Research Article

Impact of different doses and application methods of biophos (Biofertilizer) on growth and fodder yield of maize

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Citation

Khalil Ahmed Brohi, Abdul Haleem Sial, Ayaz Latif Siyal, Kamran Razzaque Kalwar, Babar Sultan Mengal, Fateh Muhammad Baloch, Aneel Ahmed Korejo and Manthar Ali Sahito. Impact of different doses and application methods of biophos (Biofertilizer) on growth and fodder yield of maize. Pure and Applied Biology. Vol. 11, Issue 3, pp725-733. <http://dx.doi.org/10.19045/bspab.2022.110073>

Received: 21/05/2021

Revised: 26/06/2021

Accepted: 19/10/2021

Online First: 04/11/2021

Abstract

The increased reliance of novel agriculture on extreme artificial input of chemical fertilizers has caused numerous environmental problems related to greenhouse effect, soil deterioration, and air and water pollution. A field study was carried out at Sindh Agriculture University, Tandojam during Kharif 2013. The analysis of variance illustrated that different doses and application methods of Biophos (Biofertilizer) as seed treatment before sowing or broadcasting after sowing affected positively and significantly ($P < 0.05$) seed germination, growth and fodder yield traits of maize variety Hycorn-8288 as compared to No Biophos (Control). Combination of Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg ha⁻¹ (Broadcasting) resulted in maximum (33.00 m⁻²) seed germination, plant height (178.87 cm), leaves plant⁻¹ (14.80), nodes plant⁻¹ (5.40), stem girth (4.75 cm), fodder weight (4.13 kg m⁻²) and fodder yield (41.33 t ha⁻¹), whereas combination of Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg ha⁻¹ (Broadcasting) Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg ha⁻¹ (Broadcasting), Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg ha⁻¹ (Broadcasting), Biophos 25.0 kg ha⁻¹ (Broadcasting), Biophos 12.5 kg ha⁻¹ (Broadcasting), Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) and Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) ranked 2nd, 3rd, 4th, 5th, 6th and 7th in all the traits particularly fodder yield (38.27, 31.93, 29.73, 23.10, 20.43, 17.70 and 15.33 t ha⁻¹), respectively. However, minimum (30.33 m⁻²) seed germination, 115.60 cm plant height, leaves plant⁻¹ (6.53), nodes plant⁻¹ (2.13), stem girth (2.38 cm), fodder weight (1.06 kg m⁻²) and fodder yield (10.60 t ha⁻¹) were recorded in No Biophos (Control). Hence, results concluded that combined application of Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg ha⁻¹ (Broadcasting) was found most suitable which produced maximum values for almost all the parameters studied, particularly fodder yield (41.33 t ha⁻¹).

Keywords: Biofertilizers; Biophos; Maize; Seed germination; Yield

Introduction

Maize (*Zea mays* L.) is the most important food and feed crop. In Pakistan, maize is the third most important cereal after wheat and rice, being grown on about one million hectares. Maize is a crop plant characterized by a high potential of biomass. Maize makes high quality silage for dairy cattle, beef and sheep at less cost than silage made from grass. Many research workers have reported that maize silage in the diet of dairy cows increases forage intake, milk yield and milk protein content [1]. Green fodder is the most valuable and cheapest source of feed for the livestock. It is very rich source of energy, nutrient elements, carbohydrates, proteins and water. Fodder shortage is the major limiting factor for livestock Production [2]. Application of biological fertilizer mycorrhiza had a significant effect on plant height, flag leaf width, grains ear⁻¹ and flag leaf length of maize. Interaction effects of mycorrhiza × varieties were non-significant plant height [3]. Maize quantity increased by utilization of bio-phosphate fertilizer [4]. The quantitative characteristics were significantly increased by phosphate-solution micro-organisms [5]. A combination of mycorrhiza and bacteria holds promise for the organic cropping system of maize. Therefore, in organic and low input cropping systems, a combination of mycorrhiza and free-living bacteria performed satisfactorily [6]. The growth and yield traits of maize in compounds phosphate-solubilising bacteria and Mycorrhiza fungi treatment were higher than other treatments under drought stress conditions except root colonization. Accordingly, this experiment showed that phosphate solubilising micro-organisms can positively have effect on the increase of plant growth and phosphorus absorption in maize plant, leading to plant tolerance improving under drought stress conditions [7]. Yosefi *et al.* [8] suggested that maximum biological yield and grain weight of maize was obtained

