

Research Article

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# Performance of Different Varieties of Cauliflower (*Brassica Oleracea* Var. *Botrytis*) Under Different Levels of Phosphorus Application in Pot Culture at Lamjung, Nepal

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## Abstract

The objective of the current review is to review and identify the research gap on the effect of different growth media on rooting percentage, roots and shoot growth performance of grape cutting. Factors affecting rooting of grape cuttings can be internal or external factors. Internal factors affecting rooting of cuttings include the amount of stored food in cuttings, the age and maturity of tissue, the formation of callus and adventitious roots and the presence of leaves and buds on cuttings. The external factors include rooting media, chemical and hormone treatments, light, temperature, mechanical treatment and mist spray. Rooting media is one of the most important factors for rooted cutting production especially in grape. It is one of the factors affecting rooting and growth of grape cuttings. Types of media have significantly influenced the rooting and vegetative growth of cuttings. Different planting media have significantly influenced the vegetative growth of cuttings; due to the level of organic matter content, water holding difference. The suitability of the rooting medium depends on the species, type of cuttings, growing conditions, season of the year and the cost effectiveness of the medium components. A media which is light, rich, porous, well drained and free from pathogens is considered ideal for growing of grape. A good potting medium must be easy to supply, process and a cheap source. Choosing the most suitable growing media for the achievement of a successful plant production is very important. Inadequate soil available Phosphorus (P) is principle limiting factor of cauliflower productivity in Nepal, and judicious P fertilizer management is one of the best strategies to increase the yield of cauliflower. A pot experiment was conducted at Lamjung Campus during October, 2018 to February, 2019 to We investigated the effect of five levels of soil application of P (0 kg ha<sup>-1</sup>, 100 kg ha<sup>-1</sup>, 120 kg ha<sup>-1</sup>, 140 kg ha<sup>-1</sup> and 160 kg ha<sup>-1</sup>) on growth and yield attributes of two cauliflower varieties (Kathmandu Local and Snow Grace) with a pot experiment. Hence, the experimental design was two factorial complete randomized designs (CRD) with four replications. The result revealed that the soil application of P showed significant effect on all growth and yield attributes of cauliflower cultivars.

It was found that maximum plant height (28.18), days to curd initiation (76.12), number of leaves (18.38), root length (28.76), curd weight (0.750 kg) and yield ha<sup>-1</sup> (27.54 tons) were recorded and Snow grace expressed highest curd weight (0.83 kg plant<sup>-1</sup>) and highest yield (31.07 ton ha<sup>-1</sup>) at P level of 160 kg ha<sup>-1</sup> as compared to other levels of P. Varieties and P level interacted significantly for plant height, curd weight and curd yield. It was concluded that application of phosphorus (160 kg ha<sup>-1</sup>) and cultivar Snow grace can produce highest yield and also further research is needed to optimize the P rate for enhancing yield.

**Keywords:** Cauliflower; Curd initiation; Curd yield; Phosphorus; Variety

## Introduction

Phosphorus is one of the major macro essential nutrient that is occurred in most of the plant in concentration by dry weight of 0.1 -0.5 percent and in most mineral soils in concentration of 0.002-0.5 percent with average of 0.05 percent and absorb P in the form of either H<sub>2</sub>PO<sub>4</sub><sup>-</sup> or as orthophosphate ion HPO<sub>4</sub><sup>2-</sup> depending on soil pH [1]. The growth and development of cauliflower is directly influenced by the application of phosphorus as the

phosphorus involves the physiological activities of cauliflower. P is the key element in many physiological [2] and biochemical process although it is absorbed in small amounts by plants [3,4] and least mobile and available to plants in most soil conditions [5].

Phosphorus is the principal yield limiting factor for cauliflower production [6] and major abiotic stress that inhibits plant growth and crop productivity on 30-40% of the world's arable land [7]

and deficient on 41.73% of total cultivated land (28%) of Nepal (MOAD, 2072). Most of the Nepalese farmers use the chemical fertilizers haphazardly and blindly without conscious about the negative impact to the soil, health and environment because of insufficient knowledge about judiciously, rationally, efficiently and site- specific use chemical fertilizer that causes the decreased the crop productivity and soil fertility in Nepal. Insufficient research on balanced fertilizer recommendation and poor selection of cauliflower cultivars is major challenge of commercialization and competitiveness production of cauliflower in Nepal. Judicious and balance use of P fertilizer as well as site specific P fertilizer management is one of the best alternative strategies to increase the production per unit limited area of production and it is hypothesized that addition of P in the soil would have significant contribute on cauliflower production.

