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EFFECT OF DIFFERENT PESTICIDES, BIOFERTILIZERS AND THEIR COMBINATIONS ON SEED QUALITY OF DIFFERENT AGED BARLEY (*HORDEUM VULGARE* L.)

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SUMMARY

The efficacy of different pesticide, fungicide and biofertilizers combinational seed treatments was tested for vigor and viability in laboratory and field experiments using fresh, one year old and two years old seeds of barley. The seeds were treated with chlorpyriphos, vitavax, *Azotobacter* and *Phosphorus solubilizing bacteria (PSB)* in different combinations and their seed quality was assessed by recording germination and seedling vigour related parameters. Results revealed that seed treated with *Azotobacter + PSB* recorded maximum enhancement in seed quality as compared to control regarding all the parameters in fresh as well as old seed lots of barley. However, treatment of chlorpyriphos + vitavax + *Azotobacter + PSB* showed negative impact and resulted in a significant reduction in all the parameters. In general, it was concluded that application of biofertilizers as seed treatment results in better performance in terms of germination and vigour, while, the insecticide chlorpyriphos has a negative impact on seed germination if applied alone or in combination with other chemicals.

Key words: Barley, seed treatments, biofertilizers, pesticides

Barley (*Hordeum vulgare* L.) is a short-season, self-pollinated and early maturing crop, considered as world's oldest cultivated grain. It is recognized as one of the most important cereal crop in world, with an annual production of 159 MMT (Statista, 2020), next to rice, maize and wheat. It is grown in India primarily in *rabi* season. Only five per cent of the total production is used for human consumption (Singh *et al*., 2016). It is more tolerant and hardier than wheat and genetically equipped to acclimatize well under limited inputs and saline soils (Bertholdsson *et al.,* 2013 and Sallam *et al.,* 2019). Barley seed contains protein (11.5%), carbohydrate (74%) and fat (1.3%). Barley is considered as high yielding crop due to its hardy nature. The realization of yield would essentially depend on quality traits of seed *viz.* seed viability, vigor and health. Any factor negatively influencing these traits would ultimately result in lowering of yield. Biotic agents like pathogen and insect pests are known to deteriorate the quality of seed resulting in poor germination, loss of vigor, poor establishment of plant and reduction in yield (Bushra *et al*., 2013 and Cammarano *et al*., 2019). The chemical application to control pest and pathogen has its own limitation such as high cost, selectivity, effect on target organisms, development of pest resistance, resurgence of pests, pollution of food and feed, health hazards, toxicity towards plants and animals and environmental pollution etc. (Rahman *et al*., 2008). Several studies have found that imprudent application of these inputs have led to the deterioration of soil structure, pollution of water bodies and overall loss of ecosystem services and ecological balance (Chandini *et al*., 2019). One of the most ecologically friendly and cost-effective methods of pre-sowing seed treatment. Seed treatment refers to the exposure of the seeds to certain physical, chemical or biological agents which are not employed to make the seeds, pest or disease free only but treated to provide the possibility of pest and disease control also, when needed during germination and emergence of young plant and early growth of the plant (Bezpalko *et al.*, 2020).

MATERIALS AND METHODS

Seed material

Three seed lots (fresh, one and two year old) of barley variety "BH-946"were used in this study. The lots were obtained from the Breeder Seed Store of the Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar. Seeds were stored in jute bagsunder ambient environmental conditions. All precautionary measures were taken to maintain the seed in good physical and physiological condition, *i.e.* ventilation, relative humidity, fumigation and moisture content during the storage.

Treatment application method

Seeds of all the three lots were treated with chlorpyriphos 20EC, Vitavax, *Azotobacter*, *PSB* and their combinations. Initially, treatment of Chlorpyriphos was done with the recommended dose (1.5 ml in 50 ml of water for 1 kg of seed) using conical flask for proper mixing and adhering of treatment to seeds uniformly, treated seeds were shade dried under fan for three hours. Vitavax treatment (2g/kg) was given after chlorpyriphos and seeds were stirred well using the conical flasks. Biofertilizer treatment (5ml/kg) was given in the last and just after the biofertilizer application; seeds were used for taking observation of various physiological parameters in three replications. The treatments were given alone as well as in different combination with each other.

