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Research Article

EFFECT OF MICRONUTRIENT ZINC AND BORON ON THE INCIDENCE OF SOIL PEST ON POTATO

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ABSTRACT

Bio-efficacy of various treatment schedules of micronutrient Zinc (Zn) and Boron (B), *viz* T_1 ($V_2Zn_0B_0$), T_2 ($V_2Zn_1B_1$), T_3 ($V_2Zn_1B_0$), T_4 ($V_2Zn_0B_1$), T_5 ($V_1Zn_0B_0$), T_6 ($V_1Zn_1B_1$), T_7 ($V_1Zn_1B_0$) and T_8 ($V_1Zn_0B_1$) were evaluated against soil pests, viz. cutworm, *Agrotis ipsilon* (Hufner), mole cricket, *Gryllotalpa africana*, P.de. Beau. and potato tuber moth (PTM), *Phthorimaea operculella* (Zeller) in two potato variety, Kufi Chandramukhi (K.CM) and Kufri Jyoti (K.JT) during *rabi* season of two consecutive years in 2015-2016 and 2016-2017 from November to February. The percentage of healthy tuber yield of K.JT and K.CM was found highest in T_2 (78.93 – 80.75%) and T_6 (81.43 – 82.47%) and found lowest in T_1 (66.45 – 69.49%) and T_5 (63.24 – 68.58%), respectively. Similarly percentage of tuber damage of K.JT and K.CM was noted highest in T_1 (30.51 – 33.55 %) and T_5 (31.42 – 36.76%) and it was lowest in T_2 (19.25–21.07%) and T_6 (17.53 – 18.57%) respectively. Among the different treatment schedules combined application of Zn and B in T_2 and T_6 revealed effective result in increasing marketable yield of potato tubers and reduction of soil pest incidence over control T_1 and T_5 and also over other treatments.

INTRODUCTION

Among the vegetable crops, the family solanaceae forms an important group, which includes potato (*Solanum tuberosum* L.) along with other essential vegetables of our daily diet. Potato is the fourth most important food crop in the world after wheat, rice and maize in terms of production and grown in about one hundred and forty countries (Haase, 2008). The potao originated from the mountains of South America, in recent years potao has spread in many countries with warmer and drier climates and it has become important in regions such as the plains of India, Bangladesh, Pakistan, Central America and Argentina (Ahmad *et al.*, 2011). It contributes about 22% of the total vegetables and about 40% of the root and tuber crops produced in the world (Ghosh and Chakraborty, 2012). In India among the states, Uttar Pradesh, West Bengal and Bihar accounted for nearly 66 per cent area and 73 per cent production of the country (Indian Horticulture Database, 2013). In West Bengal, potato is the most important food crop, next to cereals and the states ranks second position in area (386.61 m. ha) and production (11591.30 m. tonnes), but first in productivity (30.00 t/ha) in the country (Indian Horticulture Database, 2013). Earlier, its cultivation was largely confined to the districts of Hooghly, Burdwan and Midnapore, but with the increasing facilities of irrigation, introduction of high yielding early maturing varieties and development of suitable agronomic practices, potato cultivation is gradually being extended to other districts of West Bengal (Anonymous 2013b). It is estimated herbivorous insects eat about 26% of the potential food production and India loses about 30% of its crops every year due to pests and diseases (Sharma and Rao, 2012). The insect pests inflict crop losses to the tune of 40 per cent in vegetable production (Gaurav, 2011). More than 100 insect pest and non-insect pest generally infest potato crop from different parts of World (Simpson, 1977). Among these insect pests, cutworm, *Agrotis ipsilon* (Hufner) (Noctuidae: Lepidoptera); Mole cricket, *Gryllotalpa africana*, P.de. Beau. (Gryllotalpidae: Orthoptera) and potato tuber moth (PTM), *Phthorimaea operculella* (Zeller) (Gelechiidae: Lepidoptera) are the most important soil pests cause tuber damage, as a result to reduce more than yield of potato tubers. In addition to tubers, they also cause damage to the foliage of the crop (Konar *et al*. 2003; Konar and Paul, 2005). They cut the tender shoots near the ground level and feed on the cutted leaves. Therefore, to