## Materials and Methods

This experiment was carried out at Sundarbazar municipality of Lamjung districts from October 2018 to February 2019 to assess the effect of soil P input on yield and yield attributes in cauliflower varieties. Soil was collected from horticulture farm of IAAS, Lamjung Campus and was analyzed for total nitrogen, available phosphorus, available potassium, organic matter and soil P<sup>H</sup> (Table 1).

**Table 1:** Chemical properties of sampled soil.

Parameter	Value	Remarks
Soil available pH	5.8	Acidic
Soil available organic matter (ton ha <sup>-1</sup> )	1.642	Low
Soil available Nitrogen	0.08%	Low
Soil available Phosphorus (kg ha <sup>-1</sup> )	7.75	Very low
Soil available Potassium (kg ha <sup>-1</sup> )	536.26	High
Soil available Boron (µg/g)	1.8	Medium

**Table 2:** Effect of different levels of phosphorus and varieties on cauliflower varieties no. of leaves, plant height, days to curd initiation, days to harvest, root length, curd weight and curd yield.

P level (kg ha <sup>-1</sup> )	Mean No. of leaves	Mean Plant Height (cm)	Mean Days to Curd Initiation (Days)	Mean Days to Harvest (Days)	Mean Root length (cm)	Mean Curd Weight (Kg)	Mean Curd Yield (tons ha <sup>-1</sup> )
0	8.88d	12.64d	93.50d	122.2d	12.54d	0.171e	3.01e
100	12.88c	17.38c	88.12c	116.8c	18.50c	0.38d	14.24d
120	15.62b	22.51b	86.62bc	112.8b	19.14c	0.52c	19.14c
140	16.38b	22.57b	85.0b	112.2b	23.93b	0.59b	21.88b
160	18.38a	28.18a	76.12a	107.2a	28.75a	0.75a	27.54a
F-test	**	**	**	**	**	**	**
SEm (±)	0.412	0.527	0.587	0.506	0.472	0.008	0.33
LSD	1.19	1.523	1.696	1.462	1.363	0.024	0.95
C.V.%	8.1	7.2	1.9	1.3	6.5	4.9	5.5
Variety							
Kathmandu local	13.3	23.57	90.55	120.35	22.7	0.43	14.88
Snow grace	15.35	17.73	81.2	107.95	18.45	0.53	19.45
F-test	**	**	**	**	**	**	**
SEm (±)	0.26	0.33	0.37	0.32	0.29	0.005	0.27

Then, we undertook two factorial experiments- levels of phosphorus inputs and cauliflowers as factors. Two commonly grown varieties of cauliflower (Kathmandu Local and Snow Grace) were purch. We mixed the air-dried soils with air dried farmyard manure (0.5kg FYM/kg Soil) and filled in poly pot (4 kg soil/pot). In each pot, N, K, B and Mo were applied at the rate 11.73gm ,3.6gm, 0.49gm and 5.12 mg respectively and also the source of nutrient like urea, potassium chloride, Borax, sodium molybdate. Then after, we applied five levels of the P with air dried soils in 0.00215 m<sup>3</sup> sized pots and applied five levels of P (0 kg ha<sup>-1</sup>, 80 kg ha<sup>-1</sup>, 120 kg ha<sup>-1</sup>, 140 kg ha<sup>-1</sup>, 160 kg ha<sup>-1</sup>) using Single super phosphate. Then after we transplanted 29 d old seedling of cauliflower in the pot and arranged the pots in completely randomized designed with four repetition. Nitrogen was top dressed at the rate of 2.93gm in 30 d and 60 d after transplanting. Soil was kept at 0.65% field capacity during the entire growing period. Before harvesting the plants at physiological maturity-appearance of white head- Plant height, leaves numbers, days for days required for the curd initiation and physiological maturity were recorded was measured. After harvesting, root length and curd yield were measured.

The mean separation was carried out with ANOVA using package SPSS software version 24 edition and graphs were developed using Origin 8 Software. The data recorded was statistically analyzed according to Complete Block Design (CRD) with double factor using a statistical.

## Results and Discussion

### Plant height

The data regarding the plant height are shown in Table (2) depicted that Phosphorus level (P<0.01) and cauliflower varieties (P<0.01) are statistically different and interaction between them also found significantly different (P<0.01).

LSD	0.75	0.96	1.07	0.92	0.86	0.015	0.6
P level * Variety							
Grand Mean	14.43	20.65	85.88	114.25	20.57	0.46	17.16
SEm ( $\pm$ )	0.583	0.746	0.83	0.716	0.667	0.011	0.469
LSD	1.683	2.154	2.398	2.068	1.928	0.032	1.354
F-test	NS	**	NS	NS	NS	**	**

Similar letter in upper case are statistically non-significant (NS) at 1% (\*\*) and 5% (\*) level of significance.

