbohydrate, nucleic acid and lipid metabolism (Marshner, 1986; Pahlsson, 1989). The plants exhibited lower rate of protein synthesis and protein accumulation under zinc deficiency. Zinc is an essential components of RNA polymers and provides structural integrity to ribosomes (Yashona et al., 2018). However, like other heavy metals when Zn is accumulated in excess in plant tissues, it causes alterations in vital growth processes such as photosynthesis and chlorophyll biosynthesis and membrane integrity (De Vos et al.., 1991). Since Zn is required for the synthesis of tryptophan (Brown et al., 1993; Alloway, 2004), which is a precursor of IAA, this metal also has an active role in the production of auxin, an essential growth hormone (Brennan, 2005). Zinc is required for pollen function and fertilization (Ali et al., 2017). Zinc (Zn) deficiency is a major yield-limiting factor in several Asian countries (Rehman et al., 2012). The availability of Molybdenum in soil has been shown to enhance the production of leguminous crops (Chandra et. al., 2020). Mo, which redeem a vital responsibility in some of the metabolic progression and regulate ascorbate-glutathione in plants. Lacking of Molybdenum in plants causes decrease in chlorophyll content and also creates some abnormal changes in plant chloroplast (Nasar et al., 2017). Molybdenum is an essential micronutrient and required for the formation of the nitrate reductase enzyme and in legume is directly involved in symbiotic nitrogen fixation (Williams and Fraustoda Silva, 2002; Roy et al., 2006). It is an important co-factor component of key enzymes of assimilatory nitrogen metabolism, nitrogen fixation, nitrate uptake (Gupta and Lipsett, 1981; Campbell, 1999). Molybdenum has a positive effect on yield quality and nodules formation in legume crops and molybdenum increased plant height, number of branches and pods plant^{-1}, number of seeds plant^{-1} and seeds yield (Togay et al., 2008).

Considering the above mention perspective the present study was conducted with different levels of zinc and molybdenum to observe the effect of zinc and molybdenum on the growth and yield of garden pea and to find out the suitable combination of Zn and Mo fertilization for maximum yield of garden pea.

2. Materials and Methods

2.1. Experimental site

The experiment was conducted at the research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from December, 2015 to March 2016. The experimental site is situated between $23^0$74'N latitude and $90^0$35'E longitude and at an elevation of 8.4 m from sea level.

The land type of the experimental soil were high land with general soil type is Shallow Red Brown Terrace soil and the soil belongs to the Tejgaon series under the Agro-ecological Zone of Madhupur Tract (AEZ-28). A composite sample of the experimental field was made by collecting soil from several spots of the field at a depth of 0-15 cm before initiation of the experiment. The collected soil was air-dried, grind and passed through 2 mm sieve and analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka for some important physical and chemical properties. The soil was having a texture of silty clay with pH and organic matter 5.7 and 1.13%, respectively. The results showed that the soil composed of 27% sand, 43% silt and 30% clay. In the soil, the total N (%), available P (ppm), exchangeable K (me/100 g soil) and available S (ppm) were 0.03%, 20.00 ppm, 0.10 me/100 g soil and 23 ppm respectively.

2.2. Planting material and treatment details

The variety *BARI Motorshuti-1* was used as the test crop which was released by Bangladesh Agricultural Research Institute. The experiment comprised of two factors as, Factor A : Levels of zinc (3 levels)- Zn_0: 0 kg Zn ha^{-1}, $Zn_{1.5}$: 1.5 kg Zn ha^{-1}, $Zn_{3.0}$: 3.0 kg Zn ha^{-1} and Factors B : Levels of molybdenum (3 levels)- Mo_0: 0 kg Mo ha^{-1}, $Mo_{0.3}$: 0.3 kg Mo ha^{-1}, $Mo_{0.6}$: 0.6 kg Mo ha^{-1}. There were in total 9 (3×3) treatment combinations such as Zn_0Mo_0, $Zn_0Mo_{0.3}$, $Zn_0Mo_{0.6}$, $Zn_{1.5}Mo_0$, $Zn_{1.5}Mo_{0.3}$, $Zn_{1.5}Mo_{0.6}$, $Zn_{3.0}Mo_0$, $Zn_{3.0}Mo_{0.3}$ and $Zn_{3.0}Mo_{0.6}$.

