Impact of micronutrient Zinc and Boron on the whitefly incidence of potato

Biplab Kahar*

*Dept. of Zoology, Panchakot Mahavidyalaya, Purulia, W.B.-723121, India; email: biplab.kahar1984@gmail.com

Abstract

Bio-efficacy of different 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 whitefly, Bemisia tabaci (Gennadius) (Hemiptera: Aleyrodidae) in two potato variety, Kufri Chandramukhi (K.CM) and Kufri Jyoti (K.JT) during Rabi season of two consecutive years in 2017-2018 and 2018-2019 from November to February. The application in combination of both zinc and boron was most effective in minimizing the whitefly population in both the cultivars of potato i.e. Kufri Chandramukhi and Kufri Jyoti. Therefore the cultivar Kufri Jyoti (T_2) and Kufri Chandramukhi (T_6), were recorded lower whitefly incidence. The percentage of healthy tuber yield of K.JT and K.CM was highest in T_6 (81.43 – 82.47%) and T_2 (78.93 – 80.75%) and lowest in T_5 (63.24 – 68.58%) and T_1 (66.45 – 69.49%), respectively. At the same time percentage of tuber damage of K.JT and K.CM was noted highest in T_5 (31.42 – 36.76%) and T_1 (30.51 – 33.55 %) and it was lowest in T_6 (17.53 – 18.57%) and T_2 (19.25–21.07%), respectively. Among the different treatment schedules combined application of Zn and B in T_2 and T_6 showed effective result in increasing marketable yield of potato tubers and decreasing whitefly incidence over control T_1 and T_5 and also over other treatments.

Keywords: Whitefly, Effectiveness, Micronutrients, Potato, Yield.

Introduction

Potato (*Solanum tuberosum* L.) plays a vital role along with other essential vegetables in our daily diet. It grows all over the country under a wide range of agro-climatic conditions and secures 3rd and 4th rank in the world (Pandey *et al.*2007) in the area (2.16 m ha) and production (53.04 mt), respectively, with the productivity of 24.56 t ha-1 (Anonymous, 2015). Varietal limitation along with pest and disease infestations are the major constrains for achieving higher production of potato. Near about 100 insect pests and non-insect pests all over the world were recorded to infest potato crop and of which the whitefly namely *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) found to be the most important sucking pest that not only causes damage by sucking plant sap, but also transmitting various potato viruses (Konar *et al.* 2003, Dharpure, 2002 and Bhatnagar, 2007), as a result yield of potato tubers being reduced. It is estimated that herbivorous insects eat about 26 per cent of the potential food production and India loses about 30 per cent of its crop every year due to pests and various viral diseases (Sharma and Rao, 2012). The insect pests inflict crop losses to the tune of 40 per cent in vegetable production (Gaurav, 2011). The yield losses have shown an increasing trend over the year. Butani and Verma (1976) and Misra and Agrawal (1998) registered a comprehensive list of insect and non-insect pests damaging this vegetable crop in India. Whitefly is the most important sucking pests, which not only cause damage by sucking plant sap, but also transmitting various potato viruses (Khurana,1999 and Paul & Konar 2006). To minimize the crop loss by

this pest the growers use pesticides not only as control tactics. As a result, the chances of health hazards are increased as in many cases potato is used just after little boiling. The knowledge in this line ultimately helps to formulate effective management strategies against the noxious sucking pests of potato and this was the major reason to focus the present study in this area of research. Therefore, keeping in view, the present investigation was conducted to assess the efficacy of different treatment schedules against whitefly of potato. A thorough study regarding the incidence pattern of whitefly and effect of various micronutrients on the occurrence of the 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 whitefly of potato in new alluvial zones of West Bengal with the role of micronutrient (Zn and B) application on the occurrence of whitefly 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 whitefly incidence of potato-pest complex for two consecutive *Rabi* seasons from November to February during 2017-18 and 2018-19 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 whitefly on potato was evaluated for two years (2017-18 and 2018-19). 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, 2015) Kufri Jyoti and Kufri Chandramukhi were sown in 6x2 sq. m. Plot with a spacing of 60 x 20 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_1= Kufri Chandramukhi; V_2 = Kufri Jyoti

