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Research Article

EFFECT OF BIO FERTILIZERS AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF POTATO (*Solanum tuberosum* L.) CV. KUFRI CHANDRAMUKHI AND KUFRI JYOTI

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A B S T R A C T

A field experiment was conducted to know the effect of application of bio fertilizer and inorganic fertilizer on growth and yield potential of potato at Horticulture Research Block of School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India during winter season of 2016-17. 3×3 Factorial Randomised Block Design (RBD) was arranged with three replication for each treatment. There were ten treatments used in which one control and remaining treatment comprising combination of inorganic fertilizer and bio fertilizers. The cultivars were used for the study was Kufri Chandramukhi and Kufri Jyoti. Growth parameters were plant height, leaf number and branch number while yield parameters were tuber weight, and tuber yield were recorded. Application of different bio-fertilizers alone or in combination with others revealed that the bio-fertilizers have stimulatory effect studied growth parameter of potato. The highest tuber weight and tuber yield with treatment T_9 using (T_6 + Bio fertilizer; Azotobactor and PSB). The results showed that the application of different bio fertilizer along with fertilizers revealed significant positive impact on number of leaves per plant, number of branches per plant, plant height, tuber weight and yield of potato tuber.

INTRODUCTION

Potato (*Solanum tuberosum* L.) popularly known as 'The king of vegetables', has emerged as fourth most important food crop in India after rice, wheat and maize. It has a place with solanaceae family. Indian vegetable basket is incomplete without Potato. Because, the dry matter, edible energy and edible protein content of potato makes it nutritionally superior vegetable as well as staple food not only in our country but also throughout the world. Now, it becomes as an essential part of breakfast, lunch and dinner worldwide. Being a short duration crop, it produces more quantity of dry matter, edible energy and edible protein in lesser duration of time than cereals like rice and wheat. Hence, potato may prove to be a useful tool to achieve the nutritional security of the nation (FAO, 2019). Depending on the varieties, potato plants grow up to 60 cm high, and are herbaceous perennials. The leaves die back after flowering, fruiting and tuber formation. The flowers of potatoes consist of white, pink, red, blue or purple along with yellow stamens.

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In general white flowers potato have white skin tuber, while the coloured flower potato tend to have pinkish skins. The pollination in potatoes is mostly cross-pollinated by insects such as bumblebees that carry pollen from other potato plant, although a substantial amount of self-fertilization occurs as well.

Nutrients uptake is at its greatest during tuber bulking up. The amount of nutrients removed by a potato crop is closely related to yield. Usually, twice the yield will result twice the removal of nutrients. Nitrogen, phosphorus and potassium are the significant supplements influencing development, improvement and yield of potato. Nitrogen is a first limiting nutrient in potato production thus has a great influence on crop growth, tuber yield and its quality. A mature crop of potato yielding 25-30 t ha-1 tubers removes 120-140 kg N ha-1 Trehan *et al.* (2018). Nutrients need to be applied as accurately as possible to the zone of uptake, slightly before, or at the time that the crop needs them. Failure to ensure that each plant gets the right balance of nutrients can spoil crop quality and reduce yield. Nitrogen being constituent of cellular material improves chlorophyll union. The phosphorus directly affects shoot development, root advancement and tuber arrangement in potato. It is also important for early root and shoots development, providing energy for plant processes such

as ion uptake and transports. Roots absorb phosphate ion only when they are dissolved in the soil water. P deficiencies can occur even in soils with abundant available P, if drought, low temperatures, or disease interfere with P diffusion to the root, through the soil solution. These deficiencies will result in stunt root development and inadequate function Mehrvarz *et al*. (2008). While, potassium is one of the vital constituent of cell and its lack has unfavourable impact on nature of tuber. Potato plants take up large quantities of potassium throughout the growing season, since this nutrient is crucial to metabolic functions such as the movement of sugars from the leaves to the tubers and the transformation of sugar into potato starch. Potassium has an important role in the control of the plant water status and internal ionic concentration of the plant tissues, with a special focus on the stomatal functioning. Potassium requirements of potato tubers during the bulking stage are very high as they are considered to be luxury consumers of potassium. Potassium deficiencies reduce the yield, size, and quality of the potato crop. There are numerous natural wellsprings of nitrogen, phosphorus and potassium among them Farm Yard Manure (FYM) is generally prominent. It contains 0.5% nitrogen, 0.2% phosphorus and 0.5% potassium and numerous different micronutrients (Yawalker *et al*., 1996). Exceptional returns must be maintained through the use of ideal NPK measurements in adjusted extent.