TABLE 1
List of treatments along with their details

Treatment	Details
T_1	Control (dry seeds)
T_2	Chlorpyriphos 20EC (1.5ml/kg of seed)
T_3	Vitavax (2g/kg of seed)
T_4	*Azotobacter* (5ml/kg of seed)
T_5	*Phosphate solubilizing bacteria* (5ml/kg of seeds)
T_6	*Azotobacter+PSB*
T_7	Vitavax+Chlorpyriphos
T_8	Vitavax+*PSB*
T_9	Vitavax+*Azotobacter*
T_{10}	Vitavax +*Azotobacter*+ *PSB*
T_{11}	Chlorpyriphos+*Azotobacter*
T_{12}	Chlorpyriphos+*PSB*
T_{13}	Chlorpyriphos+*Azotobacter*+*PSB*
T_{14}	Chlorpyriphos+Vitavax+*Azotobacter*
T_{15}	Chlorpyriphos+Vitavax +*PSB*
T_{16}	Chlorpyriphos+Vitavax+*Azotobacter*+ *PSB*

Standard germination test was performed by using 'Between Paper' method. 100 seeds were taken randomly from each treatment and placed between two moistened towel papers. These samples were then kept in the seed germinator at 20°C with 90±2% relative humidity. The seedlings were examined on the final count (7th day) and normal seedlings were selected according to guidelines (ISTA, 2011) and expressed as standard germination in percentage.

To calculate the speed of germination, fifty seeds were placed on sufficiently moistened filter papers in petri-plates in replicates of three. The newly emerged radicles (≥2 mm) of germinated seeds were counted on daily basis. Speed of germination was calculated based on the formula given by Maguire (1962):

$$\text{Speed of germination} = \frac{X1}{Y1} + \frac{X2-X1}{Y2} + \cdots \frac{Xn-Xn-1}{Yn}$$

Where,

X_1, X_2 and Xn = number of seeds germinated on first, second and n^{th} day, respectively

Y_1, Y_2 and Yn= number of days from sowing to first, second and n^{th} count, respectively

To obtain the average seedling length, thirty normal seedlings were chosen at random from three replications to measure root and shoot length in centimeter. Those thirty seedlings whose root and shoot lengths were recorded; they have been dried in a hot air oven for one day (24 hours) at 80 ± 1°C. The dried seedlings were weighed for each replication and the average dry weight of seedling was calculated.Vigor indices were calculated by using the formula, suggested by Baki and Anderson (1973) as follows:

Vigor index-I = Standard germination (%) × Average seedling length (cm)

Vigor index-II = Standard germination (%) × Average seedling dry weight (mg)

The field emergence index was recorded after sowing three replications of 100 seeds from each treatment in the field. The number of seedlings that emerged each day were counted until a consistent emergence was achieved (up to 21 days after sowing). The following formula was used to determine the field emergence index (Maguire, 1962):

$$\text{Field Emergence Index} = \frac{\text{No.of seedlings emerged}}{1^{st}\text{ Day of sowing}} + \ldots + \frac{\text{No. of seedlings emerged}}{\text{Day of last count}}$$

When the emergence was complete or there was no more addition to the total emergence, the seedling establishment was recorded by counting the total number of seedlings.

RESULTS AND DISCUSSION

With the passage of time, seed quality decreased among different seed lots due to seed ageing. The same trend observed in different physiological parameters like speed of germination, standard germination, seedling length, seedling dry weight, vigor indices, field emergence index, seedling establishment etc. The mean sum of squares due to lots and treatments were highly significant for the most of the characters and showed a significant difference among the various treatments and existence of high degree ofvariability was observed as shown in the Table 2 and 3.

