

Efficacy of Biozyme on Yield and Yield Attributing Traits in Potato (*Solanum tuberosum* L.)

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Abstract Research studies on Efficacy of Biozyme on yield and yield attributing traits in Potato (*Solanum tuberosum* L.) was carried out during 2013-14 and 2014-15 in randomized block design with five treatments having recommended fertilizer dose, N:P:K: 150:150:200 kg/ha with four replications. Study revealed that biozyme had positive impact in respect to plant height, number of leaves, number of shoots per plants, tuber weight, tuber diameter and yield. Highest total tuber yield of 38.57 t/ha in 2013-2014 and 37.77 t/ha in 2014-2015 were recorded with 30% reduced RDF of biozyme.

Keywords Biozyme, Potato, Yield.

Introduction

The potato is a starchy, tuberous crop from the perennial *Solanum* genus. It is the world's fourth-largest food crop following maize, wheat and rice. It can contribute substantially towards providing both food and nutrition security in the years to come as it is one of the most productive edible crops known to man and it produces the higher amount of dry matter, carbohydrate, minerals, edible protein, dietary fiber and vitamins. It contains 74.4% water, 22.9% sugar, 1.6% protein, 0.1% fat, 0.6% mineral matters, 0.01% Ca, 0.03% P, and 0.007% Fe, While according to Mac Gillivray [1], it contains 77.8% water and food value per 100 g of edible portion is energy 85 cal, protein 2 g, Ca 13 mg, Vit-A 40IU, ascorbic acid 12 mg, thiamin 0.11 mg, riboflavin 0.06 mg and niacin 1.18 mg.

The united nations FAO reports that the world production of potatoes in 1013 was about 368 million tonnes, Globally, potato is sharing about 1.35% of the total cultivated land area and in India; potato is being grown for 0.75% of total cropped area. India has made major strides in potato improvement and now ranks 3rd in acreage and 2nd in production. It has carved a niche for itself in the intensive cropping system particularly in the five states of the Indo-Gangetic region viz. Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal, which together constitute the potato bowl of India accounting for 90% of potato production [2].

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Table 1. The treatment details, which are followed, are given below.

Notation	Treatments	Remarks
T ₁	Recommended fertilizer dose (RDF) (60:60:80::N:P:K kg/acre)	Biozyme aaloo granules@20kg/ha at basal and earthing up.
T ₂	10% reduction of fertilizer with biozyme	
T ₃	20% reduction of fertilizer with biozyme	Biozyme vegetable liquid@500ml at 50DAT
T ₄	30% reduction of fertilizer with biozyme	
T ₅	40 % reduction of fertilizer with biozyme	

The present investigation was aimed to evaluate the impact of biozyme, a relatively recently introduced bio regulator, with fertilizer on potato. Biozyme is an organic storehouse of naturally occurring nutrient derived from morwegian seaweed (*Ascophyllum nodosum*), traditionally known for its rich possession of vital nutritional elements. It is known to be rich in cytokinins and auxin precursor, enzymes and hydrolyzed protein [3]. It is an eco-friendly, non-toxic, non-chemical organic storehouse of naturally occurring substances which stimulates the natural physiological system of the plant by providing additional support of essential nutritional elements in all stages of plant growth at very low concentrations. It contains elements which help in cell growth and breakdown of complex molecules into simpler one which are in a naturally chelate form and are readily assimilated by plants which helps to improve cell division and cell enlargements thus resulting into better chlorophyll content and increased production. It also helps in improving plants natural self-defense system, which results in healthier crop with low pest pressure. Keeping the above in view, the present investigation were undertaken.

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Materials and Methods

The field investigation was carried out at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, for consecutive two years during the period autumn winter season of 2013-14 and 2014-15. The experimental design was laid out in simple randomized block design with five different combinations of biozyme and recommended dose of fertilizer application replicated four times in a plot size of 4.5 m × 5.0 m. Biozyme and fertilizers were applied according to the schedule of the experiment.

