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EFFECT OF HUMIC ACID AND VERMICOMPOST ON GROWTH AND YIELD OF POTATO (*SOLANUM TUBEROSUM* L.) CV. CHIPSONA-1

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ABSTRACT

The effects of humic acid and vermicompost on the growth and tuber yield were evaluated during two seasons (2021 and 2022). The pooled data clearly showed that both organic substances enhanced vegetative as well as tuber yield in potato cv. Chipsona-1. The effect of humic acid was stronger than the effect of vermicompost treatment. Also, a great effect of combined application of both was observed. The treated with humic acid 1000ppm + Vermicompost 10t/ha exhibited highest potato tuber yield as compared to control.

Key words : *Solanum tuberosum* L., Humic acid, Vermicompost, Growth and Yield parameters.

Introduction

Potato (*Solanum tuberosum* L.), belongs to the Solanaceae family, is cultivated in nearly 150 countries with an important role in the global food network and food security (Singh, 2010). It is world's fourth largest crop after maize, wheat and rice (FAOSTAT, 2021). Potato is extensively grown in India and requires both organic and inorganic fertilizer for higher yield. Continuous use of inorganic fertilizer in crop cultivation is causing health hazards and creating problems to the environment including the pollution of air, water and soil. The extensive chemical fertilizer based cultivation and pesticides have become a matter of great concern in recent days. The chemical fertilizer based cultivation is badly affecting the soil texture and structure decreases organic matter and hamper microorganism activity (Brady, 1990). The organic matter of most of the soils of India is below 2% as compared to an ideal minimum value 4% (Bhuiya, 1994).

The continuous diminishing level of organic matter is a challenging problem for India. Application of organic manure, particularly vermicompost, is a good source over traditional organic manures to improve the physical,

chemical and biological qualities of soil in opposition to the use of harmful chemical fertilizer in soil to solve this problem. It is a good source of various macro and micronutrients, especially nitrogen, phosphorus, potassium and sulphur.

Application of humic substances plays a pivot role in making the plants more resistant against drought stress, and also stimulates sprouting. Humic acid has a positive effect on nutrient uptake by the plant and spraying with humic acid has effects in increasing vegetative growth, photosynthesis efficiency and leaves area. Humic is an effective agent use as a complement to synthetic or organic fertilizers. A frequent use of Humic acid reduces the fertilizer use. The application of fertilizer entirely replace by proper use of organic matter that improve the microbial as well as humic status. The reasonable use of Humic acid and fertilizer, improve the soil fertility and carbon-based matter in the soil (Chen and Aviad, 1990; Munazza *et al.*, 2010). Organic amendments like vermicompost promote humification, increased microbial activity and enzyme production which, in turn, increases the aggregate stability of soil particles, resulting in better aeration (Tisdale and Oades, 1982; Dong *et al.*, 1983; Perucci, 1990). In this paper, we report the effect of

Humic acid and Vermicompost on growth and yield of potato cultivar Chipsona-1.

Materials and Methods

A field experiment was conducted at Horticulture Research Farm, Department of Horticulture, C.B.G. Agriculture P.G. College, BKT, Lucknow-226 201 (U.P.), India during *Rabi* season of 2021-2022. There were total nine treatments consisting three levels of Humic Acid (0 ppm, 1000ppm, 2500ppm) and three levels of Vermicompost (10 t/ha, 15 t/ha, 20 t/ha). The experiment was laid out in randomized block design with three replications. Each replication was represented by two ridges. Vermicompost was added as basal application and humic acid sprayed after one month of sowing. The soil of the experimental plot was alluvial sandy loam. The findings of the present research work regarding the effect of humic acid and vermicompost either alone or in combination on growth characters and yield were observed and statistically analyzed as per method described by Panse and Sukhatme (1967).

Results and Discussion

Effect of humic acid on growth and yield of potato Vegetative characters

The results recorded for plant height were differed significantly with application of Humic acids as compared to the control (Figs. 1-3). The highest plant height (5.29, 19.38 and 48.32 cm) was achieved in the 1000ppm concentration of Humic acid at 15, 30 and 60 DAT, respectively. The increase in the plant height might be due to the application of humic acid increases the uptake of calcium which plays a major role in the mitotic cell division of apical meristems and influences the plant height (Haider *et al.*, 2017). The similar results were observed by Kirn *et al.* (2010), Kumar *et al.* (2015) and Gad *et al.* (2015).