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minimize shoot damage and tuber damage caused by soil pests on potato, a number of synthetic insecticides are applied randomly, but with limited success. Therefore, keeping in view, the present investigation was conducted to assess the efficacy of different treatment schedules against soil pests of potato. A thorough study regarding the incidence pattern of different insect pests and effect of various micronutrients on the occurrence of insect pests are very much essential to control these pests effectively. Sometimes excess application of micronutrients increase the incidence of pest and diseases and make the crop susceptible to pest and diseases. Therefore the present investigation was undertaken to study the incidence pattern of different insect pests of potato in new alluvial zones of West Bengal with the role of micronutrient (Zn and B) application on the occurrence of insect pests of Kufri Jyoti and Kufri Chandramukhi varieties of potato. Apart from this field trial efforts were also being made to work out the most effective way to controlling these pests with a view of safer human toxicity.

MATERIALS AND METHODS

The present field study was laid down to find out the effect of zinc and boron on the soil pest incidence of potato-pest complex for two consecutive *rabi* seasons from November to February during 2015-16 and 2016-17 respectively at District Seed Farm, Department of Agriculture, Government of West Bengal, P.O. - Burdwan, Dist. - Burdwan and West Bengal. The effect of micronutrients (Zn and B) on the incidence of important pest and diseases of potato was evaluated for two years (2015-16 and 2016-17). The experiment was carried out in 2-factor RBD with three replications (Gomez and Gomez, 1984). All standard agronomic practices, recommended for the state, were strictly followed during raising the crop (Anonymous, 2012) Kufri Jyoti and Kufri Chandramukhi were sown in 6x2 sq. m. Plot with a spacing of 60x20 cm. The recommended agronomic practices were followed without any application of plant protection chemical for growing the crop. There were eight treatments with different dose of Zn and B in both the varieties (Table 1).

Table 1 Different treatments of Zn and B applied in the experiment

Number of treatments	Treatments	Quantity of Zn and B
1	T_1 ($V_2Zn_0B_0$)	0 kg Zn + 0 kg B/ha on V_2
2	T_2 ($V_2Zn_1B_1$)	5 kg Zn + 5 kg B/ha on V_2
3	T_3 ($V_2Zn_1B_0$)	5 kg Zn + 0 kg B/ha on V_2
4	T_4 ($V_2Zn_0B_1$)	0 kg Zn + 5 kg B/ha on V_2
5	T_5 ($V_1Zn_0B_0$)	0 kg Zn + 0 kg B/ha on V_1
6	T_6 ($V_1Zn_1B_1$)	5 kg Zn + 5 kg B/ha on V_1
7	T_7 ($V_1Zn_1B_0$)	5 kg Zn + 0 kg B/ha on V_1
8	T_8 ($V_1Zn_0B_1$)	0 kg Zn + 5 kg B/ha on V_1

V_2 = Kufri Jyoti
V_1= Kufri Chandramukhi

The population dynamics of different insect pests were recorded at 7 days interval after germination of potato till harvesting of the crop. The observations on aphid population was done on 100-leaf index method (Simpson, 1940), whereas for other pest population in a plant was recorded from one upper, one middle and one lower compound leaves. Following this method, of 10 plants were selected at random in each plot. Observations on the number of plants affected by different viral diseases were also recorded. Besides this, the yield of healthy and damaged tubers by different soil pests in the field was also noted down during harvesting. The data recorded were subjected to necessary transformations before proceeding to any statistical analysis.

RESULT AND DISCUSSION

Eight micronutrient treatments consisting of Zinc (Zn) and Boron (B) were evaluated against aphid and whitefly incidence on Kufri Jyoti (K.JT) and Kufri Chandramukhi (K.CM) varieties of potato in consecutive two years during 2015-16 and 2016-17. The data recorded for two consecutive years were presented separately for each pest.