The data obtained in two years were analysed by analysis of variance by a standard method [4] and significance of different sources of variation was tested by error mean square by Fisher Snedecor's 'F' test at probability level of 0.05. For determination of critical difference (CD) at 5% level of significance, Fisher and Yates [5] table was consulted.

Results and Discussion

Application of biozyme has shown marked effect on plant height (Table 2). Treatment comprised of recommended dose of inorganic fertilizer + biozyme aaloo

Table 2. Effect of biozyme on plant height, number of leaves per plant and number of shoots per plant in potato. NS : Non significant. Small size tuber (C)= <100g (weight); Medium size tuber (B) =100-150g (weight); Large size tuber (A) =>150g (weight).

Treatments	Plant height (cm)		No. of leaf / plant		No. of shoots/plant	
	2013-2014	2014-2015	2013-2014	2014-2015	2013-2014	2014-2015
T ₁	34.75	35.33	204.75	214.75	5.50	5.25
T ₂	38.65	36.53	207.50	243.50	5.25	6.00
T ₃	41.42	41.21	253.50	275.25	5.75	6.75
T ₄	48.80	46.37	364.50	349.00	7.25	7.75
T ₅	43.87	44.88	302.00	342.00	6.50	7.00
SEm ±	1.83	0.54	21.29	10.43	0.78	1.02
CD (0.05)	5.66	1.68	65.62	32.16	NS	NS
CV (%)	8.85	2.68	15.98	7.32		

Table 3. Effect of biozyme on tuber diameter (cm) and individual tuber weight (g) in potato.

Treatments	Tuber diameter (cm)						Individual tuber weight (g)					
	A		B		C		A		B		C	
	2013 -14	2014 -15	2013 -14	2014 -15	2013 -14	2014 -15	2013 -14	2014 -15	2013 -14	2014 -15	2013 -14	2014 -15
T ₁	6.27	6.07	5.22	5.1	4.01	4.27	164.76	160.04	124.39	121.53	57.63	61.36
T ₂	6.87	6.22	5.42	5.25	4.18	4.5	185.20	167.67	126.89	122.91	58.33	62.79
T ₃	7.00	6.37	5.44	5.4	4.20	4.65	185.80	169.07	125.11	124.19	65.44	80.36
T ₄	7.36	7.12	5.76	5.62	4.55	4.87	251.15	242.96	131.97	130.04	99.60	96.16
T ₅	7.11	6.97	5.45	5.47	4.32	4.72	212.35	208.16	129.62	128.76	73.55	84.13
SEm ±	0.06	0.12	0.16	0.15	0.10	0.11	0.67	2.69	0.50	0.90	1.654	0.70
CD (0.05)	0.19	0.39	NS	NS	0.31	0.34	2.09	8.30	1.54	2.78	5.09	2.15
CV (%)	1.83	3.95			4.84	4.89	0.67	2.84	0.78	1.44	4.66	1.81

+ biozyme vegetable liquid (T₄) recorded maximum plant height (48.8 cm) in 2013-2014 and (46.37 cm) in 2014-2015 which was significantly differ from other treatments. The increase plant height in different treatments over T₁ treatment might be due to the favorable combined influence of recommended dose of inorganic fertilizer, biozyme aaloo granules and biozyme vegetable liquid. Hence, biozyme play the vital role on growth of plants. The present results are in conformity with the findings of Gore et al. [6] who observed that foliar application of biozyme increased plant height in chilli. Similarly, higher growth obtained with the application of seaweed liquid fertilizer in *Cyamopsis tertragonoloba* and in *Lycopricon esculentum* was reported by Thirumaran et al. [7] and Reeta et al. [8] respectively.

Treatment T₄ produced highest number of leaves per plant 364.5 in 2013-2014 and 349 in 2014-2015 which showed significantly differ from the treatment T₁, T₂ and T₃. However, it was at par with the treatment T₅. The tretment T₁ performed lowest number of leaves per plant (204.75) in 2013-2014 and (214.75) in 2014-2015. This result was in conformity with the findings of Thirumaran et al. [7] who reported that seaweed liquid fertilizer of *Rosenvigea intricate* increased number of leaves in *Abelmoschus esculentus*.

