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Effect of different phosphorus levels on growth attributes physiological parameter and grading of tuber in potato crop (*Solanum tuberosum* L.)

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Abstract
A field experiment was conducted during 2015-16 at ICAR- CPRS, Gwalior M.P. during *Rabi* season, to judge the effect of different phosphorus levels on growth attributes, physiological parameter and grading of tuber in potato crop (*Solanum tuberosum* L.). The experiment consisted of 10 treatments with four replications. The results revealed that both farmers practice and application of 120 Kg P_2O_5/ha through fertilizer produced significantly higher dry matter/plant, tuber dry matter/plant, AGR and RGR and both these treatments were statistically at par to each other. On the other hand 100% P_2O_5 through FYM recorded significantly higher number of leaves/plant whereas application of 100% P_2O_5 through FYM recorded minimum number and weight of crack tuber as compared to other treatments. Control treatment recorded significantly higher root length and root shoot: ratio, tuber number and tuber yield under < 25 g while application of 120 kg P_2O_5/ha through fertilizer was higher in case of total number of tuber (per plot), number of tuber and yield of tuber under 20-50 and 50-75 g. However, number and yield of tuber under <75 g was highest in farmers practice. However, quadratic equation line ($Y = 21.748 + 5.489 X – 0.587X^2$) for inorganic doses of phosphorus resulted in, 116.93 and 63.42 kg P_2O_5/ha were the optimum physical and economical levels, respectively for getting higher yield of tuber. Therefore, it is concluded that application of 120 and 60 Kg P_2O_5/ha through fertilizer was the best dose of phosphorus for achieving higher optimum physical and economical productivity, respectively.

Keywords: growth attributes, grading, physiological parameter and potato

Introduction
Potato (*Solanum tuberosum L.*) is a herbaceous annual that grow up to 100 cm and contributes substantially towards food and nutritional security in the world. The potato is ranked by FAO of United Nations as the world's 4th most important food crop after rice, wheat and maize. Potato is an ingredient in many dishes and salads. It is a non-fattening, nutritious and wholesome food that supplies many important nutrients to the diet. It contains approximately 78% water, 22% dry matter (specific gravity) and less than 1% fat. About 82% of dry matter is carbohydrate, mainly starch with some dietary fiber and have better nutritional quality than cereals. Potato contains at least 12 essential amino-acid, minerals and is also source of vitamin C, thiamine, iron and folic acid.

The current global production of potato is around 317.7 million tonnes and China being the biggest producer globally. India ranks 2nd in area and production of potato in the world after China which contribute 11 per cent of world potato production (FAO STAT, 2014) [1]. In India, it is grown on an area of 2 million hectares with the production of 44.3 million tonnes and the productivity is 21967 kg/ha (Anonymous, 2015) [2].

Different nutrients have major influence on the yield and quality of crop in different ways. Phosphorus is the 2nd limiting nutrient after nitrogen. It is one of the key nutrient and sways the early crop development and tuber initiation, tuber size, tuber specific gravity. (Dyson and Watson, 1971) [7].

Phosphorus promotes rapid canopy development, root cell division, tuber set, and starch synthesis. Adequate P is essential for optimizing tuber yield, solids content, nutritional quality and resistance to some diseases (Rosen *et al.*, 2014) [22].

Potato is highly responsive to soil-applied nutrients, especially to phosphorus (P), due to its short cycle and high yield potential. Phosphorus is essential for plants, mainly for the metabolic processes related to energy uptake, and therefore limiting for potato development. Therefore, there is a need Plant growth is delayed at low-P levels already in initial stages; besides, number and length of roots and stolon are reduced as well as tuber yield (Fontes, 1997) [11].

Phosphorus nutritional status affects the absorption of other nutrients and, consequently, influence crop nutrition and production. The plant requirement of magnesium (Mg) can be related to the P levels in nutrient solution (Vichiato *et al*., 2009) [24]. Phosphorus also interacts positively with nitrogen (N) uptake and plant growth (Fageria, 2001) [9], and P deficiency reduces the uptake of both nitrate (Araújo & Machado, 2006) [4] and ammonium. The application of high P levels increases the severity of zinc (Zn) deficiency in soils with low Zn levels (Fageria, 2001) [9].