The maximum standard germination (89.11%) was recorded in T_6 (*Azotobacter* + *PSB*) followed by *PSB* (88.56%), while, minimum (77.89%) was found in T_2 (Chlorpyriphos 20EC) as shown in Table 4.Similarly, in case of vigor indices shown in Table 6 same trend was observed. It might be due to the beneficial effect of biofertilizers which helped the seed in mobilizing the essential nutritional elements from non-usable to usable form *via* biological processes. Nitrogen fixing properties of bioinoculants along with the encouragement of seed nutrient uptake by *Azotobacter* and *PSB* was also reported previouslyby Me Carty *et al.* (2017) in wheat and Patra & Singh (2019) in cereals. Chlorpyriphos showed a negative effect on germination and the minimum germination percentage and vigor in all the lots was observed which was even less than control (untreated seed). This could be because Chlorpyriphos inhibited normal cell division or elongation by depressing nitrogen metabolism, amylase and ATP activities, impairing respiration and inhibiting respiration as reported by Santhosh kumar *et al.* (2015) in mungbean. The loss of germinability and viability occurred during natural ageing after one year of ageing and loss of germination was very high after two year of ageing.

The maximum speed of germination (55.89)was observed in T_{13} (Chlorpyriphos + *Azotobacter*+ *PSB*) followed by T_{12}(Chlorpyriphos + *PSB*) (54.89), T_{11} (Chlorpyriphos + *Azotobacter*-) (53.90) and minimum was found in T_{16}(Chlorpyriphos + Vitavax + *Azotobacter* + *PSB*)(43.36) as illustrated in Table 3.It might be because chlorpyriphos was used as a solute and water was used as a solvent to make a solution for seed treatment and that solvent aids seed for early embryo protrusion, as well as the impact of

TABLE 2
Analysis of variance for various seed quality parameters in barley (Hordeum vulgare L.) as influenced by different treatments

Source of variation	d. f.	Standard Germination (%)	Speed of Germination	Seedling length (cm)	Seedling dry weight (mg)
L	2	3065.98**	1691.07**	3487.24**	840.54**
T	15	71.75**	144.05**	47.71**	9.24**
L×T	30	1.12*	1.02*	0.96*	0.17*
Error	96	0.75	1.67	1.34	0.50

TABLE 3
Analysis of variance for various seed quality parameters in barley (Hordeum vulgare L.) as influenced by different treatments

Source of variation	d. f.	Vigour Index- I	Vigour Index- II	Seedling establishment (%)	Field emergence index
L	2	46293817**	11193509**	6767.23**	145.02**
T	15	746081**	149775**	77.82**	19.83**
L×T	30	22469**	2281*	3.95*	0.23*
Error	96	12025	4122	5.46	0.22

**Significant at p=0.01;*Significant at p=0.05, L=Lot, T=Treatment, L×T= Interaction between lot and treatment, DF=Degree of freedom, SOG = Speed of germination, EC=Electrical conductivity.

biofertilizers such as *Azotobacter* and *PSB* as co-treatment for providing the appropriate nutrient to seed. Whereas, the only Chlorpyriphos treatment showed as lower speed of germination. Chlorpyriphos + biofertilizers therapy had an effect on embryo protrusion from the second day. The minimum speed of germination was observed with Chlorpyriphos + Vitavax + *Azotobacter*+ *PSB* treatment. Treatment T_{14}, $T_{15}$and T_{16}showed the adverse effect on speed of germination as compared to control itmight be due to the combination treatment of Chlorpyriphos, Vitavax, *Azotobacter* and *PSB*.