Table 1 Details of treatments

S.No.	Symbol	Treatments
1.	T_1	50% dose of NPK
2.	T_2	75% dose of NPK
3.	T_3	100% dose of NPK
4.	T_4	T_1+tuber soaked in 1% urea
5.	T_5	T_2+tuber soaked in 1% urea
6.	T_6	T_3+tuber soaked in 1% urea
7.	T_7	T_4+bio fertilizer (Azotobacter+PSB)
8.	T_8	T_5+bio fertilizer (Azotobacter+PSB)
9.	T_9	T_6+bio fertilizer (Azotobacter+PSB)
10.	T_{10}	Control

use of substance manures and help in improving the soil (Densilin *et al*., 2010). Soil microorganisms assume an imperative part in change of supplement for plant utilization. There are basically two kinds of bio fertilizers i.e. nitrogen settling bio fertilizers and phosphatic bio fertilizers.

Nitrogen settling bio fertilizers add nitrogen into the soil by diminishing environmental nitrogen and phosphatic bio fertilizers can solubilizes the phosphates bound in soil and builds its accessibility in plant. To build the creation and nature of potato, sensible blend of natural supplement alongside inorganic and bio fertilizers (azotobactor, phosphobacteria) get great reaction (Nag, 2016). Bio fertilization is presently a critical technique for giving the plants their healthful necessities without undesirably affecting the soil health (Lampkin, 1999). Therefore, the objective of this experiment was to study the effect of selected doses of nitrogen and phosphorus fertilizers on growth, development, quality and yield of two potato cultivars. The result of this research work may help in improving the growth and yield of potato tuber.

MATERIAL AND METHODS

The experiment was carried out in Horticulture Research Block of School of Agricultural Sciences, SGRR University, Dehradun, Uttarakhand, India (29°58' N, 77°34' E) during *Rabi* season of 2016-17. The soil of the experimental plot was sandy loam in texture and slightly acidic in reaction with pH 6.8 and EC 0.55 dS/m. The soil was low in available nitrogen (283 kg/ha), high in available phosphorus (69 kg/ha) and medium in available potash (233 kg/ha). The inorganic source of fertilizers was satisfied with Urea, MOP, DAP (as N, P, k) and organic source as FYM (Farm Yard Manure) which had a significant effects on the growth and yield of Potato. Ten treatments comprising of T_1-50% dose of NPK, T_2 – 75% dose of NPK, T_3 –100% dose of NPK, T_4 - T_1+tuber soaked in 1% urea, T_5 – T_2+tuber soaked in 1% urea, T_6 – T_3+tuber soaked in 1% urea, T_7 - T_4+bio fertilizer (Azotobacter+PSB), T_8 – T_5+bio fertilizer (Azotobacter+PSB), T_9 – T_6+bio fertilizer (Azotobacter+PSB) and T_{10}-Control. The improved cultivars of potato Kufri Chandramukhi and Kufri Jyoti were used in this experiment.

Table 1 Effect of Bio fertilizers (PSB + Azotobactor) and inorganic fertilizers on growth and yield parameters at 60 days in potato cultivars Kufri Chandramukhi and Kufri Jyoti

Treatments	Number of Leaves per Plant		Number of Branches per Plant		Plant Height (cm)		Tuber Weight (g)		Yield Per Hectare (t/ha)	
	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2
T_1	65.8	66.7	10.33	9.65	45.9	46.6	172.2	174.8	12.8	12.3
T_2	66.8	65.6	9.86	9.28	56.8	55.8	245.4	251.5	18.0	17.6
T_3	66.6	65.6	9.46	10.44	48.6	45.8	136.6	142.2	10.2	9.86
T_4	68.8	67.8	12.02	12.00	48.2	47.6	146.8	143.6	10.8	10.5
T_5	65.9	64.4	11.36	11.05	45.4	44.6	247.6	242.2	17.8	17.7
T_6	68.9	66.3	11.27	11.13	48.8	47.6	138.2	144.6	10.8	9.9
T_7	67.6	65.8	12.44	12.20	57.6	56.5	255.2	253.5	18.4	18.0
T_8	75.6	72.4	12.86	12.52	64.6	62.2	234.6	235.7	16.8	16.8
T_9	66.8	67.6	11.36	11.45	46.8	49.8	256.8	254.2	18.9	18.6
T_{10}	64.2	63.4	8.46	8.18	44.8	43.8	139.2	158.4	11.1	10.0
S.Em. ±	0.3	0.3	0.3	0.2	0.2	0.3	5.0	3.6	0.0	0.0
CD at 5%	0.8	1.0	1.1	0.9	0.7	0.9	14.9	10.6	0.1	0.0
CV	0.7	0.9	0.8	0.7	0.8	1.1	4.5	3.1	0.3	0.2

C_1.Kufri Chandramukhi; C_2.Kufri Jyoti

Bio fertilizers are living life forms utilized as a part of the preparation of soil and are helpful in supplementing the typical

and can be grown in plains as well as in the hills. It matures in 110-130 days. The plants are medium tall, vigorous with light purple flowers. Tubers are large, oval, uniform with flat eyes.