The number of leaves was also significantly influenced by different levels of humic acid (Figs. 4, 5 and 6). The maximum number of leaves (29.55, 110.40 and 207.60) was significantly affected by 1000 ppm various levels of humic acid at 15, 30 and 60 DAT, respectively. Increase in the number of leaves per plant might be due to the maximum availability and uptake of nutrients improved the plant growth and increases the plant height which is the key factor for number of leaves. The results are considered with the results obtained by Haider *et al.* (2017) and Shafeek *et al.* (2016).

The number of nodes was significantly affected by various levels of humic acid (Table 1). The maximum (40.60) number of nodes was recorded in H₂ treatment,

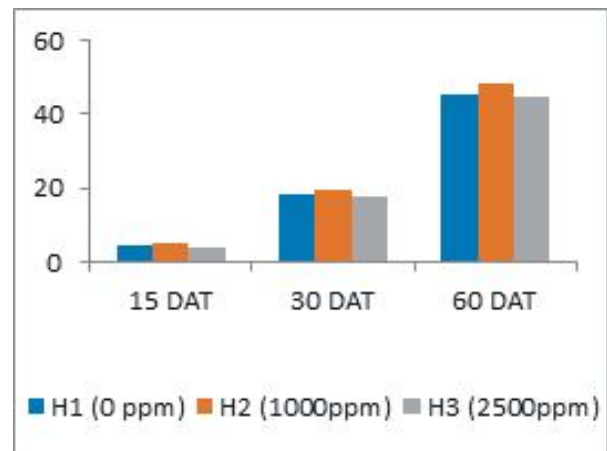


Fig. 1 : Effect of Humic acid on the plant height of Potato.

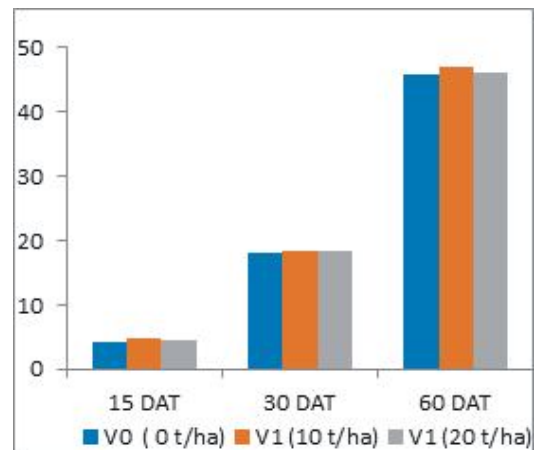


Fig. 2 : Effect of Vermicompost on the plant height of Potato.

i.e. 1000 ppm humic acid, which was found to be significantly higher over H₁ and H₃. The higher Number of nodes of potato plants with humic acid may be due to the differences in genetic makeup of the plants under different concentrations of Humic acid and adaptation ability of this cultivar to particular environment (Muhammad *et al.*, 2012). A perusal of data pertaining to length of roots of potato plant has been presented in Table 1. The length of roots was significantly affected by various levels of humic acid. The maximum (34.55 cm) length of roots was inscribed in H₂ treatment, *i.e.* 1000 ppm humic acid, which was found to be significantly higher over H₁ and H₃. The length of roots indicates that both ridging and mounding provided adequately favorable conditions for sweet potato growth and both loosened the soil, optimized infiltration and facilitated root expansion (Danquah *et al.*, 2014). With regard to plant fresh weight of potato application of humic acid @ 1000ppm showed maximum (144.69 g) plant fresh weight which was found to be significantly higher over treatment H₁ and H₃.

