Int.J.Curr.Microbiol.App.Sci (2021) *10*(06): 764-773

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 10 Number 06 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1006.083

Effect of VC, FYM, S, Zn, Azotobacter and PSB on Growth and Yield Attributes of Maize and Wheat

Pushpendra Kumar*, S. D. Dubey, U. S. Tiwari, R. K. Pandey, Karam Hussain and R. K. Singh

Department of Soil Science and Agril. Chemistry, C. S. Azad University of Agriculture and Technology, Kanpur-208002, India

**Corresponding author*

Keywords

Azotobacter, phosphorus solubilising bacteria, organic manure

Article Info

Accepted:
25 May 2021
Available Online:
10 June 2021

ABSTRACT

A field experiment was conducted at Agriculture Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur to study the effect of Vermicompost, FYM, sulphur, zinc, Azotobacter and PSB on growth, yield and uptake of nutrients in maize and their residual effect on succeeding wheat during 2018-19 and 2019-20. The results of the experiment revealed that the growth and yield attributes of maize *viz*., plant population, plant height, length and diameter of cobs and 1000 grain weight were significantly increased with T_{14} (100% RDN+25% N-VC+S+Zn+Az+PSB) followed by T_{13} (100% RDN+25% N-FYM+S+Zn+Az+PSB), T_{10} (100% RDN+S+Zn+Az+PSB) during both the years and on pooled mean basis. It was further noticed that the application of T_{14} in maize significantly improved the growth and yield contributing parameters of wheat *viz*., plant height, spike length, 1000 grain weight except plant population during both the years of experimentation. The results revealed that the integrated use of either 75 or 100 % RDN with VC or FYM in maize significantly enhanced the growth and yield attributing parameters of maize as well as succeeding wheat. It was also noticed that the application of S and Zn further improved the growth and yield attributes of maize and wheat. It clearly indicated that the addition of FYM or VC with S, Zn and Az+PSB in maize significantly increased the growth and yield attributes of maize and wheat during both the years of experimentation.

Introduction

Maize (*Zea mays*) popularly known as corn is one of the most important cereal of the world agriculture as staple food for human being, feed for animals as well as providing valuable industrial raw materials. In the context of world, 58% of maize is utilized in animal feed, 16% in human food and 26% in bioethanol production (HLPE, 2013). It ranks third amongst the food crops, stands after rice and wheat both in terms of area and production. Globally, The United States of America (USA) is the largest producer of maize contributes nearly 35% of the total production in the world and maize is the driver of the US economy. The USA has the highest productivity (> 9.6 t ha^{-1}) which is double than the global average (4.92 t ha^{-1}).Whereas, the average productivity of India is 3.02 t ha^{-1}. In India maize is grown in an area of 9.47 m ha with the production of 28.72 million tonnes while the average productivity is only 3032 kg ha^{-1}. The predominant maize growing states, contributes more than 80 % of the total maize production are Andhra Pradesh (20.9 %), Karnataka (15.00 %), Rajasthan (13.00 %), Maharashtra (9.1 %), Bihar (8.9 %), Uttar Pradesh (6.1 %), Madhya Pradesh (10.00 %), Himachal Pradesh (4.4 %). However, in Uttar Pradesh it contributes 7.87 and 5.14 per cent in terms of area and production with an average productivity of 1981 kg ha^{-1} (Anonymous 2017-18). It is the most versatile crop with wider adaptability in diverse agro-ecosystems and has highest genetic yield potential among food grain crops, owing to this it is termed as "queen of cereal". It is widely grown in tropical, subtropical and temperate regions of the world throughout the year mainly due to its photo-thermo-insensitive character.