2.3. Experimental design

The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications in a area of 20×15 m^2. The size of the each unit plot was 4.0×1.6 m^2. The space between two plots and two replications were 0.5 m and 1.0 m respectively.

2.4. Fertilizer application

Urea, Triple super phosphate (TSP), Muriate of potash (MoP), gypsum, zinc sulphate and boric acid were used as a source of nitrogen, phosphorous, potassium, gypsum, sulphur, zinc and boron, respectively. N, P, K and S were applied at the rate of 90, 60, 60 and 40 kg $hectare^{-1}$, respectively following the Bangladesh Agricultural Research Institute (BARI) recommendation and zinc & molybdenum were applied as per treatment. All of the fertilizers except urea were applied during final land preparation.

2.5. Sampling and data collection

Five plants from each treatment were randomly selected and marked with sample card. After harvest of crop soil samples were collected from each plot at a depth of 0 to 15 cm. Soil samples of each plot was air-dried, crushed and passed through a two mm (10 meshes) sieve. Data on different yield contributing characters, yield and nutrient status of post-harvest soil were statistically analyzed.

3. Results and Discussion

3.1. Yield contributing characters and yield of garden pea

3.1.1. Plant height

Statistically significant variation was recorded in terms of plant height of garden pea due to different levels of zinc, molybdenum and their interaction effect. In case of zinc, data revealed that the tallest plant (62.08 cm) were recorded from $Zn_{3.0}$, which were statistically similar (60.44 cm) to $Zn_{1.5}$, whereas the shortest plant (56.76 cm) were found from Zn_0 (Table 1). From the recorded data it was observed that, with the increase of application of zinc nutrients plant height showed increasing trend. Zinc ensured the availability of other macro and micro nutrients that created a favorable condition for the growth of garden pea with optimum vegetative growth and the ultimate results was the tallest plant. Stoyanova and Doncheva (2002) reported that Zn nutrient accumulated in plant tissues and it causes alterations in vital growth processes such as photosynthesis and chlorophyll biosynthesis and ultimate results was the longest plant due to the application of zinc fertilizer. Alam et al. (2010) reported longest plant with the application of 2.5 kg Zn ha^{-1} in earlier experiment. For different levels of molybdenum, the tallest plant (61.41 cm) were found from $Mo_{0.6}$ which were statistically similar (60.70 cm) to $Mo_{0.3}$, while the shortest plant (57.18 cm) from Mo_0 (Table 1). It was revealed that with the increase of molybdenum plant height increased up to the highest level. Hazra and Tripathi (1998) observed that molybdenum application at the rate of 1.5 kg ha^{-1} increased forage in calcareous soil. Due to the interaction effect of different levels of zinc and molybdenum, the tallest plant (65.50 cm) were recorded from $Zn_{3.0}Mo_{0.6}$ which were statistically similar (64.20 cm, 62.24 cm and 61.67 cm, respectively) to $Zn_{1.5}Mo_{0.3}$, $Zn_{3.0}Mo_0$ and $Zn_{1.5}Mo_{0.6}$. On the other hand, the shortest plant (53.85 cm) were found from Zn_0Mo_0 (Table 2). El Sayed Hameda et al., (2012) reported that foliar spraying pea plants with a mixture of microelements significantly increased yield components expressed as plant height.