It was found to be ineffective in combinational seed treatment and the other factors were also responsible, as previous research has shown that Chlorpyriphos and fungicidal treatment of cereal seeds induces chromosomal abnormalities as reported by Dubey *et al.* (2015) in barley and impeded amylase activity and ATPs activities, starch and protein degradation which is responsible for poor speed of germination in wheat and mungbean (Dalvi *et al.*, 1972). The speed of germination showed the significant variation for all the lots and treatments. Large number of treatments with biofertilizers showed the substantial impact on speed of germination. Basra *et al.* (2003) found that decline in speed of germination during ageing was accompanied with the increase in emergence time.

The maximum seedling lengthand seedling dry weight was (as shown in Table 3 and Table 4) recorded in T_6 (*Azotobacter* + *PSB*) followed by T_5 (*PSB*) as compared to control and minimum was found in T_{16} (Chlorpyriphos + Vitavax + *Azotobacter*+ *PSB*). It indicated that the Chlorpyriphos depressed the overall germination of the seedling and caused the reduction inseedlinglength andseedlingdryweight.

The highest field emergence index was recorded in T_6-*Azotobacter* + *PSB* (10.46) followed by T_5- *PSB* (10.00), T_4-*Azotobacter* (9.59) and minimum observed in T_{14}-Chlorpyriphos + Vitavax + *Azotobacter* (5.97) as shown in Table 7.

The highest seedling length was recorded in T_6-*Azotobacter* + *PSB* (64.54%) followed by T_5- *PSB* (63.47%), T_1- control (58.55%) and minimum observed in T_{14}-Chlorpyriphos + Vitavax + *Azotobacter* (55.57%). This could be attributed to biofertilizers' provided high metabolism, quick nutrient absorption, the availability of plant growth-promoting bacteria and phosphate solublization. Seedling establishment is lower in the field than in the lab, which could be due to climate variations, temperature or in sufficient moisture availability. Lessseed ling establishment in

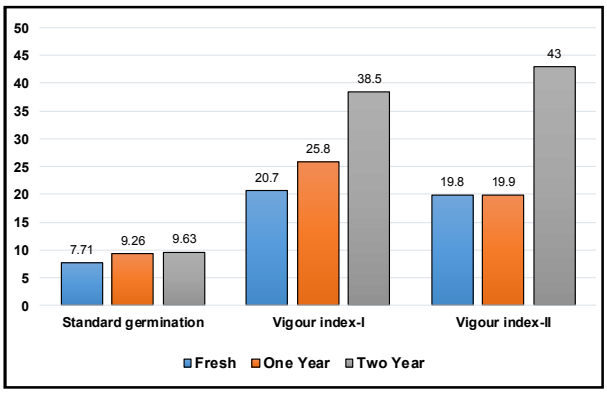

Fig. 1. Percent increase in germination and seedling vigour in the treatment T_6 (*Azotobacter* + *PSB*) as compared to control in three lot of barley.

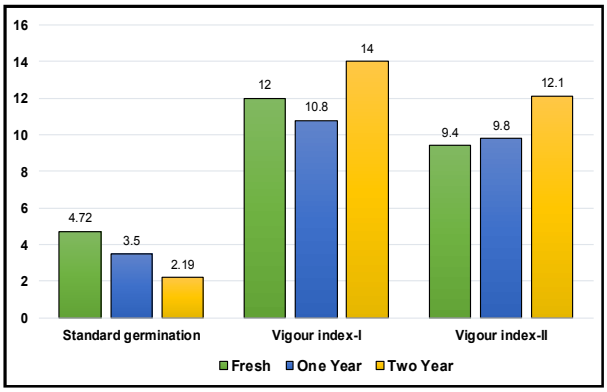

Fig. 2. Percent reduction in germination and seedling vigour in the treatment T_{16} (Chlorpyriphos + Vitavax + *Azotobacter* + *PSB*) as compared to control in three lot of barley.