The maximum (32.04 g) plant dry weight was documented in H₂ treatment, *i.e.* 1000 ppm humic acid

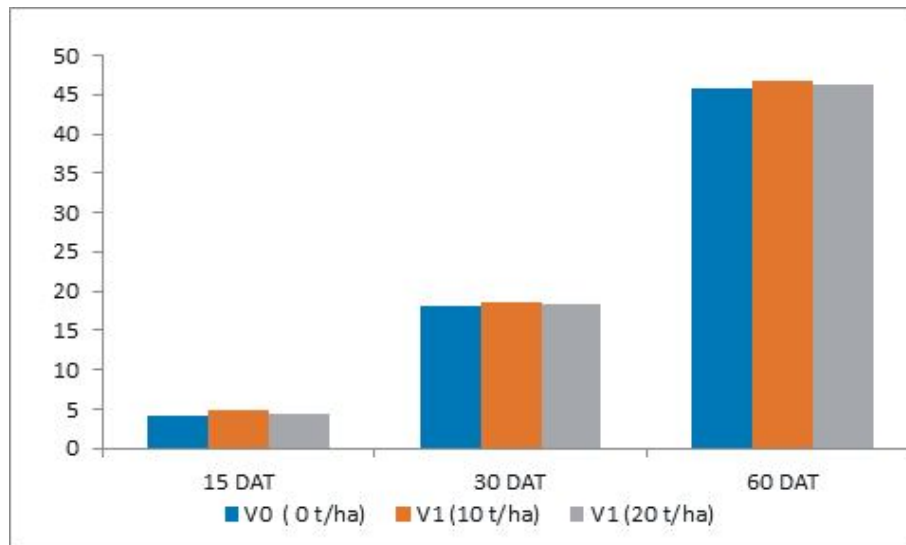


Fig. 3 : Effect of Humic acid and Vermicompost on the plant height of Potato.

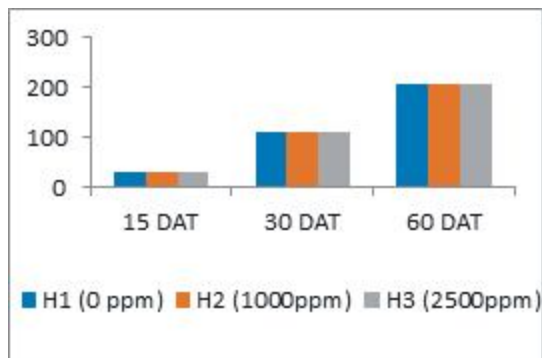


Fig. 4 : Effect of Humic acid on the number of leaves per plant.

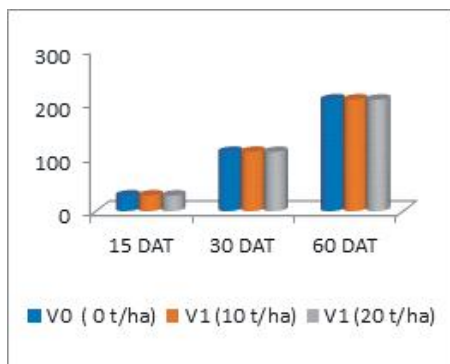


Fig. 5 : Effect of Vermicompost on the number of leaves per plant.

which was found to be significantly higher over H_1 , H_3 . These results are in the same line with those of El-Bassiony *et al.* (2010) in snap bean and Mahmoud and Hafez (2010); Sarhan (2011) in potato and Akthar *et al.* (2017) in mung bean. Such results could be due to that humic acid is a rich source of many essential nutrients including, Nitrogen, as well as many other nutrients which encourages plant growth (Akinci *et al.*, 2009). As well as, Humic acid when applied to field is converted into readily available humic substances which directly or

indirectly positively affect plant growth (Buyukkeskin and Akinci, 2011).

Yield attributes and yield

A perusal of data on tuber weight of potato as shown in Table 1. The tuber weight was significantly affected by various levels of humic acid. The maximum (113.32 g) tuber weight was recorded in H_2 treatment, *i.e.* 1000 ppm humic acid which was exhibited to be significantly higher over H_1 and H_3 . El-Desuki, (2004) and Selim *et al.* (2010) and Abbas (2014), who indicated that the additional humic substances to fertigated potato may improve soil fertility status. Also, the combined application of humic substances could be an effective method to increase the nutrient availability to plant.

That yield/plant was significantly affected by various levels of humic acid (Table 1). The maximum (1.82 kg) yield/plant was recorded in H_2 treatment, *i.e.* 1000ppm humic acid which was noted to be significantly higher over H_1 and H_3 . Yield components in this trial came to the same trend of the results reported on potato by Mahmoud and Hafez (2010) and Rizk *et al.* (2013). On the other hand, soil application of humic acid did not affect potato yield components (Suh *et al.*, 2014).