Materials and Methods

A field experiment was conducted during the *Rabi* season of 2015-16 at ICAR- Central Potato Research Station, Gwalior. Geographical conditions of experimental field, Gwalior was 26°13' N latitude, 78°14' East longitude and 206 m above mean sea level. The soil was silty-clay-loam with pH 7.4 and EC 0.23 dS/m, being low in organic carbon (0.37%) and available nitrogen (165.93 kg/ha), medium in available phosphorus (20.35 kg/ha) and high in available potassium (395.20 kg/ha). Bulk density, particle density and water holding capacity of experimental field were 1.28 g/m^3, 2.56 g/m^3 and 44.47 %, respectively. The experiment was laid out in randomized block design with 4 replications. There were 10 treatments, viz. T_1: farmers practice (180:120:60 kg N:P_2O_5:K_2O, respectively), T_2: Zero P_2O_5/ha (control), T_3: 30 kg P_2O_5/ha through fertilizer, T_4: 60 kg P_2O_5/ha through fertilizer, T_5: 90 kg P_2O_5/ha through fertilizer, T_6: 120 kg P_2O_5/ha through fertilizer, T_7: 50% P_2O_5 through FYM + 50 % P_2O_5 through fertilizer, T_8: 50% P_2O_5 through vermicompost + 50% P_2O_5 through fertilizer, T_9: 100% P_2O_5 through FYM and T_{10}: 100% P_2O_5 through vermicompost.

The recommended dose of N, P_2O_5 and K_2O were 180, 80 and 120 kg/ha, respectively for the crop. Nitrogen, phosphorus and potassium were applied in the form of urea, dia-ammonium phosphate (DAP) and muriate of potash (MOP), respectively. Half dose of nitrogen and full doses of phosphorus and potassium were applied through Urea, DAP and (MOP), respectively, as basal dose at the time of planting, whereas remaining nitrogen was applied at the time of earthing up through urea. FYM and vermicompost were applied according to the treatments to replace the recommended doses of phosphorus. Cultural practices were followed as per standard recommendation to potato. Variety 'Kufri Jyoti' was used for experimentation. Prior to planting, the field was prepared as per the standard procedure and planting was done on 19th October, 2015.

After harvesting the crop, grading was performed on the basis of size, weight, and crack tubers. Tubers were graded into 4 categories viz. <25 g (< 3 cm), 25-50 g (3-4 cm), 50-75 g (4-5 cm), >75 g (>5 cm). Five potato plants were randomly sampled from the inner rows of the each plot leaving the border rows. The tagged plants were carefully dunged up, the roots thoroughly washed under running water, put in labeled envelop bags and taken to the laboratory where the growth parameters were recorded. The plant samples were partitioned into various plant fractions viz. root, stem and leaves and after sun drying sample were subjected to oven-drying at 62°C until a constant weight was attained. Completely dried samples were weighed and the dry matter (DM) content of different plant parts was measured and expressed in g/plant. Growth and physiological parameter were recorded at 30, 60 DAP, maturity stage. Economics was worked out taking both variable and fixed costs into account. Data were analyzed as per standard procedure with 5% probability level. In physiological parameter AGR and CGR were calculated as:

$$\text{Absolute Growth Rate (AGR)} = \frac{W_2 - W_1}{t_2 - t_1}$$

Where,
W_1 = Dry weight of the plant (g) at time t_1
W_2 = Dry weight of the plant (g) at time t_2

$$\text{Relative Growth Rate (RGR)} = \frac{(\log_e W_2 - \log_e W_1)}{(t_2 - t_1)}$$

Where,
W_1 = Dry weight of plant (g) at time t_1
W_2 = Dry weight of plant (g) at time t_2
$t_2 - t_1$ = Time interval in days

Results and Discussion

Plant Height

In general, the plant height increased with the advancement in crop age irrespective of the treatment and reached maximum at maturity. The rate of increase in plant height was more during 30 to 60 DAP as compared to 60 DAP to maturity. The height of plants was almost ceased or slightly declined at maturity because of senescence.

The plant height varied significantly among the different phosphorus doses at all growth stages due to positive effect of phosphorus. At all growth stages, significantly tallest plant was noted under 100% P_2O_5 through FYM and at final stage, it was at par with 100% P_2O_5 through vermicompost (54.95 cm),120 Kg P_2O_5 through fertilizer (52.50 cm), 50% P_2O_5 through vermicompost + 50% P_2O_5 through fertilizer (52.35 cm). Lowest plant height was recorded with control which was lower than remaining treatments at all the stages which was 45.80 cm at final stage. This may be due to an increased availability of nutrients to the plant in the presence of organic manure. Organic manure have micro nutrient along with macro nutrients which is essential for plant growth and development. It increased availability of nutrients to the plants in balanced proportion resulting in higher uptake of nutrients which ultimately resulted in higher plant height. It might also be due to significant effect of FYM in phosphorus solubilization on plant height. Corroboratory findings were also reported by Baishya *et al.* (2012) [5], Iseal *et al.*, (2012) [13], Zelalem *et al.*, (2009) [26] and Kumar *et al.* (2012) [16].