As both the crops require high nutrient and response well to higher levels of inorganic fertilizers and exhibit full yield potential when nutrients supplies in balanced proportion at proper time. No doubt to replenish the soil nutrient depletion, application of chemical fertilizers is essential. The application of chemical fertilizers play significant role by improving the yield as well as balancing the nutrient through replenishment of soil nutrients ultimately improving soil fertility and productivity. Although fertilizers alone are unable to maintain the long-term soil health and crop productivity (Brar *et al.*, 2015) as they lack in secondary and micronutrients. Furthermore, continued indiscriminate and disproportionate use of high analysis inorganic fertilizers devoid of secondary and/or micronutrients coupled with less addition of organic source in the intensive cropping system has led to severe depletion of soil organic matter resulted in the widespread emerging multiple nutrient deficiencies; particularly secondary and micronutrients. It is assuming major challenges for achieving the desirable agricultural intensification required to feed quality food to the burgeoning population. The emerging scenario necessitates the need for the adoption of practices which maintain soil health, makes the production system more sustainable, and provides quality food for meeting the nutritional requirements. Therefore, to maintain soil fertility and to ensure food security in India, the use of other alternative options of soil fertility replenishment is indispensable. Although, various long term research results have shown that neither organic nor mineral fertilizers alone can achieve sustainability in crop production. Rather, integrated use of organic and inorganic fertilizers has become more effective in maintaining higher productivity and stability through correction of deficiencies of primary, secondary and micronutrients.

Materials and Methods

A field experiment was conducted during *kharif* and *rabi* seasons of 2018-19 and 2019-20 at Student's Instructional Farm, C.S. Azad University of Agriculture and Technology, Kanpur (UP) situated at between 25 ^{0}26' to 26 ^{0}58' North latitude and 79 ^{0}31' to 80 ^{0}34' East longitude at an elevation of 125.9 m above mean sea level. The region falls under agro-climatic zone V (Central Plain Zone) of Uttar Pradesh. The soil of the experimental field was alluvial in origin. The experiment was laid out in completely randomized block design with three replications treatments replicated thrice and plot size was 6×5 cm^2. Maize Variety Azad Uttam was sown in *kharif* whereas HD-2967 was taken as wheat variety during *rabi* season. was g In the present experiment fourteen treatments *viz*., T_1 (control), T_2 (75 % RDN), T_3 (75 % RDN +25 % N-FYM), T_4 (75 % RDN+25 % N-VC), T_5 (75 % RDN +25 % N-FYM +S+Zn+Az+ PSB), T_6 (75 % RDN +25 % N-VC +S+Zn+Az+PSB), T_7 (100% RDN), T_8 (100% RDN+S), T_9 (100% RDN+S+Zn), T_{10} (100% RDN+S+Zn+Az+PSB), T_{11} (100% RDN+25 % N-FYM), T_{12} (100% RDN+25 % N-VC), T_{13} (100% RDN+25 % N-FYM+S+Zn+ Az+PSB), T_{14} (100% RDN+25 % N-FYM+S+ Zn+Az+PSB) were applied in maize. Whereas in wheat a similar RDF (@ 120:60:40) of NPK was given in all the treatments of maize. The soil of the experimental field was sandy loam in texture which was low in organic carbon (3.35 g kg^{-1}), slightly alkaline in reaction. The soil was low in available N (156 kg ha^{-1}), medium in available P (10.34 kg ha^{-1}), high in available K (198.16 kg ha^{-1}), low in available S (14.20 kg ha^{-1} and medium in available Zn (0.36 mg kg^{-1}).

Field preparation

The experimental field was ploughed once with soil turning plough fallowed by two cross harrowing. After each operation, planking was done to level the field and to obtain the fine tilth. Finally layout was done and plots were demarked with small sticks and rope with the help of manual labour in each block. Application of fertilizers:

The crop was fertilized as per treatment. The recommended dose of nutrient i.e. N, P, and K was applied @ 120: 60: 40 kg ha-1 respectively. Time and method of fertilizer: Half does N2 and total phosphorus, potash, zinc and sulphur were applied as basal dressing. Remaining dose of nitrogen was applied through top dressing after knee-high stage. Well decompose FYM applied @ 60 t ha-1 15 day after sowing. Seed Treatment: To ensure the seeds free from seed borne diseases, seeds were treated with thiram 75% WDP (1.5g/kg of seed). Seed and sowing: 20 kg seed ha-1 maize variety Azad Uttam was used and sown on 22 June 2017. Row to row and plant to plant distance remain 60 and 20 respectively. Seed were sown about 5-6 cm. depth. Intercultural operations: Weeding and hoeing were done with khurpi and hand hoe after germination. Irrigation: Tube-well was the source of irrigation. Irrigation was provided in the crop as and when required. Harvesting: The crop was harvested at proper stage of maturity as determined by visual observations.

Biometric observation

The observations were recorded as per the procedure described below. For this purpose 5 plants were selected randomly in each net plot and were tagged with a level for recording various observations on growth and yield parameters. Biometric observation: Biometric observation such as plant population, plant height at maturity, length and diameter of cobs, test weight of 1000.

Plant population

The initial plant population (per square meter) was recorded after thinning and final plant population was counted before harvesting of crop. For counting plant population, one meter scale at three places in each plot was ear marked after thinning. In marked places, plants were counted for both initial and final population. The total of all the plants from three places was divided by three to get number of plants per running meter.

Plant height

The height of maize plants was measured in cm at harvesting stage from ground level to transverse mark of top portion of the plant. The average value was used for statistical analysis.

Plant height

The height of maize plants was measured in cm at harvesting stage from ground level to transverse mark of top portion of the plant. The average value was used for statistical analysis.

Length and diameter of cob

Length and girth of five randomly selected cobs from sampled plants were measured in cm and the average was worked out. Girth of dehusked cobs was measured separately at three places in each crop, middle and lower portion and then average value was worked out.

Results and Discussion

Growth and yield attributes of maize

Growth and yield parameters like plant population, plant height, cob weight, 1000 grain weight, length and diameter of cobs were influenced significantly with different treatments applied in maize during both the years and on pooled mean basis.

Plant population

The plant count at initial stage and harvest could not differ significantly with the application of different treatments as depicted in table 1.0. The maximum plant stand at initial and harvest stage recorded with treatment of T_{14} (100% RDN+25% N-VC+S+Zn+Az+PSB) followed by T_{13} ((100% RDN+25% N-FYM+S+Zn+Az+PSB). The increase in plant stand might be attributed to fact as organic manure adds sufficient amount of organic matter thereby improved soil physical conditions *i.e*., soil porosity and water holding capacity (Gaur, 1994, Prasad and Sinha, 2000; Bhattacharyya *et al.*, 2008). At initial stage the plant number could not differ significantly might be due to fact that the seed germination largely depends upon vigour and genetic makeup of the seed. The other factors like moisture, light and air were commonly available to the all seeds applied in the different treatment.

Whereas, at final stand, the plant stand was recorded maximum in T_{14} (100% RDN+25% N-VC+S+Zn+Az+PSB) whilst lowest in T_1 (control)**.** Plant population was gradually decreased from initial to final stage in both the years, due to biotic and abiotic stress during crop growth period. Similar results were also reported by Balasubramaian and Ramamoorthy (1996). Integrative application of inorganic sources with organic manures increased the availability of nutrients, and showed higher plant population compared to application of inorganic fertilizers. A similar result of higher final plant population observed with application of integration of organic manures with fertilizers was reported by Gunri and Nath (2012) and Yogendra Kumar *et al.*, (2013).