Number of shoots per plant was not significantly varied among the treatments (Table 2). However, maximum number of shoots (7.25) in 2013-2014 and (7.75) in 2014-2015 was produced under treatment T₅ (40% reduction recommended dose of inorganic fer-

tilizers + biozyme aaloo granules + biozyme liquid). Such result of treatment T₅ might be due to favorable influence of biozyme.

The highest diameter of tuber in large size tuber (>150g) was observed in the treatment T₄ (7.36 cm) in 2013-2014 and (7.12 cm) in 2014-2015 followed by T₅, T₃, T₂ and T₁. The minimum diameter of tuber was obtained in the treatment T₁ (6.27 cm) in 2013-2014 and (6.07 cm) in 2014-2015.

There was no significant variation in the treatments in relation to medium diameter of tuber per plant of application of biozyme (Table 3). The medium diameter of tuber in large size tuber (100-150g) was observed in the treatment T₄ (5.76 cm) in 2013-2014 and (5.62 cm) in 2014-2015 followed by T₅, T₃, T₂ and T₁. The minimum diameter of tuber was obtained in the treatment T₁ (5.22 cm) in 2013-2014 and (5.1 cm) in 2014-2015.

There was significant variation in the treatments in relation to diameter of tuber per plant of application of biozyme (Table 3). The highest diameter of tuber in small size tuber (<100 g) was observed in the treatment T₄ (4.55 cm) in 2013-2014 and (4.87 cm) in 2014-2015 followed by T₅, T₃, T₂ and T₁. The minimum diameter of tuber was obtained in the treatment T₁ (4.01 cm) in 2013-2014 and (4.27 cm) in 2014-2015. The increase in the diameter of fruit per plant with the application of biozyme was observed by Ofosuf-Anim et al. [9] in tomato and Eris et al. [10] in pepper (cv california Wonder).

Table 4. Effect of biozyme on tuber yield (t/ha) in potato.

Treatments	A		B		Yield (T/ha)		Unmarketable		Total	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-13	2014-15	2013-14	2014-15
T ₁	13.30	10.6	8.13	10.83	7.11	7.33	0.06	0.01	28.60	28.76
T ₂	15.62	15.86	12.88	11.13	7.16	6.32	1.07	1.19	36.73	34.5
T ₃	16.17	13.13	11.83	12.19	8.28	7.88	0.61	0.56	36.88	34.76
T ₄	15.44	14.56	11.49	11.9	10.39	9.71	1.24	1.5	38.57	37.77
T ₅	17.17	13.97	10.68	11.77	7.96	8.23	1.24	1.29	37.04	34.89
SEm±	1.33	1.38	0.82	0.28	0.88	0.69	0.36	0.45	1.01	0.67
CD (0.05)	NS	SS	2.53	0.89	NS	NS	NS	NS	3.12	2.07
CV (%)			14.93	5.01					5.69	3.94

Individual weight of tuber was influenced significantly by different treatments (Table 3). Treatment T₄ (30% reduction of recommended dose of inorganic fertilizers + biozyme aaloo granules + biozyme vegetable liquid) showed maximum tuber weight (251.15 g) in 2013-2014 and (242.96 g) in 2014-2015 in large while it was minimum (164.76 g) in 2013-2014 and (9160.04 g) in 2014-2015 in treatment T₁ (control) in the large size tuber. Higher tuber weight under treatment T₄ was due to favorable influence of biozyme.

The treatment T₄ (30% reduction of recommended dose of inorganic fertilizers + biozyme aaloo granules + biozyme vegetable liquid) showed maximum tuber weight (131.97 g) in 2013-2014 and (130.04 g) in 2014-2015 in large size it was minimum (124.39 g) in 2013-2014 and (121.53 g) in 2014-2015 in treatment T₁ (control) in the medium size tuber (Table 3). Highest tuber weight under treatment T₄ was due to favorable influence of biozyme.