Table 1: Effect of different phosphorus doses on root shoot ratio, AGR and RGR of potato

Treatments	Plant height (cm)			Dry biomass/plant			Tuber dry weight/plant		
	30 DAS	60 DAS	Maturity	30 DAS	60 DAS	Maturity	30 DAS	60 DAS	Maturity
T_1	26.38	47.21	51.27	16.25	36.84	52.40	0.15	23.49	89.27
T_2	22.20	46.57	45.80	12.20	21.73	27.39	0.03	13.52	54.12
T_3	23.95	48.57	50.45	13.20	25.10	33.07	0.09	15.58	62.56
T_4	23.50	48.37	50.40	14.30	27.41	36.53	0.14	18.47	70.81

T_5	25.90	49.38	52.05	14.40	30.23	41.39	0.15	20.98	73.21
T_6	27.10	49.79	52.50	16.90	36.39	53.28	0.17	25.75	93.21
T_7	26.40	50.15	52.10	14.73	29.71	40.69	0.13	22.81	66.56
T_8	26.83	49.73	52.35	14.00	29.46	40.29	0.14	22.93	66.27
T_9	28.95	53.10	55.50	14.69	29.04	39.75	0.13	18.09	65.37
T_{10}	27.20	51.65	54.95	14.42	29.04	39.44	0.09	15.01	66.88
S.E.(m)±	1.05	0.94	1.13	0.23	0.51	0.65	0.01	0.84	2.93
C.D. (at 5%)	3.05	2.74	3.27	0.68	1.49	1.87	0.02	2.45	8.51

Leaves/plant
Phosphorus levels caused a marked variation in number of leaves/plant at all the crop growth stages. Phosphorus treatments significantly increased number of leaves/plant over control. The maximum number of leaves/plant was recorded with 100% P_2O_5 through FYM at all growth stages over control whose values were 32.26, 28.33, 21.94 % higher compare to control at 30 DAP, 60 DAP and maturity. It may be owing to increased supply of multi-nutrients, plant growth regulators and beneficial microflora released from FYM, which is a rich source of nutrients, vitamins, enzymes, antibiotics, plant growth hormones and a number of beneficial microorganisms (Bhawalker, 1991) [6] resulted in higher number of leaves/plant. The result is also in line with findings of Baishya *et al.* (2012) [5].

Root length
It is apparent from Table 1, increase in root length was higher at 30 DAP as compare to succeeding stages. Application of phosphorus with vermin-compost, FYM along with fertilizer and sole recorded vague response at all the stages of crop growth.
Phosphorus application through fertilizers gave significant response at all the stages of crop growth. At all the stages, control recorded maximum root length except at 30 DAP on which it was at par with 30 kg P_2O_5/ha through fertilizer while farmers practice registered lower root length at all the stages of crop growth except 60 DAP on which application of 120 kg P_2O_5/ha through fertilizer recorded minimum root length compared to others. It might be possible due to formation of thinner and longer roots in case of P deficiency. The findings lined with Hu *et al.* (2010) [12] and Fernandes and Soratto (2012) [10].

Table 2: Effect of different phosphorus doses on root shoot ratio, AGR and RGR of potato

	Root length/plant			Tuber number/plot				
	30 DAS	**60 DAS**	**Maturity**	**<25 g (< 3 cm)**	**25-50 g (3-4 cm)**	**50-75 g (4-5 cm)**	**>75 g (> 5 cm)**	**Total**
T_1	13.84	15.85	16.02	203.25	146.25	131.75	235.00	716.25
T_2	16.39	18.36	19.45	253.50	74.75	79.25	126.00	533.50
T_3	15.44	17.07	17.85	244.50	98.75	87.50	153.50	584.25
T_4	15.21	16.93	17.37	238.50	116.75	110.25	184.00	649.50
T_5	15.09	16.93	17.14	223.25	141.00	122.25	204.50	691.00
T_6	13.88	15.70	16.83	213.25	156.50	136.75	244.50	751.00
T_7	14.91	17.24	17.43	202.25	101.25	92.50	213.50	609.50
T_8	14.52	17.28	17.41	194.00	102.50	97.25	195.25	589.00
T_9	14.49	17.17	17.20	156.75	103.25	91.50	208.00	559.50
T_{10}	14.27	17.06	17.30	148.25	100.50	94.75	184.00	527.50
S.E.(m)±	0.39	0.36	0.39	3.79	3.19	2.15	4.90	7.27
C.D. (at 5%)	1.14	1.06	1.13	11.00	9.26	6.25	14.23	21.09