Plant height

The plant height was significantly influenced with the application of any level of nutrients over control (T_1) during both the years (table 2.0). The application of N through FYM or VC either with 75% or 100% RDN significantly contributed for the enhancement of plant height over their respective RDN. The application of 100% RDN with 25 % N through FYM or VC, Sulfur, Zinc, Azotobacter and PSB attained maximum plant height than any other treatment but among themselves no significant effect was observed however, application of VC was found numerically best for enhancement of plant height of maize. These results are in close conformity with the findings of Kannan *et al.*, (2013) and Naveed *et al.*, (2008)

Length and diameter of cobs

Among the various treatments under study the diameter of cobs ranged from 7.71 to 8.65 cm and 7.69 to 8.70 cm during first and second year respectively (table 3.0). Whereas, length of cobs varied from12.33 to 14.52 and 12.31 to 14.56 cm in that order. The result clearly revealed that the treatment T_{14} (100% RDN+25%-VC+S+Zn+Az+PSB) recorded maximum cob diameter as well as length of cob and significantly superior to which was significantly superior to control, 75 % RDN, 100% RDN, and VC or FYM with 75 or 100 % RDN75% and remained statistically at par value with rest of the treatments. The increase in length and diameter of cobs at higher nutrient levels or addition of organics fertilizer and sulphur and zinc might be due to their positive impact for supply of plant nutrients in adequate and balance quantities to the crop throughout growth and development period resulting to increase in total photosynthetic area, dry matter accumulation and translocation of photosynthates towards sink as reported by Sarwar *et al.,* (2007).

Test weight

The perusal of data as presented in table reveals the test weight ranged from 221.81 to 224.06 and 221.80 to 224.10 during first and second years, respectively. The data clearly indicates that the maximum test weight was recorded with the application of T_{14} (100% RDN+25%-VC+S+Zn+Az+PSB) which was highly significant than T_1 (control), T_2 (75% RDN), T_3 (75% RDN+25% N-FYM) and T_4 (75% RDN+25% N-VC) and remained statistically at par with the rest of the treatments. The increase of test weight might be due to the application of inorganic fertilizers along with organic manure could have encouraged the better rhizosphere environment, which would have made more nutrient availability in root zone consequently increased the nutrient absorption and translocation from source to sink Meena *et al.,* (2017).

Growth and yield attributes of wheat

Plant population

The plant stand of wheat was recorded at harvest stage (table 4.0). The maximum plant stand at harvest were recorded with treatment of T_{14} (100% RDN+25 % N-VC+S+Zn+Az+PSB) and which was closely followed by T_{13} (100% RDN+25 % N-FYM+S+Zn+Az+PSB) but could not observe significant difference. The germination is affected due to vigor and genetic potentialities of seed, the seeds were common to all the treatments. This is due to better soil condition with application of organics and biofertilizers. This is in conformity with the results of Amruthesh *et al.,* (2003) and Hameeda *et al.,* (2008) who observed such increased germination due to biofertilizers application.

Plant height

The results of plant height clearly revealed that the application of different treatments in maize significantly influenced the plant height of wheat over control during both the years and on pooled mean basis (table 4.0). Among the 75 % RDN combinations, the application of T_6 (75% RDN+25% N-VC+S+Zn+Az+PSB) recorded significantly taller plants over all the treatments of 75% RDN combinations however, remained at par with T_5 (75% RDN+25% N-FYM+S+Zn+Az+PSB).

The tallest plant was measured with T_{14} (100% RDN+25 % N-VC+S+Zn+Az+PSB) followed by T_{13} (100% RDN+25% N-FYM+S+Zn+Az+PSB) and significantly superior over rest of the treatments during both the years. It might be due to the positive impact of availability of individual plant nutrients and humic substances from manure and balanced supplement of nitrogen through inorganic fertilizers might have induced cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency and regulation of water intake into the cells, resulting in the enhancement of yield parameters (Sekar, 2003). These findings are corroborated with the results of (Chandel *et al.*, 2014 and Ram and Mir 2006).