Cauliflower varieties showed significant difference at different level of phosphorus application. Cauliflower varieties showed maximum values of plant height (28.18cm) when 160 kg $ha^{-1}$  of P was applied and low value of plant height (12.64cm) for control treatment plants. The plant height at 160 kg $ha^{-1}$  was significantly different with recommended dose of P. i.e. 120 kg $ha^{-1}$  (22.51cm) which was statistically non-significant with plant height at 140 kg $ha^{-1}$ (22.57cm).

Variety Kathmandu Local expressed maximum value of plant height (23.57cm) and minimum value of plant height (17.73cm) was expressed by Snow Grace. The result showed that plant height is increased with increases P level. This might be due to its vital role in root development and nutrient absorption that increase plant growth and ultimately influence plant height. These results could be due to the synergistic effect of P with N that helped the efficiency of nitrogen uptake, which enhanced vegetative growth of broccoli plants [8]. Sharma et al., [9], Singh [10] and Reddy et al., [8] found the same trend of the present investigation of research. The plant height is directly influenced by cauliflower varieties which might be due to its genotypic governing varietal characters on plant height and also depend on whether plant is taller or dwarf variety. The effect on plant height by interaction between P level and varieties are significant which might be due to highly genetic response and high nutrient use efficiency of one variety that other variety.

### Number of leaves

The data regarding the number of leaves are shown in Table (2) interpreted that Phosphorus level ( $P<0.01$ ) and cauliflower varieties ( $P<0.01$ ) are statistically different but interaction between them found non-significantly different ( $P=0.990$ ). Cauliflower varieties showed significant difference at different level of phosphorus application. The maximum numbers of leaves per plant (18.38) were obtained at 160kg P  $ha^{-1}$  and minimum number of leaves per plant (8.88) in without application of P. The variety Snow grace had a greater number of leaves per plant (15.35) which was significantly superior over Kathmandu local variety (13.50). The increased number of leaves per plant with increased level of P might be due to being major macro nutrient which play vital role in photosynthesis, energy storage, cell division and cell enlargement that helps in enhancement of number of leaves [11]. Randhawa and Bhail [12] reported that higher dose of P gave positive response in increasing the numbers of leaves. Similarly, Elahi et al., [13] and Uddain [11] found that phosphorus had significantly influenced the number of leaves per plant of cauliflower. The number of leaves

per plant varied with varieties due to their own genetic makeup which is linked with inters nodal length [13]. The interaction of P level and varieties had not affected on number of leaves per plant that might be due to their effect on number of leaves independently and genotype of two varieties almost similar response to different P level.

### Days to curd initiation

The effect of different level of phosphorus on days to curd initiation of different varieties showed Table (2) that expressed the cauliflower varieties ( $P<0.01$ ) and Phosphorus level ( $P<0.01$ ) were statistically significant but their interaction between them were statistically insignificant ( $P=0.089$ ). The minimum days to curd initiation (76.12days) obtained at application of 160 kg P  $ha^{-1}$  and maximum days to curd initiation (93.50days) at control treated plants. The application of P level i.e. 100 kg $ha^{-1}$ , 120kg $ha^{-1}$  and 140kg $ha^{-1}$  had statistically almost similar effect on days to curd initiation of cauliflower varieties. Snow grace varieties had minimum days to curd initiation (81.20 days) which is significantly superior over the Kathmandu local variety (90.55 days). The days to curd initiation decreased with the increased phosphorus level significantly that might be due to its involvement in shorter the vegetative growth period and forced the plants to reach the reproductive stage relatively earlier than other nutrients by increasing metabolic activities in the plan system and involvement in promotion of flower primordial formation earlier. Elahi et al. [13] and Islam et al. [14] found that phosphorus had significant effect in the days required to curd initiation and improved flower formation, fruiting and curd ignition. Similarly, Katiyar [15] and Mitra et al. [16] found that application of phosphorus hastened the crop to reach reproductive stage which is an agreement with the finding of present work. The days to curd initiation was significantly influenced by cauliflower varieties that might be due to the internal genotypic characteristic of varieties that directly determine the period required to curd initiation. The reasons behind this might be days to curd initiation depend on whether the plant is short duration or long duration varieties [17]. Some varieties produce certain chemical signaling that enhance metabolic activities of plant and enhance flowering earlier than other. Saini [18] reported that period for curd initiations were differed among varieties due to the genetic characteristics of the cultivars. The interaction of cauliflower varieties and P level had similar effect on days to curd initiation that might be the genetic responses of two varieties almost similar to the different level of phosphorus on days to curd initiation which is similar result with [13,14].