Dry matter/plant
Accumulation of dry matter/plant due to different P doses linearly augmented accumulation of dry matter with the advancement of the growth stages till the maturity. Rapid rate of dry matter increase was observed during the period between 30 to 60 DAP. The increase rate of DM/plant was very slow at early growth stage (30 DAP) in all the treatments. Plant height and leaves/plant were minimum up to 30 DAP. Hence, a little food material accumulated and photosynthates synthesis was slow in plants due to less canopy resulting into less DM production at very early stage (30 DAP). Further rapid development of vegetative parts increased the rate of DM/plant which was continued up to 60 DAP. During 30 DAP to 60 DAP, plants attained their maximum height and number of leaves/plant, therefore rate of DM production/plant was maximum in all treatments at 30-60 DAP. Similarly at the same time, accumulated photosynthates and food materials were utilized for the development of tuber up to maturity. DM production also increased during 60 to 90 DAP but lesser than 30 to 60 DAP. Subsequently, dry matter accumulation by plants increased till the maturity stage.
Different P levels significantly varied for DM/plant at all growth stages till the maturity due to encouraging effect of P on dry matter accumulation (Eleiwa *et al.* 2012) [8]. The treatment stood in the same order for DM/plant at all growth stages till maturity. At all the stages, application of 120 kg P_2O_5/ha through fertilizer and farmers practice topped among all for DM/plant while control had the least DM/plant at all the stages. These results are in close conformity with the findings of Eleiwa *et al.* (2012) [8], and Zelalem *et al.* (2009) [26].

Tuber dry weight/plant
Tuber dry weight/plant was augmented significantly due to applied doses of phosphorus over control. Tuber dry weight/plant increased significantly with increasing levels of phosphorus and recorded significantly highest with application of 120 kg P_2O_5/ha through fertilizer (0.17, 25.75 and 93.21 g/plant at 30, 60 and at maturity, respectively) and farmers practice (015, 23.49 and 89.27 g/plant at 30, 60 and at maturity, respectively) and these two treatments were significantly higher over rest of the treatments at all the stages except T_5 at 30 DAP and T_8 at maturity at which these were statistically at par. These results were in close agreement with the findings of Misgina N.A. (2016) [18], Zelalem *et al.* (2009) [26] and Sommerfeld and Knutson (1965) [23]. The higher tuber dry weight over control may be due to increased growth and physiological parameters as well as biomass/plant resulting in increased supply of all the essential plant nutrients with improved physico-chemical and biological properties of the soil. All these favourable conditions might have resulted in greater accumulation of carbohydrates, proteins and their translocation from source to the sink (reproductive organs) which, in turn, increased the tuber dry weight. The increment in tuber dry weight might have resulted from favourable influence of different P levels and efficient and greater partitioning of metabolites and adequate translocation of photosynthates and nutrients to developing reproductive structures.

Root: shoot ratio
Root: shoot ratio is an important physiological parameter which gives clear understanding of plant growth as root growth of plant in respect to shoot growth. Root: shoot ratio was statistically significant at all stages of crop growth. Generally, Root: shoot ratio was higher at lower phosphorus levels, which decreased with phosphorus doses increased in.

Control recorded significantly higher root: shoot ratio (0.74: 1,0.42: 1 and 0.39: 1 at 30, 60 DAP and maturity, respectively) as compared to other treatments. Application of 100% P_2O_5 through FYM recorded minimum root: shoot ratio at all the stages, however, it was same in value with application of 120 kg P_2O_5/ha through fertilizer and farmers practice at 60 DAP and maturity stage, respectively. It might have been possible because of higher increase in shoot growth as compare to root due to thinner and longer roots formation in case of P deficiency. The findings lined with Hu *et al*. (2010) [12] and Fernandes and Soratto (2012) [10].