Spike length

The data pertaining to spike length have been furnished in (table 5.0) revealed that the application of various treatments in maize significantly increased the spike length in wheat. The spike length varied from 7.23 to 10.28 and 7.26 to 10.36 cm during first and second years, respectively. The maximum number of spike length was measured in T_{14} (100% RDN+25% N-VC+S+Zn+Az+PSB) followed by T_{13} (100% RDN+25% N-FYM+S+Zn+Az+PSB), T_6 (75% RDN+25% N-VC+S+Zn+Az+PSB)and T_5 (75% RDN+25%N-FYM+S+Zn+Az+PSB) and significantly superior to rest of the treatments. It clearly indicated that the addition of FYM or VC with S, Zn, Azotobacter and PSB had profound influence on spike length during both the years of experimentation. The similar findings were reported by (Chandel *et al.*, 2014).

Table.1 Effect of different treatments on initial and final plant population of maize

Treatments combinations	Plant population per running meter		Plant population per running meter	
	Initial		Final	
	2018-19	2019-20	2018-19	2019-20
T_1. Control	6.11	6.13	5.98	5.95
T_2. 75%RDN	6.20	6.22	6.07	6.10
T_3. 75% RDN+25% N-FYM	6.23	6.25	6.11	6.14
T_4. 75%RDN+25%N-VC	6.25	6.27	6.13	6.16
T_5. 75%RDN+25%N-FYM+S+Zn+Az.+PSB	6.43	6.46	6.32	6.35
T_6. 75%RDN+25%N-VC+S+Zn+Az.+PSB	6.45	6.48	6.43	6.47
T_7. 100%RDN	6.28	6.30	6.16	6.19
T_8. 100%RDN+S	6.32	6.35	6.18	6.21
T_9. 100%RDN+S+Zn	6.41	6.44	6.33	6.37
T_{10}. 100%RDN+S+Zn+Az.+PSB	6.48	6.51	6.37	6.41
T_{11}. 100%RDN+25%N –FYM	6.37	6.40	6.28	6.31
T_{12}. 100%RDN+25%-VC	6.40	6.43	6.30	6.33
T_{13}. 100%RDN+25% N-FYM+S+Zn+Az.+PSB	6.53	6.56	6.44	6.57
T_{14}. 100%RDN+25% N-VC+S+Zn+Az.+PSB	6.55	6.58	6.47	6.59
SE(m)	0.28	0.31	0.28	0.25
CD (5%)	N.S.	N.S.	N.S.	N.S.

Table.2 Effect of different treatments on plant height and 1000 grain weight of maize

Treatments combinations	Plant height (cm)		1000 grain weight (g)	
	2018-19	2019-20	2018-19	2019-20
T_1. Control	175.63	175.61	221.81	221.80
T_2. 75%RDN	177.85	177.88	222.15	222.18
T_3. 75% RDN+25% N-FYM	178.23	178.26	223.21	223.24
T_4. 75%RDN+25%N-VC	178.32	178.35	223.25	223.30
T_5. 75%RDN+25%N-FYM+S+Zn+Az.+PSB	179.05	179.09	223.71	223.75
T_6. 75%RDN+25%N-VC+S+Zn+Az.+PSB	179.13	179.17	223.80	223.84
T_7. 100%RDN	178.42	178.45	223.33	223.36
T_8. 100%RDN+S	178.51	178.54	223.40	223.43
T_9. 100%RDN+S+Zn	178.8	178.83	223.62	223.66
T_{10}. 100%RDN+S+Zn+Az.+PSB	179.2	179.24	223.85	223.90
T_{11}. 100%RDN+25%N –FYM	178.66	178.69	223.48	223.51
T_{12}. 100%RDN+25%-VC	178.75	178.78	223.55	223.58
T_{13}. 100%RDN+25% N-FYM+S+Zn+Az.+PSB	179.28	179.32	223.93	223.97
T_{14}. 100%RDN+25% N-VC+S+Zn+Az.+PSB	179.33	179.37	224.06	224.10
SE(m)	0.45	0.62	0.39	0.41
CD (5%)	1.30	1.81	1.15	1.18