T_{14},$T_{15}$and T_{16}in all of the lots it might be due to the combinations of Chlorpyriphos, Vitavax, *Azotobacter* and *PSB* it showed that it was not suitable as incombinational seed treatment. Previous studies have also recognized that chlorpyriphos and fungicidal combinational treatment on cereal seeds causes chromosomal aberrations Dubey *etal.* (2015) in barley and impeded amylase activity and ATPase activities, starch and protein degradation, which is responsible for poor germination Dalvi *et al.* (1972) in wheat and mungbean. Chlorpyriphos depressed the nitrogen metabolism, impaired respiration and causedthe inhibition of normal cell division or elongation, previously reported by Santhosh kumar *et al.* (2015) in mungbean.

Among lots, there were optimum increase was observed in different lots treated with chlorpyriphos, vitavax, *Azotobacter* and their combinations. But the most favorable result were obtained with the treatmentT_6 (*Azotobacter* + *PSB*) and negative increment observed in T_{16} (Chlorpyriphos + Vitavax + *Azotobacter* + *PSB*) followed by T_2 (Chlorpyriphos).The maximum increment in standard

TABLE 4
Effect of various seed treatments on standard germination and speed of germination of barley

S. No.	Standard germination (%)			Mean	Speed of germination			Mean
	Lot				Lot			
	Fresh	One Year	Two Year		Fresh	One Year	Two Year	
T_1	91.33 (72.87)	86.00 (68.01)	70.33 (56.98)	82.56 (65.95)	50.49	46.10	34.97	37.61
T_2	86.00 (68.01)	81.67 (64.62)	66.00 (54.31)	77.89 (62.31)	53.47	48.15	35.81	38.29
T_3	91.67 (73.24)	86.33 (68.28)	70.67 (57.19)	82.89 (66.23)	52.04	47.12	35.95	38.43
T_4	95.33 (77.55)	91.00 (72.53)	76.00 (60.65)	87.44 (70.24)	56.48	51.09	35.38	37.98
T_5	95.67 (77.97)	92.33 (73.90)	77.67 (61.77)	88.56 (71.22)	57.17	52.20	35.79	38.16
T_6	96.00 (78.49)	92.67 (74.31)	78.67 (62.47)	89.11 (71.76)	57.37	52.73	36.35	38.72
T_7	92.33 (73.95)	86.67 (68.56)	71.33 (57.61)	83.44 (66.7)	50.78	46.90	36.63	39.01
T_8	93.33 (75.04)	88.00 (69.72)	73.67 (59.10)	85.00 (67.95)	58.67	53.37	36.19	38.57
T_9	92.33 (73.95)	87.00 (68.85)	71.67 (57.82)	83.67 (66.87)	55.56	49.84	36.49	38.87
T_{10}	94.33 (76.21)	90.00 (71.55)	75.00 (59.98)	86.44 (69.25)	55.68	50.14	36.64	39.02
T_{11}	90.67 (72.19)	86.00 (68.00)	70.33 (56.98)	82.33 (65.72)	59.61	54.90	36.62	39.00
T_{12}	93.33 (75.02)	87.67 (69.42)	72.00 (58.03)	84.33 (67.49)	59.86	56.47	36.56	38.93
T_{13}	93.67 (75.40)	88.33 (70.00)	74.67 (59.76)	85.56 (68.39)	60.56	57.85	36.66	39.03
T_{14}	87.00 (68.85)	82.00 (64.88)	66.67 (54.71)	78.56 (62.81)	49.45	45.08	36.59	38.97
T_{15}	89.33 (70.93)	83.33 (65.89)	70.00 (56.77)	80.89 (64.53)	50.42	45.55	36.70	39.07
T_{16}	87.67 (69.43)	83.00 (65.63)	68.33 (55.73)	79.67 (63.6)	47.61	44.69	36.71	39.08
Mean	87.00 (69.01)	72.06 (58.12)			54.70	50.14	36.25	
C. D. (P=0.05)	L	T	LXT		L	T	LXT	
	0.35	0.81	NS		0.52	1.21	NS	
SE(m)(±)	0.12	0.29	0.50		0.19	0.43	0.49	