The population dynamics of whitefly were recorded at 7 days interval after germination of potato till harvesting of the crop. The observations on whitefly population was done on 100-leaf index method (Simpson, 1940). The pest population in a plant was recorded from one upper, one middle and one lower compound leaf. Following this method, of 10 plants were selected at random in each plot. Besides this, the

yield of healthy and damaged tubers 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 whitefly incidence on Kufri Jyoti and Kufri Chandramukhi varieties of potato in two consecutive years during 2017-18 and 2018-19. The pooled data of two years revealed that the potato treated with different treatments of Zn and B reduced the number of whitefly significantly over untreated control in both the varieties of potato (Kufri Chandramukhi and Kufri Jyoti) (Table 2). It showed that T_2 (B_1Zn_1) recorded the lowest mean whitefly population (1.74) as against the highest mean population of whitefly (2.82) in untreated control (T_1) in case of Kufri Jyoti. It was closely followed by T_4 (B_1Zn_0) and T_3 (B_0Zn_1) recording the population of (2.23 and 2.51) respectively. But in case of Kufri Chandramukhi T_6 (B_1Zn_1) gave maximum decrease of whitefly population (1.82) over control (T_5) recording the highest mean population of 3.44 and then in the order were T_7 (2.20) and T_8 (2.69). The lowest population of whitefly in both the varieties Kufri Jyoti and Kufri Chandramukhi was found in T_2 (B_1Zn_1) and T_6 (B_1Zn_1) with a minimum mean population of 1.74 and 1.82 respectively. The findings indicated that higher pest population during this period might be due to the prevailing favourable weather condition and maximum vegetative growth phase of the crop as the population of pest was favoured by bulking stage of the crop characterized by more foliage (Chandramohan and Nanjan, 1992; Kishore *et al.* 2005; Lanunocheta and Pankaj 2012). The population of whitefly decreased gradually after attaining the peak in all the cultivars till full maturity of the crop. These treatments (T_2 and T_6) were found effective to some extent in reducing the incidence of whitefly population in both the varieties of potato as compared to other treatments including control. Micro nutrient alone in (B_0Zn_1 and B_1Zn_0) in T_3, T_4, T_7 and T_8 treatments cannot manage the infestation of whitefly on both the varieties of potato throughout crop growing season below its critical limit. From the results it is evident that the combine application of both zinc and boron showed best result in minimizing the whitefly population in both the varieties of potato Kufri Chandramukhi and Kufri Jyoti against the other treatments. On the other hand, single application of boron recorded minimum population of whitefly in Kufri Jyoti in comparison to single application of zinc while single application of zinc gave better result in minimizing the population of whitefly in Kufri Chandramukhi.

The yield of potato tuber was also mainly depends on the infestation level of whitefly. Therefore the yield of potato tubers on different treatments was evaluated during harvesting of the crop. In the first year of study (2017-18), it has been observed that yield of the crop varied significantly with different treatments (Table 3). The weight of healthy tuber per plot was obtained maximum in T_2 (27.50 t ha-1) which was succeeded by T_4 (26.20 t ha-1) and T_3 (25.67 t ha-1) over T_1 (20.10 t ha-1), 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 t ha-1) followed by T_8 (24.00 t ha-1) and T_7 (23.20 t ha-1) than control in T_5 (18.90 t ha-1), 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. 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. Therefore, in weight basis in T_4 (8.58 t ha-1) and T_8 (6.94 t ha-1) 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 t ha-1) and T_5 (8.66 t ha-1), respectively in both the varieties of potato *i.e.* K.JT and K.CM.

Table 2. Effect of zinc and boron on the whitefly incidence in K. Chandramukhi and K. Jyoti during (Pooled data of two years)