Table.3 Effect of different treatments combinations on diameter and length of cobs

Treatments combinations	Cob diameter (cm)		Cob length (cm)	
	2018-19	2019-20	2018-19	2019-20
T_1. Control	7.71	7.69	12.33	12.32
T_2. 75%RDN	8.25	8.28	13.58	13.60
T_3. 75% RDN+25% N-FYM	8.32	8.36	13.76	13.78
T_4. 75%RDN+25%N-VC	8.36	8.40	13.80	13.82
T_5. 75%RDN+25%N-FYM+S+Zn+Az.+PSB	8.53	8.57	14.20	14.22
T_6. 75%RDN+25%N-VC+S+Zn+Az.+PSB	8.56	8.60	14.28	14.30
T_7. 100%RDN	8.39	8.42	13.83	13.85
T_8. 100%RDN+S	8.41	8.44	13.95	13.97
T_9. 100%RDN+S+Zn	8.50	8.53	14.13	14.15
T_{10}. 100%RDN+S+Zn+Az.+PSB	8.61	8.65	14.36	14.34
T_{11}. 100%RDN+25%N –FYM	8.43	8.46	14.03	14.02
T_{12}. 100%RDN+25%-VC	8.46	8.49	14.10	14.09
T_{13}. 100%RDN+25% N-FYM+S+Zn+Az.+PSB	8.61	8.65	14.47	14.45
T_{14}. 100%RDN+25% N-VC+S+Zn+Az.+PSB	8.65	8.70	14.56	14.54
SE(m)	0.061	0.089	0.19	0.13
CD (5%)	0.177	0.258	0.55	0.36

Table.4 Effect of previously applied treatments on plant population and plant height

Treatments combinations	Plant population per running meter		Plant height (cm)	
	2018-19	2019-20	2018-19	2019-20
T_1. Control	28.55	28.67	82.76	82.78
T_2. 75%RDN	29.32	29.48	83.62	83.65
T_3. 75% RDN+25% N-FYM	29.53	29.79	84.68	84.70
T_4. 75%RDN+25%N-VC	29.58	29.86	84.70	84.73
T_5. 75%RDN+25%N-FYM+S+Zn+Az.+PSB	29.96	30.35	85.00	85.04
T_6. 75%RDN+25%N-VC+S+Zn+Az.+PSB	30.02	30.50	85.03	85.07
T_7. 100%RDN	29.4	29.58	84.66	84.69
T_8. 100%RDN+S	29.61	29.91	84.75	84.78
T_9. 100%RDN+S+Zn	29.67	29.99	84.77	84.80
T_{10}. 100%RDN+S+Zn+Az.+PSB	29.89	30.29	84.96	85.00
T_{11}. 100%RDN+25%N –FYM	29.76	30.12	84.79	84.83
T_{12}. 100%RDN+25%-VC	29.8	30.20	84.81	84.85
T_{13}. 100%RDN+25% N-FYM+S+Zn+Az.+PSB	30.11	30.59	85.08	85.12
T_{14}. 100%RDN+25% N-VC+S+Zn+Az.+PSB	30.17	30.71	85.11	85.15
SE(m)	0.78	0.89	0.080	0.97
CD (5%)	N.S.	N.S.	0.23	0.28

Table.5 Effect of previously applied treatments on length of spike and test weight