Absolute growth rate (AGR)
The perusal of data in Table 2 revealed that the AGR, in general, tended to increase up to 30- 60 DAP and then decrease up to maturity. It may be due to senescence and aging of leaves. AGR ranged from 0.41 to 0.56, 3.21 to 5.60, 0.94 to 2.81 g/day at 0-30, 30-60 DAP and 60- maturity stage, respectively in different treatments. At all the stages, different levels of P exerted significant variation in respect to AGR.

Table 3: Effect of different phosphorus doses on root shoot ratio, AGR and RGR of potato

Treatment	Root shoot ratio			AGR (g/day)			RGR (mg/g/day)		
	30 DAS	60 DAS	Maturity	30 DAS	60 DAS	Maturity	30 DAS	60 DAS	Maturity
T_1	0.53	0.34	0.31	0.54	5.60	2.60	92.93	80.93	11.71
T_2	0.74	0.42	0.39	0.41	3.21	0.94	83.37	72.81	7.81
T_3	0.65	0.35	0.35	0.44	3.74	1.33	86.00	75.06	9.20
T_4	0.65	0.35	0.34	0.48	4.09	1.52	88.67	75.32	9.59
T_5	0.59	0.34	0.33	0.48	4.56	1.86	88.90	78.37	10.49
T_6	0.51	0.32	0.32	0.56	5.50	2.81	94.23	79.23	12.70
T_7	0.57	0.34	0.34	0.49	4.46	1.83	89.64	77.03	10.51
T_8	0.54	0.35	0.33	0.47	4.44	1.81	87.96	78.44	10.45
T_9	0.50	0.32	0.31	0.49	4.35	1.79	89.56	76.38	10.46
T_{10}	0.53	0.33	0.32	0.48	4.36	1.74	88.94	77.00	10.21
S.E.(m)±	0.02	0.01	0.01	0.008	0.09	0.12	1.40	0.82	0.74
C.D. (at 5%)	0.07	0.03	0.03	0.023	0.25	0.35	4.08	2.39	2.13

Farmers practice and application of 120 kg P_2O_5/ha through fertilizer gave significantly higher AGR (0.54, 5.6 and 2.6 g/day at 30, 60 DAP and maturity, respectively with farmers practice and 0.56, 5.50 and 2.81 g/day at 30, 60 DAP and maturity stage, respectively with 120 P_2O_5/ha) as compared to other treatments at all the stages of crop growth. However, control treatment registered with lowest AGR (0.41, 3.21 and 0.94 g/day at 30, 60 DAP and maturity stage, respectively) at all the stages. These findings are also supported by Rajput (1985) [19] and Rajput (1989) [20].

Table 4: Effect of different phosphorus doses on root shoot ratio, AGR and RGR of potato

	Tuber yield (t/ha)					Crack tuber/ha	
	<25 g (< 3 cm)	25-50 g (3-4 cm)	50-75 g (4-5 cm)	>75 g (> 5 cm)	Total	Number	Yield (t)
T_1	2.39	3.69	6.38	22.62	35.07	489.50	6.47
T_2	2.81	2.66	2.68	12.84	20.98	238.92	2.64
T_3	2.78	3.57	4.78	18.20	29.32	240.75	3.10
T_4	2.75	3.60	5.02	19.29	30.66	283.33	3.97
T_5	2.67	3.66	5.42	21.51	33.25	403.67	5.58
T_6	2.48	3.78	6.43	22.37	35.05	600.00	5.64
T_7	2.45	3.41	4.69	21.15	31.69	252.08	3.41
T_8	2.34	2.91	4.52	17.00	26.76	267.58	3.74
T_9	2.09	3.15	3.92	21.42	30.56	233.33	2.13
T_{10}	2.04	3.49	3.69	18.49	27.70	241.67	2.44
S.E.(m)±	0.08	0.07	0.11	0.40	0.61	12.58	0.20
C.D. (at 5%)	0.22	0.21	0.32	1.16	1.77	36.58	0.59

Relative growth rate (RGR)
It is evident from the result that RGR values gradually declined in all P treatments with the advancement of growth stages till maturity stage (Table 2). The RGR values were maximum at 0 to 30 DAP stage, because previously accumulated DM by plants was zero in the beginning. But at advanced growth stages, the quantity of previously accumulated DM by plants was higher, which attributed to decline in RGR values.
Farmers practice and application of 120 kg P_2O_5/ha through fertilizer gave significantly higher RGR (92.93, 80.93 and 11.71 mg/g/day at 30, 60 DAP and maturity stage, respectively with farmers practice and 94.23, 79.23 and 12.70 mg/g/day at 30, 60 DAP and maturity stage, respectively with 120 P_2O_5/ha)) as compared to other treatments at all stages. Control treatment recorded lowest RGR (83.37, 72.81 and 7.81 mg/g/day at 30, 60 DAP and maturity stage, respectively) at all the stages. These findings are in line with the findings of Rajput (1989) [20].