germination was observed in two years old lot (9.63%) followed by one year (9.26%) and fresh seed lot (7.71%) with treatment T_6 (*Azotobacter* + *PSB*) (Fig. 1) while negative impact of Chloropyriphos resulted into reduction in all the parameters. However, the reduction was maximum in the fresh lotfor standard germination followed by one year and two years old lot (Fig. 2).The vigor indices also shown same trend with different treatments. In vigor index I and vigor index II, increment was observed in two years old lot (20.7%,19.8%) followed by one year (25.8%, 19.69%) and fresh seed lot (38.5%, 43.0%) with treatment T_6 (*Azotobacter* + *PSB*).

CONCLUSION

The seed treatments with the biofertilizers significantly improved all the seed quality parameters as compared to control in all the three lots of barley. The highest values of different parameters both under laboratory and field condition were observed with the treatment of *Azotobacter* + *PSB* followed by *PSB* and

TABLE 5
Effect of various seed treatments on seedling length (cm) and seedling dry weight (mg) of barley

S. No.	Seedling length (cm)			Mean	Seedling dry weight (mg)			Mean
	Lot				Lot			
	Fresh	One Year	Two Year		Fresh	One Year	Two Year	
T_1	34.99	30.43	18.77	28.07	17.66	14.58	9.14	13.79
T_2	33.84	30.03	18.24	27.37	17.13	14.01	8.69	13.28
T_3	36.30	31.94	19.08	29.11	17.19	14.52	9.07	13.59
T_4	39.57	35.06	22.24	32.29	19.59	15.65	11.10	15.45
T_5	39.69	35.11	22.42	32.41	19.66	15.68	11.64	15.66
T_6	40.17	35.51	23.23	32.97	20.14	16.24	11.73	16.03
T_7	34.40	30.21	18.77	27.79	18.45	15.37	10.14	14.65
T_8	38.28	32.24	21.38	30.64	18.96	15.61	10.66	15.08
T_9	36.90	31.94	20.69	29.84	17.93	14.80	9.69	14.14
T_{10}	39.11	34.17	21.54	31.61	18.01	15.31	9.83	14.38
T_{11}	38.12	32.05	20.86	30.35	18.82	15.51	10.32	14.88
T_{12}	38.22	32.76	21.02	30.67	18.86	15.43	10.53	14.94
T_{13}	38.77	33.59	21.43	31.26	19.12	15.63	11.03	15.26
T_{14}	33.07	29.96	17.84	26.96	16.88	13.91	8.67	13.16
T_{15}	32.50	29.33	17.69	26.51	16.80	13.73	8.46	13.00
T_{16}	32.08	28.12	16.59	25.60	16.67	13.62	8.27	12.85
Mean	36.63	32.03	20.11		18.24	14.97	9.94	
C. D. (P=0.05)	L	T	LXT		L	T	LXT	
	0.47	1.09	NS		0.29	0.66	NS	
SE(m)(±)	0.17	0.39	0.67		0.10	0.27	0.41	

TABLE 6
Effect of various seed treatments on vigour Index-I and vigour Index-II of barley

S. No.	Vigour Index-I			Mean	Vigour Index-II			Mean
	Lot				Lot			
	Fresh	One Year	Two Year		Fresh	One Year	Two Year	
T_1	3196	2617	1320	2378	1614	1254	643	1170
T_2	2867	2452	1204	2174	1451	1144	574	1056
T_3	3327	2758	1348	2478	1575	1254	641	1156
T_4	3773	3192	1690	2885	1867	1425	844	1379
T_5	3798	3242	1741	2927	1881	1448	904	1411
T_6	3857	3292	1828	2992	1933	1504	923	1453
T_7	3177	2618	1339	2378	1702	1332	723	1252
T_8	3573	2837	1575	2662	1770	1373	785	1310
T_9	3407	2778	1483	2556	1655	1288	694	1212
T_{10}	3690	3075	1615	2794	1699	1378	737	1271
T_{11}	3457	2757	1468	2560	1706	1334	726	1255
T_{12}	3567	2871	1513	2651	1761	1353	758	1291
T_{13}	3631	2967	1600	2733	1792	1381	824	1332
T_{14}	2878	2457	1190	2175	1469	1141	578	1063
T_{15}	2904	2444	1238	2196	1501	1143	592	1079
T_{16}	2813	2334	1134	2094	1461	1130	565	1052
Mean	3370	2793	1455		1677	1305	719	
C. D. (P=0.05)	L	T	LXT		L	T	LXT	
	44.50	102.76	177.99		26.07	60.21	NS	
SE(m)(±)	15.82	36.55	63.31		9.27	21.41	37.09	