by inoculation of seeds with biological phosphate fertilizer prior to sowing. The findings of a study showed that the effect of plant growth promoting rhizobacteria on all traits was significant. Double-inoculation of *Azotobacter* and *Azospirillum* had the highest plant height (212.4 cm), stem diameter (2.5 cm), rows ear⁻¹ (14.5 row), grains row⁻¹ (44.2), 1000-grain weight (315.4 g), grain yield (10190 kg ha⁻¹), biological yield (21320 kg ha⁻¹) and protein content (10.7%) when compared with other treatments. In view of above facts, the study was proposed to evaluate the impact of different doses and application methods of biophos (biofertilizer) on growth and fodder yield of maize.

Materials and Methods

The field study to evaluate the impact of different doses and application methods of biophos (biofertilizer) on growth and fodder yield of maize was carried out at Students Farm, Department of Agronomy, Faculty of Crop Production, Sindh Agriculture University, Tandojam during Kharif, 2013. The experiment was laid out in a three replicated randomized complete block design (RCBD), having net plot size 5 m x 4 m (20 m²). The treatments included: No Biophos (Control), Biophos 5 g kg⁻¹ seed (Seed treatment before sowing), Biophos 10 g kg⁻¹ seed (Seed treatment before sowing), Biophos 12.5 kg h⁻¹ (Broadcasting), Biophos 25.0 kg h⁻¹ (Broadcasting), Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h⁻¹ (Broadcasting), Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h⁻¹ (Broadcasting), Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h⁻¹ (Broadcasting) and Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h⁻¹ (Broadcasting). The observations were recorded on parameters of economic importance such as seed germination (m⁻²), plant height (cm), leaves plant⁻¹, nodes plant⁻¹, stem girth (cm), fodder weight (kg m⁻²) and

fodder yield (t ha^{-1}). The collected data were statistically analyzed using Statistix 8.1 computer software (Statistix, 2006). The LSD test was applied to compare treatment means, where necessary.

Results and Discussion

Seed germination (m^{-2})

The results showed in (Table 1) that application of Biophos 10 g kg^{-1} seed (Seed treatment before sowing) + Biophos 25.0 kg h^{-1} (Broadcasting) produced maximum seed germination of 33.0 m^{-2} , closely followed by 32.67 , 32.33 and 32.00 m^{-2} recorded from the plots fertilized with Biophos 10 g kg^{-1} seed (Seed treatment before sowing) + Biophos

12.5 kg h^{-1} (Broadcasting), Biophos 5 g kg^{-1} seed (Seed treatment before sowing) + Biophos 12.5 kg h^{-1} (Broadcasting) and Biophos 5 g kg^{-1} seed (Seed treatment before sowing) + Biophos 25.0 kg h^{-1} (Broadcasting), respectively. The seed germination was nominally reduced to 31.67 , 31.33 , 31.00 and 30.67 m^{-2} in plots fertilized with Biophos 25.0 kg h^{-1} (Broadcasting), Biophos 12.5 kg h^{-1} (Broadcasting), Biophos 10 g kg^{-1} seed (Seed treatment before sowing) and Biophos 5 g kg^{-1} seed (Seed treatment before sowing), respectively. However, No Biophos (Control) had minimum seed germination of 30.33 m^{-2} .