The total yield was significantly affected by various levels of humic acid (Table 1). The maximum (405.91 q) total yield was recorded in H_2 treatment, *i.e.* 1000 ppm humic acid which was found to be significantly higher over H_1 and H_3 . The influence of Humic acid significantly affect the total yield, it might be due to the properties of Humic acid in increasing the fertility level of the soil, and also providing and make obtainable the essential nutrients for the better growth of the plant and hence the increase in the yield of the crop these results also agree with the

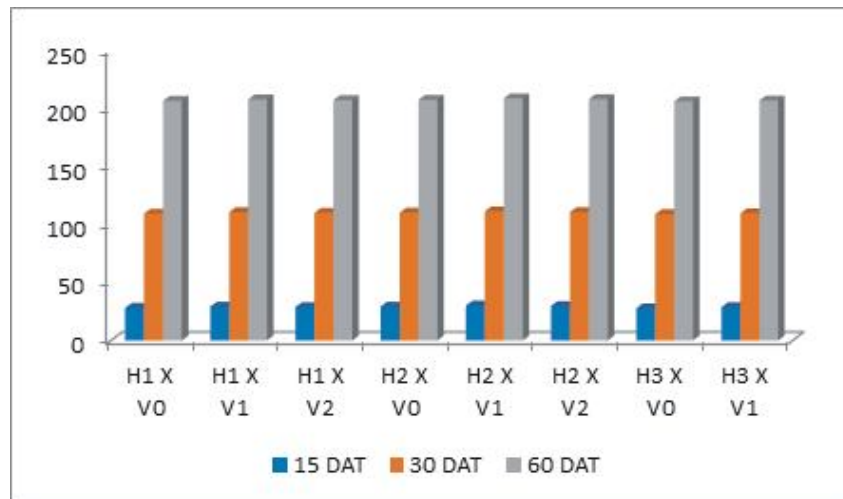


Fig. 6 : Effect of Humic acid and Vermicompost on the number of leaves per plant.

findings of Kirnet *et al.* (2010). Also, researchers specified that the greatest of the pepper plant development parameters and nutrient fillings remained positively affected by Humic acid applications (Tufenkci *et al.*, 2006).

The tuber dry weight at 60 DAT was significantly affected by various levels of humic acid (Table 1). The maximum (22.71) tuber dry weight was recorded in H₂ treatment, *i.e.* 1000 ppm humic acid which was found to be significantly higher over H₁ and H₃ (Table 1). The present study dry weight of tuber per hectare was influenced significantly by the application of different treatments that humic acid caused significant effect on all yield characteristics as compared to untreated plants found that humic acid improve plant growth by improving soil texture and act to increase water, plants roots ability to enter soil and penetrate, Humic acid is very important as transmissive media for nutrition's from soil to plant and increase soil water holding ability and stimulate soil microorganisms activity (Sarhan, 2011).

Effect of vermicompost

Growth characters

The plant height was significantly affected by the treatments at different growth period (Table 1). The Data showed that different levels of vermicompost significantly influenced the plant height at different growth stages. The maximum (4.88, 18.50 and 46.84 cm) plant height was recorded at 15, 30 and 60 DAT, respectively with treatment V₁ *i.e.* 10 t/ha vermicompost while, minimum (4.20, 18.08, 45.87 cm) under control. The above results are similar to Joshi and Vig (2010) and Narkhede *et al.* (2011), who reported that vermicompost incremented height of plant significantly, as compared to control in chili and tomato. In this regard, the researchers showed

that the application of 15 t/ha of vermicompost significantly incremented the canary grass plant height compared to the control (Ghandali *et al.*, 2016). Similarly, the lowest plant height was related to the treatment of non-application of vermicompost and the highest plant height to the use of 10 t/ha of vermicompost (Khalesro and Malekian, 2017).

The perusal of data on number of leaves in potato apparently showed that different levels of vermicompost significantly influenced the number of leaves at successive growth stages. The maximum (28.86, 109.77 and 206.88) number of leaves was recorded at 15, 30 and 60 DAT, respectively with treatment V₁ *i.e.* 10 t/ha vermicompost while, minimum (28.60, 109.64 and 206.66, respectively) under control ((Table 1). Vermicompost with improving the physical properties of the environment, increasing the microorganisms activity and increasing the water holding capacity, led to a significant increase in traits such as the leaves number in potato (Ozenc, 2008). In another study on strawberries, the researchers attributed the increase in the leaves number in vermicompost use to the increase in the microbial population in the vermicompost (Arancon *et al.*, 2004). These results agree with the results of Suthar (2009) in garlic and EL-Bassiony *et al.* (2010) in sweet pepper based on the positive effect of vermicompost on this trait.