Treatments	Population dynamics of whitefly on different treatment schedules													Mean
	December				January				February				March	
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	
$T_1=V_2B_0Zn_0$	0.00	0.00	0.00	0.00	2.00	2.33	3.00	3.67	5.33	6.00	6.67	4.67	3.00	**2.82**
	(0.71)	(0.71)	(0.71)	(0.71)	(1.52)	(1.65)	(1.71)	(1.94)	(2.40)	(2.29)	(2.56)	(2.15)	(1.71)	
$T_2=V_2B_1Zn_1$	0.00	0.00	0.00	0.00	0.00	1.67	2.00	2.33	3.33	4.00	4.00	3.00	2.33	**1.74**
	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(1.46)	(1.52)	(1.55)	(1.78)	(2.08)	(2.08)	(1.71)	(1.65)	
$T_3=V_2B_0Zn_1$	0.00	0.00	0.00	1.67	2.00	2.00	2.33	3.67	4.00	4.67	5.00	4.33	3.00	**2.51**
	(0.71)	(0.71)	(0.71)	(1.35)	(1.52)	(1.52)	(1.65)	(2.04)	(2.08)	(2.27)	(2.28)	(2.06)	(1.71)	
$T_4=V_2B_1Zn_0$	0.00	0.00	0.00	0.00	1.33	2.00	2.00	3.33	4.00	4.67	5.00	4.00	2.67	**2.23**
	(0.71)	(0.71)	(0.71)	(0.71)	(1.35)	(1.52)	(1.52)	(1.78)	(2.08)	(2.27)	(2.28)	(2.08)	(1.64)	
$T_5=V_1B_0Zn_0$	0.00	0.00	0.00	0.00	2.33	4.00	4.00	5.33	5.00	5.67	7.00	6.00	5.33	**3.44**
	(0.71)	(0.71)	(0.71)	(0.71)	(1.55)	(2.08)	(2.08)	(2.40)	(2.28)	(2.40)	(2.60)	(2.29)	(2.34)	
$T_6=V_1B_1Zn_1$	0.00	0.00	0.00	0.00	1.00	2.33	2.33	2.67	3.00	4.33	5.00	2.00	1.00	**1.82**
	(0.71)	(0.71)	(0.71)	(0.71)	(1.17)	(1.55)	(1.55)	(1.64)	(1.71)	(2.06)	(2.28)	(1.52)	(1.17)	
$T_7=V_1B_0Zn_1$	0.00	0.00	0.00	0.00	1.00	2.33	3.33	4.00	4.00	4.33	4.67	3.00	2.00	**2.20**
	(0.71)	(0.71)	(0.71)	(0.71)	(1.17)	(1.55)	(1.78)	(2.08)	(2.08)	(2.06)	(2.15)	(1.71)	(1.52)	
$T_8=V_1B_1Zn_0$	0.00	0.00	0.00	2.00	2.67	3.00	3.00	3.33	4.00	5.00	5.67	4.33	2.00	**2.69**
	(0.71)	(0.71)	(0.71)	(1.52)	(1.64)	(1.86)	(1.86)	(1.78)	(2.08)	(2.28)	(2.33)	(2.06)	(1.52)	
S.Em. (±)	-	-	-	0.15	0.22	0.12	0.25	0.26	0.30	0.35	0.32	0.20	0.20	-
C.D. $_{0.05}$	-	-	-	0.45	NS	0.36	0.76	0.79	0.91	1.06	0.97	NS	0.61	-

*Figures in parentheses are square root transformed values.

V_1 = Kufri Chandramukhi; V_2 = Kufri Jyoti

Table 3. Percent yield (weight basis) of healthy and damaged tubers under different micronutrient (Zn and B) treatments during 2017-18 and 2018-19

Treatment schedule	Healthy Tubers (t ha-1)		Damage tubers (t ha-1)		Percent yield of Healthy tubers (%)		Percent yield of damage tubers (%)	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
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	78.57
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

In the next year of study during 2018-19, healthy tuber yield of potato on different micronutrients treatments ranged from 22.30 t ha-1 to 26.10 t ha-1 over control (21.16 t ha-1) in weight basis in K.JT (Table 3). In K.CM, T_6 (26.26 t ha-1) recorded highest yield of healthy tubers followed by T_7 (23.10 t ha-1) over control T_5 (16.67 t ha-1) which had significantly superior over control. Therefore, the damaged tubers was found maximum in T_3 (8.20 t ha-1) and T_8 (8.97 t ha-1) over control in T_1 (9.29 t ha-1) and in T_5 (9.69 t ha-1) in 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 3). 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 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

It could be concluded that application in combination of both zinc and boron was most effective in reducing the population of whitefly in both the cultivars of potato *i.e.* Kufri Chandramukhi and Kufri Jyoti. The cultivar Kufri Jyoti (T_2) and Kufri Chandramukhi (T_6), when treated with both zinc and boron recorded lower whitefly infestation. The yield of healthy potato tubers was also recorded higher in the above mentioned treatments as compared to untreated control. It was also revealed that the application of zinc and boron either in alone or in combination could not protect the crop from of insect pests attack during the entire period of crop growth period. However, boron had better performance than zinc regarding its single application on potato in both the varieties.

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