Table 1. Seed germination (m^{-2}) of maize as affected by doses and application methods of Biophos (Biofertilizer)

Treatments	R-I	R-II	R-III	Mean
No Biophos (Control)	31.00	31.00	29.00	30.33
Biophos 5 g kg^{-1} seed (Seed treatment before sowing)	31.00	31.00	30.00	30.67
Biophos 10 g kg^{-1} seed (Seed treatment before sowing)	31.00	31.00	31.00	31.00
Biophos 12.5 kg h^{-1} (Broadcasting)	31.00	32.00	31.00	31.33
Biophos 25.0 kg h^{-1} (Broadcasting)	31.00	31.00	33.00	31.67
Biophos 5 g kg^{-1} seed (Seed treatment before sowing) + Biophos 12.5 kg h^{-1} (Broadcasting)	32.00	33.00	32.00	32.33
Biophos 5 g kg^{-1} seed (Seed treatment before sowing) + Biophos 25.0 kg h^{-1} (Broadcasting)	32.00	32.00	32.00	32.00
Biophos 10 g kg^{-1} seed (Seed treatment before sowing) + Biophos 12.5 kg h^{-1} (Broadcasting)	33.00	32.00	33.00	32.67
Biophos 10 g kg^{-1} seed (Seed treatment before sowing) + Biophos 25.0 kg h^{-1} (Broadcasting)	33.00	33.00	33.00	33.00

Plant height (cm)

The data showed in (Table 2) that application of Biophos 10 g kg^{-1} seed (Seed treatment before sowing) + Biophos 25.0 kg h^{-1} (Broadcasting) produced maximum plant height of 178.87 cm , closely followed by 169.53 , 157.13 and 149.60 cm recorded from the plots fertilized with Biophos 10 g kg^{-1} seed (Seed treatment before sowing) + Biophos 12.5 kg h^{-1} (Broadcasting), Biophos 5 g kg^{-1} seed (Seed treatment before sowing) + Biophos 12.5 kg h^{-1} (Broadcasting) and

Biophos 5 g kg^{-1} seed (Seed treatment before sowing) + Biophos 25.0 kg h^{-1} (Broadcasting), respectively. The plant height was nominally reduced to 140.13 , 133.67 , 131.53 and 129.20 cm in plots fertilized with Biophos 25.0 kg h^{-1} (Broadcasting), Biophos 12.5 kg h^{-1} (Broadcasting), Biophos 10 g kg^{-1} seed (Seed treatment before sowing) and Biophos 5 g kg^{-1} seed (Seed treatment before sowing), respectively. However, No Biophos (Control) had minimum plant height of 115.60 cm .

Table 2. Plant height (cm) of maize as affected by doses and application methods of Biophos (Biofertilizer)

Treatments	R-I	R-II	R-III	Mean
No Biophos (Control)	116.00	115.00	115.80	115.60
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing)	129.60	128.60	129.40	129.20
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing)	145.40	124.20	125.00	131.53
Biophos 12.5 kg h ⁻¹ (Broadcasting)	134.20	133.00	133.80	133.67
Biophos 25.0 kg h ⁻¹ (Broadcasting)	140.80	139.40	140.20	140.13
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h ⁻¹ (Broadcasting)	150.00	149.00	149.80	149.60
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h ⁻¹ (Broadcasting)	157.60	156.40	157.40	157.13
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h ⁻¹ (Broadcasting)	170.00	168.80	169.80	169.53
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h ⁻¹ (Broadcasting)	179.20	178.20	179.20	178.87

Leaves plant⁻¹

The results showed in (Table 3) that application of Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h⁻¹ (Broadcasting) produced maximum leaves plant⁻¹ of 14.80, closely followed by 13.80, 12.80 and 11.20 leaves plant⁻¹ recorded from the plots fertilized with Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h⁻¹ (Broadcasting), Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h⁻¹ (Broadcasting) and

Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h⁻¹ (Broadcasting), respectively. The leaves plant⁻¹ were nominally reduced to 9.80, 9.00, 7.80 and 7.00 in plots fertilized with Biophos 25.0 kg h⁻¹ (Broadcasting), Biophos 12.5 kg h⁻¹ (Broadcasting), Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) and Biophos 5 g kg⁻¹ seed (Seed treatment before sowing), respectively. However, No Biophos (Control) had minimum leaves plant⁻¹ of 6.53 m⁻².