They showed that different levels of vermicompost significantly influenced the number of nodes. The maximum (38.80) number of nodes was recorded with treatment V₁ *i.e.* 10 t/ha vermicompost while, minimum (37.62) under control (Table 1). The physical and chemical attributes of vermicompost and its extract by increasing the storage capacity of nutrients and increasing growth regulatory hormones increase nitrogen accumulation by plants. As nitrogen increases, plant growth factors such

Table 1 : Effect of humic acid and vermicompost on number of nodes, length of roots (cm), plant fresh weight (g), plant dry weight (g), tuber weight (g), tuber weight (g), yield plant⁻¹, total yield ha⁻¹ and tuber dry weight (g).

Treatment	Number of nodes	Length of roots (cm)	Plant fresh weight (g)	Plant dry weight (g)	Tuber weight (g)	Yield plant ⁻¹ (kg)	Total yield/ha (q/ha)	Tuber dry weight (g)
Humic Acid (ppm)								
H ₁ (0 ppm)	37.95	33.55	142.36	30.56	106.62	1.55	345.17	21.32
H ₂ (1000ppm)	40.60	34.55	144.69	32.04	113.32	1.82	405.91	22.71
H ₃ (2500ppm)	35.93	31.45	141.03	29.50	103.22	1.39	309.12	20.64
SE(m)	0.15	0.04	0.07	0.05	0.19	0.015	3.33	0.03
C.D. at 5%	0.47	0.11	0.21	0.14	0.60	0.045	10.06	0.11
Vermicompost (t/ha)								
V ₀ (0 t/ha)	37.62	32.76	142.54	30.49	107.67	1.57	350.60	21.58
V ₁ (10 t/ha)	38.80	33.57	142.97	30.86	108.65	1.64	364.92	21.73
V ₁ (20 t/ha)	38.06	33.22	142.57	30.75	106.87	1.55	344.68	21.36
SE(m)	0.15	0.04	0.07	0.05	0.19	0.015	3.33	0.03
C.D. at 5%	0.47	0.11	0.21	0.14	0.60	0.045	10.06	0.11
Interaction of Humic acid (H) x Vermicompost (V)								
H ₁ × V ₀	36.73	32.48	140.65	29.44	101.96	1.33	296.28	20.39
H ₁ × V ₁	39.06	34.52	143.92	31.46	111.66	1.82	404.43	22.33
H ₁ × V ₂	38.06	33.38	142.52	30.32	106.33	1.50	334.80	21.24
H ₂ × V ₀	38.73	33.59	143.55	31.68	110.56	1.65	367.39	22.25
H ₂ × V ₁	42.66	35.75	145.84	32.80	117.40	2.05	456.28	23.48
H ₂ × V ₂	40.40	34.56	144.68	31.87	112.00	1.77	394.06	22.40
H ₃ × V ₀	35.06	30.34	140.16	28.35	100.80	1.26	279.99	20.16
H ₃ × V ₁	37.00	32.49	142.43	30.55	106.60	1.54	342.92	21.32
H ₃ × V ₂	35.73	31.54	140.50	29.84	102.26	1.37	305.18	20.45
SE(m)	0.27	0.07	0.12	0.08	0.34	0.026	5.76	0.06
C.D. at 5%	0.81	0.20	0.36	0.25	1.03	0.078	17.43	0.20

as the nodes number will increase (Arancon *et al.*, 2005). Alam *et al.* (2007) stated that high consumption of vermicompost increase the availability of macro and microelements necessary for the potato plant due to the presence of vermicompost, increase the number of nodes in the plant. As the amount of nitrogen increased, the node number in the lemon balm and basil's main stem increased (Wahab and Larson, 2002).

The root length of potato showed a significant difference due to application of vermicompost was recorded in Table 1. The maximum length of roots (33.5 cm) was recorded with treatment V_1 *i.e.* 10 t/ha vermicompost while, minimum under control (32.76 cm). The increased growth parameters attributed to beneficial effect of VC has been reported by Subedi *et al.* (2018) in radish, Sylvester *et al.* (2015) in carrot and Jagadeesh *et al.* (2018) in beetroot.