The treatment T₄ (30% reduction of recommended dose of inorganic fertilizers + biozyme aaloo granules + biozyme vegetable liquid) showed maximum tuber weight (99.60 g) in 2013-2014 and (96.16 g) in 2014-2015 in large size while it was minimum (57.63 g) in 2013-2014 and (61.36 g) in 2014-2015 in treatment T₁ (control) in the small size tuber (Table 3). Highest tuber weight under treatment T₄ was due to favorable influence of biozyme. The present result is in conformity with this finding of Ofose-Anim et al. [9], who observed increase fruit weight in tomato with the application of biozyme. Similar results reported that NAA application increase the fruit weight in brinjal, GA₃ application in brinjal increase fruit weight as

observed by Gupta et al. [11].

Significant effect of biozyme application was noticed on tuber yield per hectare in this experiment (Table 4). Total tuber yield ranged from 28.60 tonnes/ha (2013-2014) and 28.76 tonnes/ha (2014-2015) in treatment T₁ to 38.57 tonnes/ha (2013-2014) and 37.77 tonnes/ha (2014-2015) in treatment T₄. Highest tuber yield in the treatment T₄ (30% recommended dose of inorganic fertilizers + biozyme aaloo granules + biozyme vegetable liquid) was followed by a yield of 37.04 tonnes/ha (2013-2014) and 34.89 tonnes/ha (2014-2015) in the treatment T₅ (40% RDF + biozyme aaloo granules + biozyme vegetable liquid)

Yield of potato depends on indirect components, a strong vegetative growth that comprise of plant height, shoot numbers and leaf numbers. In present investigation all the components contributing indirectly and directly towards yield viz, plant height, numbers of shoot, numbers of leaves per plant, tuber diameter and tuber weight were superior in the treatment T₄ (30% recommended dose of inorganic fertilizers + biozyme aaloo granules + biozyme vegetable liquid). Thus, it is amply cleared that the biozyme which consists of precursor of auxins, enzyme, protein and micronutrients were responsible to improve vegetative growth and in turn yield of crop. The result is in agreement with the finding of Kumar et al. [3] who reported significant yield of bell pepper due to application of biozyme over control.

Economics

The maximum benefit and cost ratio 1.59 in 2013-2014

Table 5. Effect of biozyme on economics of potato

Treatments	Cost of cultivation per hectre (Rs/ha)		Gross return per hectre (Rs/ha)		Net return per hectre (Rs/ha)		Benefit and cost ratio	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
T ₁	148630.00	151380.00	285400.00	142700.00	136770.00	-8680.00	0.92	-0.05
T ₂	147025.00	149680.00	356600.00	178300.00	209575.00	28620.00	1.42	0.19
T ₃	145421.00	147980.00	362700.00	181350.00	217279.00	33370.00	1.49	0.22
T ₄	143817.00	146280.00	373300.00	186650.00	229483.00	40370.00	1.59	0.27
T ₅	142212.00	144580.00	359200.00	179600.00	216988.00	35370.00	1.52	0.24

and 0.27 in 2014-2015 were observed in treatment T₄. (Table 5). The second maximum benefit cost ratio 1.52 in 2013-2014 and 0.24 in 2014-2015 were observed in treatment T₅. The lowest benefit and cost ratio were observed in treatment T₁ (0.92) in 2013-2014 and -0.05 in 2014-2015. In 2014-2015, benefit and cost ratio was low due to the low price of the crop. This finding is supported by Gracia and Norrie. [12] who reported that economic return to the grower indicated a significant benefit to use the fortified *Ascophyllum nodosum* extract product on tomato.

Conclusion

The results led to a conclusion that for better growth and yield of potato, the crop may be applied with different formulation of biozyme in combination with the recommended dose of fertilizer, applied under the plains of West Bengal with the special reference of new alluvial zone.

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