Treatments combinations	Spike length (cm)		Test weight (g)	
	2018-19	2019-20	2018-19	2019-20
T_1. Control	7.23	7.26	39.08	39.11
T_2. 75%RDN	8.56	8.61	39.21	39.25
T_3. 75% RDN+25% N-FYM	9.12	9.19	39.50	39.54
T_4. 75%RDN+25%N-VC	9.16	9.23	39.52	39.56
T_5. 75%RDN+25%N-FYM+S+Zn+Az.+PSB	9.88	9.96	40.28	40.32
T_6. 75%RDN+25%N-VC+S+Zn+Az.+PSB	9.91	10.02	40.30	40.37
T_7. 100%RDN	8.91	8.96	39.37	39.40
T_8. 100%RDN+S	9.20	9.26	39.63	39.66
T_9. 100%RDN+S+Zn	9.33	9.39	39.68	39.71
T_{10}. 100%RDN+S+Zn+Az.+PSB	9.76	9.82	40.15	40.19
T_{11}. 100%RDN+25%N –FYM	9.62	9.69	39.71	39.75
T_{12}. 100%RDN+25%-VC	9.66	9.73	39.73	39.77
T_{13}. 100%RDN+25% N-FYM+S+Zn+Az.+PSB	10.23	10.31	40.52	40.56
T_{14}. 100%RDN+25% N-VC+S+Zn+Az.+PSB	10.28	10.36	40.53	40.57
SE(m)	0.133	0.138	0.255	0.257
CD (5%)	0.39	0.41	NS	NS

Test weight

The data pertaining to 1000 grain weight as presented in table (table 5.0) revealed that the application of various treatments in maize. The test weight of grain of wheat varied from 39.08 to 40.53 and 39.11 to 40.57 g during first and second years, respectively. The test weight of wheat could not make significant difference due to applied treatments in maize crop. It is evident from table that the application of FYM or VC had pronounced impact on test weight compare to only RDN of 75 or 100 %. Though, maximum test weight was recorded with T_{14} (100% RDN+25% N-VC+S+Zn+Az+PSB) followed by T_{13} (100% RDN+25% N-FYM+S+Zn+Az+PSB), T_6 (75% RDN+25% N-VC+S+Zn+Az+PSB) and T_5 (75% RDN+25% N-FYM+S+Zn+Az+PSB) during both the years. This might be due to relatively more nutrient supply in available form which enhanced the plant growth and development ultimately increase in test weight. The results are corroborated with the findings of Rasool *et al.,* (2007) and Chandel *et al.,* (2014).

The maximum value regarding growth and yield attributes of maize and wheat were recorded with the treatment of T_{14} (100% RDN+25% N-VC+S+Zn+Az+PSB) which was statistically at par with T_{13} where FYM was given in place of VC. It was significantly superior for all the growth parameters except plant population than control during both the years of experimentation. It might be concluded that the integration of organic and inorganic sources along bio-inoculants proved better over sole inorganic or organic sources in terms of cost optimization as well as growth parameters.

References

Amruthesh, K. N., Raj, S. N., Kiran, B., Shetty, H. S. and Reddy, M. S. 2003. Growth promotion by plant growth promoting rhizobacteria in some economically important crop plants. In: Sixth International PGPR Workshop, 5–10 October, Calicut, India, 97– 103.

Anonymous, 2018. Agricultural Statistics at a Glance. Government of India Ministry of Agriculture & Farmers Welfare Department of Agriculture, Cooperation & Farmers Welfare Directorate of Economics and Statistics.

Bhattacharyya, R., S. Kundu, V. Prakash and H. S. Gupta. 2008. "Sustainability under combined application of mineral and organic fertilizers in a rain-fed soybean-wheat system of Indian Himalayas." *European Journal of Agronomy,* 28: 33-46.

Balasubramanian, A. and Ramamoorthy, K., 1996. Effect of nitrogen and phosphorus fertilization on juice yield and quality of sweet sorghum (*Sorghum bicolor L.*). *Madras Agricultural Journal*, 83(7): 463-464.

Brar, B. S., Singh, J., Singh, G., and Kumar, G. (2015). Effects of long term application of inorganic and organic fertilizers on soil organic carbon and physical properties in Maize–Wheat rotation. *Agron.,* (5): 220-238.

Chandel, B. S., Singh, H. and Singh, B. 2014. Direct and residual effect of nutrient management in wheat-maize cropping sequence. *Journal of Indian Society of Soil Science,* 61(2):126-130.