Table 1: Effect of zinc and molybdenum on yield contributing characters and yield of garden pea

Treatments	Plant height (cm)	No. of pods $plant^{-1}$	No. of seeds pod^{-1}	Pod length (cm)	Green pod yield ha^{-1} (t)
Levels of zinc					
Zn_0	56.76^b	16.40^b	5.61^c	6.78 b	7.39^b
$Zn_{1.5}$	60.44^a	19.58^a	6.17^b	7.47^a	8.18^a
$Zn_{3.0}$	62.08^a	19.96^a	6.62^a	7.76^a	8.41^a
LSD(0.05)	3.146	1.820	0.385	0.383	0.432
Level of significance	0.01	0.01	0.01	0.01	0.01
Levels of molybdenum					
Mo_0	57.18^b	17.29^b	5.71^b	6.87^b	7.59^b
$Mo_{0.3}$	60.70^a	18.76^{ab}	6.24^a	7.44^a	8.08^a
$Mo_{0.6}$	61.41^a	19.89^a	6.44^a	7.69^a	8.31^a
LSD(0.05)	3.146	1.820	0.385	0.383	0.432
Level of significance	0.05	0.05	0.01	0.01	0.01

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

3.1.1.1. Pods $plant^{-1}$

Statistically significant variation was recorded in terms of number of pods $plant^{-1}$ of garden pea due to different levels of zinc, molybdenum and their interaction effect. The maximum number of pods $plant^{-1}$ (19.96) were recorded from $Zn_{3.0}$ which were statistically similar (19.58) to $Zn_{1.5}$, whereas the minimum number of pods plant $^{-1}$ (16.40) were found from Zn_0 (Table 1). Kumar et al. (2014) reported that seed inoculation with zinc @ 5 kg ha^{-1} gave the significantly higher growth and yield attributes. The maximum number of pods $plant^{-1}$ (19.89) were found from $Mo_{0.6}$ which were statically similar (18.76) to $Mo_{0.3}$, while the minimum number of pods $plant^{-1}$ (17.29) were recorded from Mo_0 (Table 1). Togay et al. (2008) reported that molybdenum increased pods $plant^{-1}$. The maximum number of pods $plant^{-1}$ (23.40) was recorded from $Zn_{1.5}Mo_{0.6}$ which were statistically similar (22.07 and 20.80) to $Zn_{3.0}Mo_{0.6}$ and $Zn_{3.0}Mo_{0.3}$. On the other hand, the minimum number of pods plant^{-1} (14.20) was found from Zn_0Mo_0 (Table 2).

Table 2: Interaction effect of zinc and molybdenum on yield contributing characters of garden pea

Treatments	Plant height (cm)	No. of pods plant^{-1}	No. of seeds pod^{-1}	Pod length (cm)	Green pod yield ha^{-1} (t)
Zn_0Mo_0	53.85^{d}	14.20^{d}	5.43^{d}	6.47^{d}	6.68^{c}
$Zn_0Mo_{0.3}$	59.38^{bcd}	18.00^{bc}	5.87^{bcd}	7.07^{cd}	7.82^{b}
$Zn_0Mo_{0.6}$	57.05^{cd}	17.00^{cd}	5.53^{d}	6.80^{cd}	7.67^{b}
$Zn_{1.5}Mo_0$	55.47^{d}	17.87^{bc}	5.63^{cd}	7.07^{cd}	7.71^{b}
$Zn_{1.5}Mo_{0.3}$	64.20^{ab}	17.47^{bcd}	6.33^{bc}	7.50^{bc}	8.48^{ab}
$Zn_{1.5}Mo_{0.6}$	61.67^{abc}	23.40^{a}	6.53^{b}	7.83^{ab}	8.36^{ab}
$Zn_{3.0}Mo_0$	62.24^{abc}	17.00^{cd}	6.07^{bcd}	7.07^{cd}	7.93^{b}
$Zn_{3.0}Mo_{0.3}$	58.50^{bcd}	20.80^{ab}	6.53^{b}	7.77^{ab}	8.39^{ab}
$Zn_{3.0}Mo_{0.6}$	65.50^{a}	22.07^{a}	7.27^{a}	8.43 a	8.91^{a}
LSD(0.05)	5.450	3.153	0.666	0.664	0.749
Level of significance	0.05	0.01	0.05	0.05	0.05