Grading
Application of 100% P_2O_5 through vermicompost recorded lowest (148.25 tuber/plot and 2.04 t/ha) however control (253.5 tuber/plot and 2.66 t/ha, respectively) registered highest tuber yield as well as tuber number in <25 g category as compare to other treatments. Whereas, application of 120 kg P_2O_5/ha through fertilizer gave higher (156.5 and 136.75 tuber/plot and 3.78 and 6.43 t/ha) and control (74.75 and 79.25 tuber/plot and 2.66 and 2.68 t/ha) obtained minimum number as well as yield of tuber under 25-50 g, 50-75 g as compare to other treatments. On the other hand, farmers practice recorded highest 235 tuber/plot and 22.62 t/ha number and yield of tuber, respectively under >75 g as compare to other treatments. However, application of 120 kg P_2O_5/ha through fertilizer recorded highest total tuber number (751/plot) whereas control (533/plot) lowest one. Similar trend was observed in case of grade wise tuber yield represented in t/ha. Total tuber yield (t/ha) was significantly affected due to different P treatments. Both 120 kg P_2O_5/ha through fertilizer and farmers practice recorded significantly higher tuber yield as compared to other treatments including control and it was 67.08 and 67.16% higher in case of tuber yield, respectively as compare to control in respect of yield. It may be due to higher tuber wt/plant, and supply of adequate amount of nutrients in balanced way at different stages and increasing the P availability (Ranganathan and Selvaseelan 1997) [21]. This result is supported by

Jatav *et al.* (2011) [14], Kumar *et al.* (2007) [17], Yohana and Carlos (2011) [25], Sommerfeld and Knutson (1965) [23].

From Table 3, it can be concluded that application of inorganic fertilizer increased the proportion of large size tuber as compare to organic manure (on the basis of % as compare to total tuber) and availability of phosphorus in lower doses caused for higher number of small tubers.

Tuber cracking

Different doses of phosphorus caused noticeable variation in cracking of tubers *viz*., number of crack tuber, yield of crack tuber (t/ha).

The perusal of data in table 3 revealed that application of P through fertilizer stimulates cracking whereas VC and FYM (organic manure) showed positive effect in reducing cracking of tubers. It might be due to optimum cell division, elongation and sufficient space for bulking of tuber in case of manure which is well known for optimizing balance nutrition which reduced cracking because of improvement in chemical and physical property of soil which ultimately lead to less cracking in the tuber.

The lowest values of all these parameters were recorded with 100% P_2O_5 through FYM and was 61.11, 52.33 % lowest in case of no. of tuber per plot, whereas 67.14, 62.33% in respect to crack tuber weight (t/ha) as compare to 120 kg P_2O_5/ha through fertilizer and farmers practice, respectively. It may be possible due to application of manure in the soil causes soil porous and improved soil plasticity (Karlen and Camp, 1985) [15] and reduced soil resistance against to tubers growth (Arancon *et al.*, 2003) [3].

Conclusion

It is concluded that based on findings of this experiment, application of 120 kg P_2O_5/ha was the best dose of phosphorus for attaining higher growth attributes, physiological parameter and grade wise tuber yield. Therefore, application of 120 Kg P_2O_5 through fertilizer gave best result in all the aspects. Whereas both application of 120 kg P_2O_5/ha and farmers practice are the best dose of phosphorus for attaining yield and number of tubers on the basis of grading. However, application 100% P_2O_5 through FYM is the best dose to reduce cracking of tubers in cultivar “Kufri Jyoti”. However, quadratic equation line ($Y = 21.748 + 5.489\ X - 0.587X^2$) for inorganic doses of phosphorus resulted in 116.93 and 63.42 kg P_2O_5/ha were the optimum physical and economical levels, respectively for getting higher yield of tuber. Therefore, it is concluded that application of 120 and 60 Kg P_2O_5/ha through fertilizer was the best dose of phosphorus for achieving higher optimum physical and economical productivity, respectively.

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