The data during 2015-16 and 2016-17 presented in Table 2 and 3 revealed that all the treatments was significantly superior in decreasing the population of soil pests during the entire crop life in both the potato varieties of K.JT and K.CM than untreated control. The initiation of the pest was started on the crop from third week of December till the dehaulmed the crop.

The yield of potato tuber was also mainly depends on the infestation level of soil pests. Therefore the yield of potato tubers on different treatments was evaluated during harvesting of the crop. In the first year of study (2015-16), it has been observed that yield of the crop varied significantly with different treatments (Table 2). Total number of healthy tubers per plot in K.JT was recorded highest in T_2 (600.00) followed by T_4 (598.33), T_3 (561.67) against control in T_1 (500.33), respectively. But maximum number of healthy potato tubers in case of K.CM were recorded in T_6 (592.33) which was closely followed by T_7 (558.33), T_8 (530.33) as against control in T_5 (407.67), respectively. The weight of healthy tuber per plot was obtained maximum in T_2 (27.50 kg/plot) which was succeeded by T_4 (26.20 kg/plot) and T_3 (25.67 kg/plot) over T_1 (20.10 kg/plot), respectively in the potato variety of K.JT. Similar performance by Zn and B was also observed in K.CM recording highest yield of healthy tubers in T_6 (26.20 kg/plot) followed by T_8 (24.00 kg/plot) and T_7 (23.20 kg/plot) than control in T_5 (18.90 kg/plot), respectively. Added to this T_2 gave highest percentage of healthy tuber (78.93 %) in K.JT against 66.45% in untreated control T_1 where as in K.CM T_6 was the best giving 82.47% of healthy tuber against 68.58% in untreated control T_5 (Table 4). Regarding the yield of potato tubers on K.CM and K.JT in T_3 and T_4 and again T_7 and T_8 were at par each other in both the potato varieties. The tuber damage caused by various soil pest viz. cutworm, mole cricket and Potato tuber moth (PTM) on both the varieties of potato under different treatment of Zn and B was also recorded (Table 2). It was inferred from the results that lowest damaged by cutworm in number and weight basis in K.JT was found in T_2 (103.00 and 4.55 kg, respectively) followed by T_4 (110 and 5.23 kg, respectively), T_3 (117.33 and 5.33 kg, respectively) and T_1 (123.67 and 6.42 kg, respectively). But in K.CM minimum damage by cutworm was recorded in T_6 (80.33 and 3.21 kg) and then the order were T_7 (90.33 and 3.92 kg), T_8 (97.33 and 4.05 kg) and T_5 (115.00 and 5.45 kg), respectively in number and weight basis. The same

parameter caused by mole cricket in both number and weight basis were also observed minimum in T_2 (2.73 and 1.00 kg, respectively) and T_6 (115.00 and 5.45 kg, respectively) and maximum in T_4 (69.67 and 3.31 kg, respectively) and in T_8 (66.00 and 2.86 kg, respectively) over check in T_1 (78.67 and 3.57 kg, respectively) and in T_5 (72.67 and 3.16 kg, respectively), respectively in both the potato varieties of K.JT and K.CM. A very less number of tubers were recorded to cause damaged by PTM which ranged from 1.00 to 4.00 and 0.04 kg to 0.16 kg in both number and weight basis in K.JT while in K.CM it was varied from (0.00 to 0.02 and 0.00 to 0.05 kg, respectively) in number and weight basis. Therefore, total tuber damaged by all the soil pests were observed highest in T_3 (184.66) and T_8 (164.33) in number basis but in weight basis T_4 (5.58 kg/plot) and T_8 (6.94 kg/plot) recorded maximum yield of damage tubers than other treatments with Zn and B and T_4 and T_8 treatments recorded lowest yield of damage tuber than control in T_1 (10.15 kg/plot) and T_5 (8.66 kg/plot), respectively in both the varieties of potato i.e. K.JT and K.CM.