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

3.1.1.1.1. Number of seeds pod^{-1}

Statistically significant variation was recorded in terms of number of seeds pod^{-1} of garden pea due to different levels of zinc, molybdenum and their interaction effect. The maximum number of seeds pod^{-1} (6.62) were recorded from $Zn_{3.0}$ which were closely followed (6.17) by $Zn_{1.5}$, whereas the minimum number of seeds pod^{-1} (5.61) were found from Zn_0 (Table 1). Rizk and Abdo (2001) reported that yield components showed a highly significant increase with the application of Zn (0.2 or 0.4 g/l) compared to the control. The maximum number of seeds pod^{-1} (6.44) were found from $Mo_{0.6}$ which were statically similar (6.24) to $Mo_{0.3}$, while the minimum number of seeds pod^{-1} (5.71) were recorded from Mo_0 (Table 1). Sarkar and Banik (1991) observed the molybdenum application significantly increased seeds pod^{-1}. The maximum number of seeds pod^{-1} (7.27) was recorded from $Zn_{3.0}Mo_{0.6}$ which were closely followed (6.53, 6.07 and 5.87) by $Zn_{3.0}Mo_{0.3}$, $Zn_{1.5}Mo_{0.6}$, $Zn_{3.0}Mo_0$ and $Zn_0Mo_{0.3}$ and they were statistically similar. On the other hand, the minimum number of seeds pod^{-1} (5.43) was found from Zn_0Mo_0 which were statistically similar (5.53) $Zn_0Mo_{0.6}$ treatment combination (Table 2).

3.1.1.1.1.1. Pod length

Pod length of garden pea showed statistically significant variation due to different levels of zinc, molybdenum and their interaction effect. The longest pod (7.76 cm) were recorded from $Zn_{3.0}$ which were statistically similar (7.47 cm) to $Zn_{1.5}$, whereas the shortest pod (6.78 cm) were found from Zn_0 (Table 1). The longest pod (7.69 cm) were found from $Mo_{0.6}$ which were statically similar (7.44 cm) to $Mo_{0.3}$, while the shortest pod (6.87 cm) were recorded from Mo_0 (Table 1). The longest pod (8.43 cm) was recorded from $Zn_{3.0}Mo_{0.6}$ and the shortest pod (6.47 cm) was found from Zn_0Mo_0 treatment combination (Table 2).

3.1.1.1.1.1.1. Green pod yield ha^{-1}

Statistically significant variation was recorded in terms of green pod yield ha^{-1} of garden pea due to different levels of zinc, molybdenum and their interaction effect. The highest green pod yield ha^{-1} (8.41 ton) were recorded from $Zn_{3.0}$ which were statistically similar (8.18 ton) to $Zn_{1.5}$, whereas the lowest green pod yield ha^{-1} (7.39 ton) were observed from Zn_0 (Table 1). Alam et al. (2010) reported that 2.5 kg ha^{-1} of each Zn produced the highest seeds yield of 8.51 t ha^{-1}. Kumar et al. (2014) reported that seed inoculation with zinc @ 5 kg ha^{-1} gave the significantly higher seed yield (11.97 q ha^{-1}). The highest green pod yield ha^{-1} (8.31 ton) were found from $Mo_{0.6}$ which were statically similar (8.08 ton) to $Mo_{0.3}$, while the lowest green pod yield ha^{-1} (7.59 ton) were recorded from Mo_0 (Table 1). Sheudzhen et al. (1985) reported highest yield with 0.05% Mo (7.46 t ha^{-1}) compared to (6.14 t ha^{-1}) zero trace element. Hazra and Tripathi (1998) observed that molybdenum application at the rate of 1.5 kg ha^{-1} increased seed yields. The highest green pod yield ha^{-1} (8.91 ton) was recorded from $Zn_{3.0}Mo_{0.6}$ which were statistically similar (8.48 ton, 8.39 ton and 8.36 ton) to $Zn_{1.5}Mo_{0.3}$, $Zn_{3.0}Mo_0$ and $Zn_{1.5}Mo_{0.6}$ treatment combination (Table 2). On the other hand, the lowest green pod yield ha^{-1} (6.68 ton) was found from Zn_0Mo_0 treatment combination (Table 2).