It is noticeable that different levels of vermicompost significantly varied the plant fresh weight. The maximum (142.97 g) plant fresh weight was registered with treatment V_1 *i.e.* 10 t/ha vermicompost while, minimum under control (142.54 g). However, the observation regarding plant dry weight was significantly influenced by vermicompost application during the experimental. The maximum (30.86 g) plant dry weight was recorded with treatment V_1 *i.e.* 10 t/ha vermicompost while, minimum (30.49 g) under lower levels of vermicompost (Table 1). These results are similar to Pavan (2013) and Khan *et al.* (2019), who described that chili fruit weight incremented with the increasing quantity of vermicompost. An increment in fruit weight with an increment in vermicompost level was due to more readily available macro and micronutrients in the root zone, resulting in maximum production and better plant growth (Khan *et al.*, 2019).

Yield attributes and yield

The data pertaining to cleaning indicated tuber weight of potato that different levels of vermicompost significantly influenced the tuber weight. The maximum (108.65 g) tuber weight was listed with treatment V_1 *i.e.* 10 t/ha vermicompost while, minimum (106.83 g) under other levels of vermicompost treatment (Table 1). Weight of tuber due to the different combinations of vermicompost levels and tuber sizes was statistically significant. It was observed that plants from smaller seedling tubers mature later than the larger. The larger seedling tuber may have increased the dry matter/hill than the smaller seedling tuber. The increase in yield with the application of vermicompost could be attributed to the corresponding increase in leaf area, which was responsible for

synthesizing photosynthetic and increase in weight of tuber (Gangele, 2017; Mostofa *et al.*, 2021).

The yield per plant of potato showed that different levels of vermicompost significantly differed the yield/plant. The maximum (1.64 kg) yield/plant was recorded with treatment V_1 *i.e.* 10 t/ha vermicompost while, minimum (1.55 kg) under control (Table 1). These consequences are like that of Arancon *et al.* (2004), who explained that pepper produced greater fruit yield with vermicompost. Singh *et al.* (1997) showed higher fruit yield per plant in chili using vermicompost @ 10 t ha⁻¹. The positive result of adding vermicompost on yield performance has been reported in bell peppers (El-Bassiony *et al.*, 2010), which is consistent with our results. The reason could be that vermicompost, which is a rich source of macro and micronutrients, enzymes and growth hormones that improved the growth of the plant and fruit yield (Khan *et al.*, 2019).

The data on total yield of potato was also significantly improved by application of vermicompost (Table 1). The maximum (364.92 q) total yield was recorded with treatment V_1 *i.e.* 10 t/ha vermicompost while, minimum (344.68 q) under control. As a result of the availability of nutrients and increase its these have been positively reflected in plant growth and photosynthesis and the manufacturing of carbohydrates and proteins in the leaves and their transfer to tubers, it is due to the increasing the dry matter in the tubers and increasing the weight and number and increase the total yield. These results are conformity with Amara and Mourad (2013), they registered increasing total yield of potato when added vermicompost. The above results were in the line of the earlier reports (Al-Sahaf, 2007).

The data on the tuber dry weight of potato as influenced by vermicompost has been presented in Table 1. It is quite clear that different levels of vermicompost significantly influenced the tuber dry weight at growth stages. The maximum (21.73 g) tuber dry weight was recorded with treatment V_1 *i.e.* 10 t/ha vermicompost while, minimum (21.36 g) with treatment H_3V_0 . Tuber dry weight of potato was observed in the treatment Vermicompost. While the minimum dry weight of potato noticed under the treatment (Control) both years. The similar finding was also recorded by Alam *et al.* (2007).

It may be concluded from the results obtained during the percent experiment with different treatment combination of humic acid and vermicompost on vegetative growth and yield of potato cv. Chipsona-1. That plant treated with humic acid 1000ppm + Vermicompost 10t/ha significantly increased the height

of plant, number of leaves, number of nodes, length of roots, plant fresh weight, plant dry weight were maximum on humic acid and vermicompost treated plants on the basis of above findings it may be concluded that for getting substance of higher yield of quality potato tuber. The plants of potato should be treated with humic acid 1000ppm + Vermicompost 10t/ha in central plains of Uttar Pradesh, India.

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