The flesh colour of tubers is dull white. Whereas Kufri Jyoti is a medium maturing variety and takes about 130-150 days to mature. It is moderately resistant to late blight both on foliage and tubers. The plants are tall, erect, vigorous and medium compact and flowers are white in colour. Potato tubers of both cultivars were planted with a spacing of 60 cm in between rows and 20 cm in between plants in the November 2016. The observations were recorded on different growth and yield attributing characters like number of leaves per plant, number of branches per plant, plant height, tuber weight, and yield per hectare. The statistical formulas were used for compilation of data and drawing of conclusion according to Fisher, 1958.

RESULT AND DISCUSSION

The highest number of leaves per plant (75.6) in cultivar Kufri Chandramukhi was observed in treatment T_8 (T_5 + bio fertilizer) and found to be statistically significant over the other treatments. The lowest number of leaves per plant (64.2) was recorded in control (T_{10}). The highest number of leaves per plant (72.4) in cultivar Kufri Jyoti was also recorded in treatment T_8 (T_5 + bio fertilizer) and found to be statistically significant over the all other treatments. The lowest number of leaves per plant (63.4) was recorded in control (T_{10}). The highest number of branches per plant (12.86) in cultivar Kufri Chandramukhi was observed in treatment T_8 (T_5 + bio fertilizer) and found to be statistically significant over the other treatments. The lowest number of branches per plant (8.46) was recorded in control (T_{10}). The highest number of branches per plant (12.52) in cultivar Kufri Jyoti was also recorded in treatment T_8 (T_5 + bio fertilizer) and found to be statistically significant over the all other treatments. The lowest number of branches per plant (8.18) was recorded in control (T_{10}).The highest plant height (64.6 cm) in cultivar Kufri Chandramukhi was recorded in treatment T_8 (T_5 + bio fertilizer) and found to be statistically significant over the other treatments. The lowest plant height (44.8 cm) was recorded in control (Table 2). The highest plant height (62.2 cm) in cultivar Kufri Jyoti was recorded in treatment T_8 (T_5 + bio fertilizer) and found to be statistically significant over the other treatments. The lowest plant height (43.8 cm) was recorded in control (T_{10}). The greater plant height was recorded in treatment with bio fertilizers (PSB and Azotobacter) in the present experiment might be due to effect of Azotobacter which is a group of bacteria which are free living nitrogen fixer. The mechanism by which the plants, inoculated with Azotobacter, derive possible benefits in terms of increased plant growth (Panda and Hota, 2017).

The highest tubers weight (256.8g) in cultivar Kufri Chandramukhi was recorded in treatment T_9 (T_6+Bio fertilizer) followed by treatment T_7 (T_4+Bio fertilizer) i.e.255.2. The lowest tubers weight (136.6g) was recorded in treatment (T_3). The highest tubers weight (254.2g) in cultivar Kufri Jyoti was recorded in treatment T_9 (T_6+Bio fertilizer) followed by treatment T_7 (T_4+Bio fertilizer) i.e.253.5. The lowest tubers weight (142.2g) was recorded in T_3 (Table 2). This might be due to more bulking rate of tubers in faster way. These results are in similarity with the observation of (Sharma and Singh, 1998) who reported progressive increase in the seed size tuber yield with the application of NPK fertilizers at the higher rates to potato seed crop. The highest value of yield per hectare (18.9 t/ha) in cultivar Kufri Chandramukhi was recorded in treatment T_9 (T_6+Bio fertilizer) followed by treatment T_7 (T_2+Tuber Soaked in 1% urea) i.e.18.4. The lowest yield per hectare (10.2) was recorded in the treatment T_3. The highest value (18.6t/ha) of yield per hectare in cultivar Kufri Jyoti was recorded in treatment T_9 (T_6+ bio fertilizer) followed by treatment T_7 (T_4+Bio fertilizer) i.e.18.0. The lowest yield per hectare (9.86 t/ha) was recorded in treatment T_3. The above experimental results are in close proximity with the findings of (Abdalla *et al*., 1995). Lampkin, 1999 recorded the application of crop residue incorporation with bio fertilizers (PSB + Azotobacter) which produced the highest total tuber yield (286.63 q/ha) in potato. Similar results were also presented by Verma *et al.,* 2014 in potato.

CONCLUSION

Based on experimental results, it seems quite logical to conclude that combined treatment of potato tuber with bio fertilizers i.e. Azotobactor and PSB showed significantly higher number of leaves per plant, number of branches per plant, plant height, tuber weight and tuber yield per hectare, as compare to other treatments. So, these two bio fertilizers (Azotobactor and PSB) along with normal doses of major other fertilizers like N,P and K may be recommended to the potato growers to obtain greater yields and also to prevent losses and to increase the overall production of potato. In this way, bio fertilizer i.e. Azotobactor play healthful stimulatory and remedial part for the boosted of yield, which makes it a potential bio-manure for potato. Likewise PSB solubilises phosphorus from soil source and makes it accessible to plant.

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