In the next year of study during 2016-17, healthy tuber yield of potato on different micronutrients treatments ranged from 490 to 572.33 as against 468.67 in untreated control and 22.30 kg/plot to 26.10 kg/plot over control (21.16 kg/plot) in number and weight basis in K.JT (Table 3). In K.CM, T_6 (630.33 and 26.26 kg/plot) recorded highest yield of healthy tubers followed by T_7 (560.00 and 23.10 kg/plot) over control T_5 (400.00 and 16.67 kg/plot) which had significantly superior over control. Maximum damaged on potato tubers caused by cutworm, mole cricket and PTM was recorded in T_3 (110.00, 70.67 and 3.00, respectively) in number and in weight basis

Table 2 Total number and weight of tuber damage caused by soil pests (cutworm, molecricket and potato tuber moth together) on potato under different treatment schedules during 2015-16

Treatments	Healthy tubres		Cutworm		Molecricket		Potato tuber moth		Damage tubers	
	No/plot	Kg/plot	No/plot	Kg/plot	No/plot	Kg/plot	No/plot	Kg/plot	No/plot	Kg/plot
T_1	500.33	20.10	123.67	6.42	78.67	3.57	4.00	0.16	206.34	10.15
T_2	600.00	27.50	103.00	4.55	60.00	2.73	1.00	0.06	164.00	7.34
T_3	561.67	25.67	117.33	5.33	65.33	3.11	2.00	0.10	184.66	8.54
T_4	598.33	26.20	110.00	5.23	69.67	3.31	1.00	0.04	180.67	8.58
T_5	407.67	18.90	115.00	5.45	72.67	3.16	2.00	0.05	189.67	8.66
T_6	592.33	26.20	80.33	3.21	56.67	2.36	0.00	0.00	137.00	5.57
T_7	558.33	23.20	90.33	3.92	64.33	2.80	0.00	0.00	154.66	6.72
T_8	530.33	24.00	97.33	4.05	66.00	2.86	1.00	0.03	164.33	6.94
S.Em. (±)	4.17	0.18	1.94	0.55	2.63	0.19	0.64	0.02	-	-
C.D. $_{0.05}$	12.67	0.54	5.88	NS	7.98	0.58	1.97	0.03	-	-

*Plot size = 12 sq. M

Table 3 Total number and weight of tuber damage caused by soil pests (cutworm, molecricket and potato tuber moth together) on potato under different treatment schedules during 2016-17

Treatments	Healthy tubres		Cutworm		Molecricket		Potato tuber moth		Damage tubers	
	No/plot	Kg/plot	No/plot	Kg/plot	No/plot	Kg/plot	No/plot	Kg/plot	No/plot	Kg/plot
T_1	486.67	21.16	126.67	5.50	90.00	3.60	4.33	0.19	221.00	9.29
T_2	572.33	26.01	100.00	4.00	50.67	2.20	0.00	0.00	150.67	6.20
T_3	490.67	22.30	110.00	5.00	70.67	3.07	3.00	0.13	183.67	8.20
T_4	550.00	23.91	99.33	4.51	70.67	2.94	2.67	0.11	172.67	7.56
T_5	400.00	16.67	130.33	5.67	82.00	3.72	7.00	0.30	219.33	9.69
T_6	630.33	26.26	90.67	3.94	55.33	2.05	0.00	0.00	146.00	5.99
T_7	560.00	23.10	106.67	4.26	60.67	2.64	0.67	0.03	168.01	6.93
T_8	487.67	22.16	120.67	5.25	78.33	3.53	4.67	0.19	203.67	8.97
S.Em. (±)	1.99	0.95	2.00	0.40	1.67	0.33	0.60	0.07	-	-
C.D. $_{0.05}$	6.03	2.88	6.07	1.21	5.06	1.00	1.82	NS	-	-

*Plot size = 12 sq.