TABLE 7
Effect of various seed treatments on field emergence index and seedling establishment of barley

S. No.	Field emergence index			Mean	Seedling establishment			Mean
	Lot				Lot			
	Fresh	One Year	Two Year		Fresh	One Year	Two Year	
T_1	8.97	7.30	5.39	7.22	86.00 (68.06)	77.67 (61.86)	51.33 (45.75)	71.67 (58.55)
T_2	8.22	6.79	4.86	6.63	82.00 (64.89)	75.00 (60.02)	49.00 (44.41)	68.67 (56.44)
T_3	10.85	8.97	7.05	8.95	89.00 (70.78)	80.00 (63.51)	53.67 (47.09)	74.22 (60.46)
T_4	11.65	9.44	7.68	9.59	92.00 (73.73)	84.00 (66.6)	55.67 (48.24)	77.22 (62.86)
T_5	12.08	9.89	8.04	10.00	93.00 (74.65)	84.67 (66.95)	56.67 (48.82)	78.11 (63.47)
T_6	12.58	10.32	8.48	10.46	94.00 (76.00)	86.00 (68.03)	58.00 (49.59)	79.33 (64.54)
T_7	9.45	7.63	5.78	7.62	84.67 (67.03)	76.00 (60.78)	50.00 (44.98)	70.22 (57.60)
T_8	10.39	8.59	6.73	8.57	91.33 (72.86)	81.67 (64.71)	54.67 (47.66)	75.89 (61.74)
T_9	10.06	8.33	6.42	8.27	86.33 (68.31)	78.33 (62.31)	51.67 (45.94)	72.11 (58.85)
T_{10}	9.81	8.04	6.12	7.99	92.00 (73.79)	82.00 (64.96)	55.00 (47.85)	76.33 (62.20)
T_{11}	7.63	6.59	4.59	6.27	84.67 (66.93)	75.33 (60.25)	50.67 (45.36)	70.22 (57.52)
T_{12}	7.94	6.73	4.75	6.48	86.00 (68.10)	76.33 (60.89)	51.00 (45.56)	71.11 (58.18)
T_{13}	8.47	7.05	5.08	6.87	90.00 (71.63)	81.00 (64.24)	54.33 (47.47)	75.11 (61.11)
T_{14}	7.12	6.43	4.37	5.97	80.67 (63.9)	73.67 (59.16)	47.67 (43.64)	67.33 (55.57)
T_{15}	7.35	6.57	4.51	6.15	81.33 (64.39)	74.33 (59.60)	48.33 (44.03)	68.00 (56.00)
T_{16}	7.22	6.46	4.41	6.03	81.00 (64.14)	74.00 (59.38)	48.00 (43.84)	67.67 (55.78)
Mean	9.36	7.82	5.89		87.13 (69.32)	78.75 (62.70)	52.23 (46.26)	
C. D. (P=0.05)	L	T	LXT		L	T	LXT	
	0.19	0.49	NS		0.95	2.19	NS	
SE(m)(±)	0.07	0.15	0.27		0.34	0.78	1.35	

Azotobacter in all the lots of barley seed. The negative impact was observed in case of the treatment of Chlorpyriphos alone or in combinations with other chemicals for most of the seed quality parameters.

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