Table 3. Leaves plant⁻¹ of maize as affected by doses and application methods of Biophos (Biofertilizer)

Treatments	R-I	R-II	R-III	Mean
No Biophos (Control)	6.60	6.40	6.60	6.53
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing)	7.20	6.80	7.00	7.00
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing)	8.00	7.60	7.80	7.80
Biophos 12.5 kg h ⁻¹ (Broadcasting)	9.20	8.80	9.00	9.00
Biophos 25.0 kg h ⁻¹ (Broadcasting)	10.00	9.60	9.80	9.80
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h ⁻¹ (Broadcasting)	11.40	11.00	11.20	11.20
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h ⁻¹ (Broadcasting)	13.00	12.60	12.80	12.80
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h ⁻¹ (Broadcasting)	14.00	13.60	13.80	13.80
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h ⁻¹ (Broadcasting)	15.00	14.60	14.80	14.80

Nodes plant⁻¹

The data showed in (Table 4) that application of Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h⁻¹ (Broadcasting) produced maximum nodes plant⁻¹ of 5.40, closely followed by 4.53, 4.13 and 3.73 nodes plant⁻¹ recorded from the plots fertilized with Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h⁻¹ (Broadcasting), Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h⁻¹ (Broadcasting) and

Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h⁻¹ (Broadcasting), respectively. The number nodes plant⁻¹ was nominally reduced to 3.33, 3.00, 2.60 and 2.33 in plots fertilized with Biophos 25.0 kg h⁻¹ (Broadcasting), Biophos 12.5 kg h⁻¹ (Broadcasting), Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) and Biophos 5 g kg⁻¹ seed (Seed treatment before sowing), respectively. However, No Biophos (Control) had minimum nodes plant⁻¹ of 2.13.

Table 4. Nodes plant⁻¹ of maize as affected by doses and application methods of Biophos (Biofertilizer)

Treatments	R-I	R-II	R-III	Mean
No Biophos (Control)	2.20	2.00	2.20	2.13
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing)	2.40	2.20	2.40	2.33
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing)	2.60	2.40	2.80	2.60
Biophos 12.5 kg h ⁻¹ (Broadcasting)	3.00	2.80	3.20	3.00
Biophos 25.0 kg h ⁻¹ (Broadcasting)	3.40	3.20	3.40	3.33
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h ⁻¹ (Broadcasting)	3.80	3.60	3.80	3.73
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h ⁻¹ (Broadcasting)	4.20	4.00	4.20	4.13
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h ⁻¹ (Broadcasting)	4.60	4.40	4.60	4.53
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h ⁻¹ (Broadcasting)	5.40	5.20	5.60	5.40

Stem girth (cm)

The results showed in (Table 5) that application of Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h⁻¹ (Broadcasting) resulted in maximum stem girth of 4.75 cm, closely followed by 4.43, 4.31 and 4.13 cm stem girth recorded from the plots fertilized with Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h⁻¹ (Broadcasting), Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h⁻¹ (Broadcasting) and Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h⁻¹ (Broadcasting), respectively. The stem girth was nominally reduced to 3.95, 3.67, 3.25 and 2.93 cm in plots fertilized with Biophos

25.0 kg h⁻¹ (Broadcasting), Biophos 12.5 kg h⁻¹ (Broadcasting), Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) and Biophos 5 g kg⁻¹ seed (Seed treatment before sowing), respectively. However, No Biophos (Control) had minimum stem girth of 2.38 cm.

Fodder weight (kg m⁻²)

The results showed in (Table 6) that application of Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h⁻¹ (Broadcasting) produced maximum fodder weight (m⁻²) of 4.13 kg, closely followed by 3.83, 3.19 and 2.97 kg fodder weight (m⁻²) recorded from the plots fertilized with Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h⁻¹ (Broadcasting), Biophos 5 g kg⁻¹ seed (Seed

treatment before sowing) + Biophos 12.5 kg h⁻¹ (Broadcasting) and Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h⁻¹ (Broadcasting), respectively. The fodder weight (m⁻²) was nominally reduced to 2.31, 2.04, 1.77 and 1.53 kg in plots fertilized with Biophos 25.0 kg h⁻¹

(Broadcasting), Biophos 12.5 kg h⁻¹ (Broadcasting), Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) and Biophos 5 g kg⁻¹ seed (Seed treatment before sowing), respectively. However, No Biophos (Control) had minimum fodder weight (m⁻²) of 1.06 kg.