3.2. pH and Nutrient status of post-harvest soil

Statistically non-significant variation was recorded in terms of soil pH in post-harvest soil of garden pea due to different levels of zinc, molybdenum and their interaction effect. The recorded data revealed that the highest soil pH (6.37) was recorded from $Zn_{3.0}$, while the lowest soil pH (6.17) was observed from Zn_0 (Table 3). The highest soil pH (6.34) was found from $Mo_{0.6}$ and the lowest soil pH (6.24) was recorded from Mo_0 (Table 3). The highest soil pH (6.42) was recorded from $Zn_{3.0}Mo_{0.6}$, whereas the lowest soil pH (6.15) was observed from Zn_0Mo_0 (Table 4).

Organic matter content of post-harvest soil of garden pea varied non-significantly due to different levels of zinc, molybdenum and their interaction effect. Data revealed that the highest organic matter (1.34%) was recorded from $Zn_{3.0}$, while the lowest organic matter (1.26%) was found from Zn_0 (Table 3). The highest organic matter (1.33) was recorded from $Mo_{0.6}$, while the lowest organic matter (1.26) from Mo_0 (Table 3). The highest organic matter (1.37) was recorded from $Zn_{3.0}Mo_{0.6}$ and the lowest organic matter (1.20) from Zn_0Mo_0 (Table 4).

Table 3: Effect of zinc and molybdenum on pH, organic matter, total N, available P, K, Zn and Mo of post-harvest soil of garden pea

Treatments	Soil pH	Organic matter (%)	Total nitrogen (%)	Available P (ppm)	Exchangeable K (me %)	Available Zn (ppm)	Available Mo (ppm)
Levels of zinc							
Zn_0	6.17	1.26	0.070	18.79	0.111	0.258^c	0.326
$Zn_{1.5}$	6.32	1.31	0.072	19.57	0.115	0.366^b	0.333
$Zn_{3.0}$	6.37	1.34	0.073	19.81	0.117	0.432^a	0.343
LSD(0.05)	--	--	--	--	--	0.025	--
Level of significance	NS	NS	NS	NS	NS	0.01	NS
Levels of molybdenum							
Mo_0	6.24	1.26	0.069	19.12	0.112	0.343	0.236^c
$Mo_{0.3}$	6.28	1.32	0.072	19.42	0.114	0.354	0.375^b
$Mo_{0.6}$	6.34	1.33	0.074	19.63	0.117	0.358	0.392^a
LSD(0.05)	--	--	--	--	--	--	0.010
Level of significance	NS	NS	NS	NS	NS	NS	0.01

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

Table 4: Interaction effect of zinc and molybdenum on pH, organic matter, total N, available P, K, Zn and Mo of post-harvest soil of garden pea

Treatments	Soil pH	Organic matter (%)	Total nitrogen (%)	Available P (ppm)	Exchangeable K (me %)	Available Zn (ppm)	Available Mo (ppm)
Zn_0Mo_0	6.15	1.20	0.068	18.55	0.108	0.251	0.230
$Zn_0Mo_{0.3}$	6.16	1.29	0.070	18.86	0.110	0.260	0.364
$Zn_0Mo_{0.6}$	6.21	1.30	0.072	18.96	0.114	0.262	0.385
$Zn_{1.5}Mo_0$	6.26	1.28	0.069	19.47	0.112	0.357	0.234
$Zn_{1.5}Mo_{0.3}$	6.33	1.32	0.073	19.57	0.115	0.366	0.375
$Zn_{1.5}Mo_{0.6}$	6.39	1.32	0.076	19.67	0.117	0.374	0.392
$Zn_{3.0}Mo_0$	6.32	1.30	0.070	19.36	0.114	0.422	0.243
$Zn_{3.0}Mo_{0.3}$	6.36	1.35	0.072	19.83	0.117	0.435	0.386
$Zn_{3.0}Mo_{0.6}$	6.42	1.37	0.075	20.25	0.119	0.439	0.399
LSD(0.05)	--	--	--	--	--	--	--
Level of significance	NS	NS	NS	NS	NS	NS	NS