Table 4 Percent yield (weight basis) of healthy and damaged tubers under different micronutrient (Zn and B) treatments during 2015-16 and 2016-17

Treatment Schedule	Healthy Tubers (kg/plot)		Damage tubers (kg/plot)		Percent yield of Healthy tubers (%)		Percent yield of damage tubers (%)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1	20.10	21.16	10.15	9.29	66.45	69.49	33.55	30.51
T_2	27.50	26.01	7.34	6.20	78.93	80.75	21.07	19.25
T_3	25.67	22.30	8.54	8.20	75.04	73.11	24.96	26.89
T_4	26.20	23.91	8.58	7.56	75.33	75.98	24.67	24.02
T_5	18.90	16.67	8.66	9.69	68.58	63.24	31.42	36.76
T_6	26.20	26.26	5.57	5.99	82.47	81.43	17.53	18.57
T_7	23.20	23.10	6.72	6.93	77.54	76.92	22.46	23.08
T_8	24.00	22.16	6.94	8.97	77.57	71.19	22.43	28.81

(5.00, 3.07 and 0.13 kg/plot, respectively) while minimum damaged was found in T_2 (100.00 and 50.67) and 4.00 kg/plot and 2.20 kg/plot), respectively but no damage by PTM were observed in T_2 in K.JT against untreated control (126.67, 90.00 and 4.33) and (5.50 kg/plot, 3.60 kg/plot and 0.19 kg/plot), respectively. In case of K.CM minimum damaged by the same pests were observed in T_6 (90.67, 55.33 in number and 3.94 kg/plot, 2.05 kg/plot) in weight basis against cutworm and mole cricket but no damaged were obtained by PTM in T_6 and the highest damaged of potato tubers by the pests were recorded in T_8 (120.67, 78.33 and 4.67) and (5.25 kg/plot, 3.53 kg/plot and 0.19 kg/plot) against untreated control (130.33, 2.00 and 7.00) and (5.67 kg/plot, 3.72 kg/plot and 0.30 kg/plot) in both number and weight basis respectively. Therefore, the total number of damaged tubers was found maximum in T_3 (183.67 and 8.20 kg/plot) and T_8 (203.67 and 8.97 kg/plot) over control in T_1 (221.00 and 9.29 kg/plot) and in T_5 (219.33 and 9.69 kg/plot) in both number and weight basis in the two potato varieties of K.JT and K.CM, respectively. Consequently, T_2 and T_6 gave the highest percentage of healthy tuber yield (80.75 % and 81.43 %) in both the potato varieties i.e. K.JT and K.CM, respectively (Table 4). However, all the treatments recorded significantly higher yield as compared to untreated control (T_1 and T_5).

It is therefore evident from the tables that combined application of both Zn and B achieved lowest percent tuber damage caused by the soil pests in both the potato varieties of K.JT and K.CM. It could be conclude from the present findings that the various treatments of Zn and B were significantly influenced to increase the healthy tuber yield of potato crop than the untreated control.

CONCLUSION

In the following eight treatments of micronutrients (Zn and B) in two potato varieties (K.JT and K.CM) were investigated on the incidence pattern of different potato pest complex and also for yield of potato. It was recorded that application in combination of both Zn and B was most effective in reducing the population of major soil pests of potato such as cutworm, PTM and mole cricket in both the cultivars of potato i.e. K.CM and K.JT. The cultivar K.JT (T_2) and K.CM (T_6), when treated with both Zn and B recorded lower infestation. The yield of healthy potato tubers was also recoded higher (number and weight basis) in the above mentioned treatments as compared to untreated control. It was also revealed that the application of Zn and B either in alone or in combination could not protect the crop from soil pest attack during the entire period of crop growth but enable to reduce their infestation. However, B had better performance than Zn regarding its single application on potato in both the varieties.

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