Table 5. Stem girth (cm) of maize as affected by doses and application methods of Biophos (Biofertilizer)

Treatments	R-I	R-II	R-III	Mean
No Biophos (Control)	2.40	2.36	2.38	2.38
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing)	2.96	2.90	2.92	2.93
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing)	3.28	3.22	3.24	3.25
Biophos 12.5 kg h ⁻¹ (Broadcasting)	3.70	3.64	3.66	3.67
Biophos 25.0 kg h ⁻¹ (Broadcasting)	3.98	3.92	3.94	3.95
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h ⁻¹ (Broadcasting)	4.16	4.10	4.12	4.13
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h ⁻¹ (Broadcasting)	4.34	4.28	4.30	4.31
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h ⁻¹ (Broadcasting)	4.46	4.40	4.42	4.43
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h ⁻¹ (Broadcasting)	4.78	4.74	4.74	4.75

Table 6. Fodder weight (kg m⁻²) of maize as affected by doses and application methods of Biophos (Biofertilizer)

Treatments	R-I	R-II	R-III	Mean
No Biophos (Control)	1.02	1.07	1.09	1.06
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing)	1.50	1.54	1.56	1.53
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing)	1.77	1.78	1.76	1.77
Biophos 12.5 kg h ⁻¹ (Broadcasting)	2.04	2.02	2.07	2.04
Biophos 25.0 kg h ⁻¹ (Broadcasting)	2.28	2.31	2.34	2.31
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h ⁻¹ (Broadcasting)	2.97	2.94	3.01	2.97
Biophos 5 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h ⁻¹ (Broadcasting)	3.15	3.21	3.22	3.19
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h ⁻¹ (Broadcasting)	3.80	3.83	3.85	3.83
Biophos 10 g kg ⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h ⁻¹ (Broadcasting)	4.08	4.12	4.20	4.13

Fodder yield (t ha⁻¹)

The results showed in (Table 7) that application of Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 25.0 kg h⁻¹ (Broadcasting) produced maximum fodder yield of 41.33 t ha⁻¹, closely followed by

38.27, 31.93 and 29.73 t ha⁻¹ fodder yield recorded from the plots fertilized with Biophos 10 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg h⁻¹ (Broadcasting), Biophos 5 g kg⁻¹ seed (Seed treatment before sowing) + Biophos 12.5 kg

h^{-1} (Broadcasting) and Biophos 5 g kg^{-1} seed (Seed treatment before sowing) + Biophos 25.0 kg h^{-1} (Broadcasting), respectively. The fodder yield was nominally reduced to 23.10, 20.43, 17.70 and 15.33 t ha^{-1} in plots fertilized with Biophos 25.0 kg h^{-1} (Broadcasting),

Biophos 12.5 kg h^{-1} (Broadcasting), Biophos 10 g kg^{-1} seed (Seed treatment before sowing) and Biophos 5 g kg^{-1} seed (Seed treatment before sowing), respectively. However, No Biophos (Control) had minimum fodder yield of 10.60 t ha^{-1} .

Table 7. Fodder yield (kg ha^{-1}) of maize as affected by doses and application methods of Biophos (Biofertilizer)

Treatments	R-I	R-II	R-III	Mean
No Biophos (Control)	10.20	10.70	10.90	10.60
Biophos 5 g kg^{-1} seed (Seed treatment before sowing)	15.00	15.40	15.60	15.33
Biophos 10 g kg^{-1} seed (Seed treatment before sowing)	17.70	17.80	17.60	17.70
Biophos 12.5 kg h^{-1} (Broadcasting)	20.40	20.20	20.70	20.43
Biophos 25.0 kg h^{-1} (Broadcasting)	22.80	23.10	23.40	23.10
Biophos 5 g kg^{-1} seed (Seed treatment before sowing) + Biophos 12.5 kg h^{-1} (Broadcasting)	29.70	29.40	30.10	29.73
Biophos 5 g kg^{-1} seed (Seed treatment before sowing) + Biophos 25.0 kg h^{-1} (Broadcasting)	31.50	32.10	32.20	31.93
Biophos 10 g kg^{-1} seed (Seed treatment before sowing) + Biophos 12.5 kg h^{-1} (Broadcasting)	38.00	38.30	38.50	38.27
Biophos 10 g kg^{-1} seed (Seed treatment before sowing) + Biophos 25.0 kg h^{-1} (Broadcasting)	40.80	41.20	42.00	41.33