Gaur, A. C. 1994. "Bulk organic manures and crop residual." In: H. L. S. Tandon, J. Ced. (Eds.) Fertilizers, Organic manures, Recyclable Wastes and Biofertilizers, 36-51. Fertilizer Development and Consultation Organization. New Delhi, India.

Gunri, S. K. and Nath, R. (2012). Effect of organic manures, biofertlizers and biopesticides on productivity of summer Groundnut in red and laterite zone.

HLPE. 2013. Investing in smallholder agriculture for food security. A report by the high level panel of experts on food security and nutrition of the committee on world food security, Rome.

Kannan, R. L., Dhivya, M., Abinaya, D., Lekshmi, K. R. and Krishna, K. S. 2013. "Effect of integrated nutrient management on soil fertility and productivity in maize," *Bull. Env. Pharmacol. Life Sci.*, 2: 61-67.

Hameeda, B., Harini, G., Rupela, O. P., Wani S. P. and Gopala Reddy, 2008. Growth promotion of maize by phosphate solubilizing bacteria isolated from composts and macrofauna. *Microbiological Research*, 163: 234-242.

Naveed, M., Khalid, M., Jones, D. L., Ahmad, R. and Zahir, Z. A. 2008. Relative efficacy of Pseudomonas spp., containing ACC deaminase for improving growth and yield of maize (*Zea mays L.)* in the presence of organic fertilizer. *Pak. J. Bot*., 40(3): 1243-1251.

Prasad, B. and M. K. Sinha. 2000. Effects of fertilizers and organic manures on crop yield, nutrient balance and soil properties in rice-wheat cropping system in Bihar Rice-Wheat consortium New Dehli, India. *pp*. 105-109.

Prasad, B. and M. K. Sinha. 2000. Effects of fertilizers and organic manures on crop yield, nutrient balance and soil properties in rice-wheat cropping system in Bihar Rice-Wheat consortium New Dehli, India. *pp*. 105-109.

Rasool, R., Kukal, S. S. and Hira, G. S. 2007. Soil physical fertility and crop performance as affected by long-term application of FYM and inorganic fertilizers in rice-wheat system. *Soil and Tillage Research*96: 64-72.

Sarwar, M., Jilani, G., Rafique, E., Akhtar, M. E. and Chaudhry, A. N. 2012. Impact of integrated nutrient management on yield and nutrient uptake by maize under rain-fed conditions. *Pakistan Journal of Nutrition* 11 (1): 27-33.

Swarup, A., and Wanjani, R. H. 2002. Three decades of all India coordinated research project on long – term fertilizer experiments to study changes in soil quality, crop productivity and sustainability. *Indian Institute of Soil Science*, *Bhopal*, *India*, *pp*-59.

Sekar, A. 2003. Studies on the evaluation of sugarcane variety and production technologies for sugarcane productivity in coastal region of Tamil Nadu. Ph.D. thesis, Annamalai University, Annamalainagar, Tamil Nadu.

Tulsa Ram and Mir, M. S. (2006). Effect of integrated nutrient management on yield and yield-attributing characters of wheat (*Triticum aestivum*). *Indian Journal of Agronomy* 51(3): 189-192.

Yogendra Kumar., Rani Saxena, K. C., Gupta and Fageria, V. D., 2013. Yield and Yield attributes of Groundnut as influenced by organic practices in semi arid region. *International journal of Agriculture Environment & Bitechnology (IJAEB)*, 6(4): 605-610.

How to cite this article:

Pushpendra Kumar, S. D. Dubey, U. S. Tiwari, R. K. Pandey, Karam Hussain and Singh, R. K. 2021. Effect of VC, FYM, S, Zn, Azotobacter and PSB on Growth and Yield Attributes of Maize and Wheat. *Int.J.Curr.Microbiol.App.Sci.* 10(06): 764-773.
doi: https://doi.org/10.20546/ijcmas.2021.1006.083