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

Statistically non-significant variation was recorded in terms of total nitrogen in post-harvest soil of garden pea due to different levels of zinc, molybdenum and their interaction effect. The highest total nitrogen (0.073%) was recorded from $Zn_{3.0}$, while the lowest total nitrogen (0.070%) was observed from Zn_0 (Table 3). The highest total nitrogen (0.074%) was found from $Mo_{0.6}$ and the lowest total nitrogen (0.069%) was recorded from Mo_0 (Table 3). The highest total nitrogen (0.075%) was recorded from $Zn_{3.0}Mo_{0.6}$, whereas the lowest total nitrogen (0.068%) was observed from Zn_0Mo_0 (Table 4).

Statistically non-significant variation was recorded in terms of available P in post-harvest soil of garden pea due to different levels of zinc, molybdenum and their interaction effect. The highest available P (19.81 ppm) was recorded from $Zn_{3.0}$, while the lowest available P (18.79 ppm) was observed from Zn_0 (Table 3). The highest available P (19.63 ppm) was found from $Mo_{0.6}$ and the lowest available P (19.12 ppm) was recorded from Mo_0 (Table 3). The highest available P (20.25 ppm) was recorded from $Zn_{3.0}Mo_{0.6}$, whereas the lowest available P (18.55 ppm) from Zn_0Mo_0 (Table 4).

Statistically non-significant variation was recorded in terms of exchangeable K in post-harvest soil of garden pea due to different levels of zinc, molybdenum and their interaction effect. The highest exchangeable K (0.117 me %) was recorded from $Zn_{3.0}$, while the lowest exchangeable K (0.111 me %) from Zn_0 (Table 3). The highest exchangeable K (0.117 me %) was found from $Mo_{0.6}$ and the lowest exchangeable K (0.112 me %) from Mo_0 (Table 3). The highest exchangeable K (0.119 me %) was recorded from $Zn_{3.0}Mo_{0.6}$, whereas the lowest exchangeable K (0.108 me %) was observed from Zn_0Mo_0 (Table 4).

Statistically significant variation was recorded in terms of available Zn in post-harvest soil of garden pea due to different levels of zinc, but different level of molybdenum and their interaction effect varied non significantly. The highest available Zn (0.432 ppm) was recorded from $Zn_{3.0}$ which was closely followed (0.366 ppm) by $Zn_{1.5}$, while the lowest available Zn (0.258 ppm) was observed from Zn_0 (Table 3). The highest available Zn (0.358 ppm) was found from $Mo_{0.6}$ and the lowest available Zn (0.343 ppm) was recorded from Mo_0 (Table 3). The highest available Zn (0.439 ppm) was recorded from $Zn_{3.0}Mo_{0.6}$, while the lowest available Zn (0.251 ppm) from Zn_0Mo_0 (Table 3).

Statistically significant variation was recorded in terms of available Mo in post-harvest soil of garden pea due to different levels of molybdenum but different level of zinc and their interaction effect varied non significantly. The highest available Mo (0.343 ppm) was recorded from $Zn_{3.0}$ and the lowest available Mo (0.326 ppm) from Zn_0 (Table 3). The highest available Mo (0.392 ppm) was found from $Mo_{0.6}$, which was closely followed (0.375 ppm) by $Mo_{0.03}$ and the lowest available Mo (0.236 ppm) from Mo_0 (Table 3). The highest available Mo (0.399 ppm) was recorded from $Zn_{3.0}Mo_{0.6}$, whereas the lowest available Mo (0.230 ppm) was observed from Zn_0Mo_0 (Table 4).

4. Conclusion

Application of 3.0 kg Zn ha^{-1} & 0.6 kg Mo ha^{-1} and 1.5 kg Zn ha^{-1} & 0.3 kg Mo ha^{-1} showed statistically similar green pod yield. So, combination of 1.5 kg Zn ha^{-1} & 0.3 kg Mo ha^{-1} can be more beneficial for the farmers to get better yield from the cultivation of garden pea.

5. References

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