Discussion

The positive effect of using biofertilizer could be attributed to increased water and nutrient uptake due to development and expansion of roots and also to biological nitrogen fixation by biofertilizers. The results are in agreement with those of [9] who reported root, shoot weight with dual inoculation in maize. Use of biofertilizers offers agronomic and environmental benefits for intensive agricultural systems. The results obtained in this study confirm the findings of [10] who stated that Seed inoculation with *Rhizobium*, phosphorus solubilizing bacteria, and organic amendment increased seed production of groundnut. The increasing growth and fodder yield of maize may be attributed to the plant growth promoting substances by root colonizing bacteria more than the biological nitrogen fixation. [11] stated that yield increased due to promoting root growth which in turn enhancing nutrients and water uptake from the soil. The results are at par with the

findings of [12] who reported that significant increase in dry matter accumulation and leaf area index due to biofertilizers along with organic manure has a synergistic effect on subsequent plant growth and increase bacterial development, as Microbin and Rizobacterine inoculum cause biological N_2 fixation, which improves plant growth. Plant height is the function of both genetic constitution and the environmental conditions under which it is grown. The greater plant height indicated maximum chances for radiation interception, its utilization efficiency and consequently higher photosynthetic rate. Leaves are the food manufacturing factories of the plant and the greater number of leaves ensured the increased fodder yield due to higher photosynthetic capacity by increasing LAI. The increase in growth attributes like plant height, leaves plant⁻¹, nodes plant⁻¹ and stem girth (cm), resultantly increased fodder yield (t ha^{-1}) might be due to the improvement in translocation of assimilates. Positive effect of biofertilizer may

be resulted from its ability to increase the availability of Phosphorus and other nutrients. Growth improvement and yield and biomass increasing was reported with the biofertilizer application which account for important benefit to the maize producers and maize fodder production, causing decrease in the inputs of production because of economizing much money to chemical fertilizers and increasing in biological yield in the production of the unit area, as well as its undamaged effect on the soil and environment, and on other hand its positive effect on physiology of growth performance [13]. Beneficial metabolites synthesis and plant growth promoters exudation are other azotobacter functions. Mycorrhizal symbiosis also improves plants growth through different mechanisms such as better uptake of water and nutrients, controlling stomata, root hydrolic conductivity, photosynthesis and increasing plants resistance to pathogens [14]. Jilani *et al.* [15] reported that energy efficiency, crop growth and yield may increase in organic farming compared with conventional systems. Mycorrhiza and bacteria with symbiosis activity could cause increase in phosphorus around roots of plants and absorption by roots.

Conclusion

The results concluded that seed germination, growth and fodder yield traits of maize variety Hycorn-8288 were affected positively and significantly ($P < 0.05$) by different doses and application methods of Biophos (Biofertilizer) as compared to No Biophos (Control). Combined application of Biophos 10 g kg^{-1} seed (Seed treatment before sowing) + Biophos 25.0 kg h^{-1} (Broadcasting) produced maximum values for almost all the parameters studied, particularly fodder yield (41.33 t ha^{-1}). Hence, the above results suggested that biofertilizers play very important role in solubilizing and making available mineral phosphorus in optimum concentration to plant roots, and enhancing crop growth and yield.

Authors' contributions

Conceived and designed the experiments: KA Brohi, FM Baloch & AL Siyal, Performed the experiments: KA Brohi & AH Sial, Analyzed the data: MA Sahito & AL Siyal, Contributed materials/ analysis/ tools: KR Kalwar, BS Mengal & AA Korejo, Wrote the paper: AL Siyal.

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