## Root length

The effect of phosphorus level on root length of cauliflower varieties is shown in Table (2) depicted that phosphorus level ( $P < 0.01$ ) and cauliflower varieties ( $P < 0.01$ ) are statistically significant but interaction between them are insignificant ( $P = 0.677$ ). The cauliflower varieties showed maximum root length (28.76cm) with application of 160 kg P ha<sup>-1</sup> and minimum root length (12.54cm) at control treated plants. The application of P level i.e. 100 kg ha<sup>-1</sup> and 120 kg ha<sup>-1</sup> had statistically almost similar effect on days to harvest of cauliflower varieties. Kathmandu Local had maximum root length (22.70 cm) which is significantly superior over the Snow Grace variety (18.45cm). The result of the study revealed that increased P level increases root length that might be due to its involvement in promotion of physiological processes in the plant system which leads to increase the root growth that ultimately helps in stimulation of root length in plants. The application of P stimulates cell division in the meristematic region and lead to higher concentration of bioactive gibberellins (GA) that may promote the root growth. Kim et al. [19] stated that increasing P supply increased root growth. Uddain [11] found that Phosphorus exhibited a significant influence on root length of broccoli plants. Kumar et al. [20] found the same trend of the present investigation. The root length was significantly influenced by cauliflower varieties that might be due to the varietal characteristics governing by internal genotypic characteristic of varieties. However, Snow grace having higher yield having minimum root length which might be due to higher Mycorrhizal association in Snow grace [17].

## Curd weight

The data regarding the curd weight are shown in Table (2) interpreted that Phosphorus level ( $P < 0.01$ ) and cauliflower varieties ( $P < 0.01$ ) are statistically different as well as interaction between them found significantly different ( $P = 0.002$ ). The cauliflower varieties showed maximum mean curd weight (0.750kg) with application of 160 kg P ha<sup>-1</sup> which is significantly superior to others P levels as well as and as over control treated plant (0.0814kg). Snow grace varieties had high mean curd weight (0.52kg) which is significantly superior over the Kathmandu local variety (0.406kg). These results revealed that increased P level increases curd weight per plant. The reasons behind that its vital role in all physiological and metabolic activities, photosynthesis, cell division and cell enlargement and strongly correlated with all yield attributes. Elahi et al., [13] found that phosphorus had significant influence on curd weight of cultivars and vigorous growths of the plant are correlated with proper nutrition. McPharlin et al., [21] found that phosphorus helps in increment of photosynthesis and proper curd formation. Similarly, Sheppard and Bates [22] reported that yield and chemical composition are related with P level. Randhawa & Bhail [12] reported that more plant curd weight was seen in the plant which received highest level of phosphorus. Uddain [11] found that Phosphorus exhibited a significant influence on main curd weight of broccoli plants.

Saimbhi et al., [23], Balyan et al., [24] and Singh [10] also found similar trend of results as present research finding. The cultivars

highly influenced the curd weight per plant as curd weight is determined by environmental factors as well as genetic factors of cultivars.

## Curd yield (ton ha<sup>-1</sup>)

The data regarding the curd yield (ton ha<sup>-1</sup>) are shown in Table (2) that Phosphorus level ( $P < 0.01$ ) and cauliflower varieties ( $P < 0.01$ ) are statistically different as well as interaction between them found significantly different ( $P = 0.002$ ).

The cauliflower varieties showed maximum mean curd yield (27.54tonha<sup>-1</sup>) with application of 160 kg P ha<sup>-1</sup> which is significantly superior to others P levels as well as and as over control treated plant (3.01 tonha<sup>-1</sup>). Snow Grace varieties had high mean curd yield (19.45tonha<sup>-1</sup>) which is significantly superior over the Kathmandu local variety (14.88tonha<sup>-1</sup>).

The result of this study verified that increased level of P increases the curd yield of cauliflower. This might be due to its significant role in role in photosynthesis, cell division and cell enlargement and strongly correlation with yield attributes. The yield was influenced by the yield containing parameters of the cauliflower which is similar with result reported by [9]. Uddain [11] found that Application of phosphorus exhibited a significant influence on yield per hectare of broccoli plants. Similar pattern of results was found by another scientist like Balyan et al. [24]; Sharma et al. [9]; Singh [10] and Reddy et al. [8]. The cultivars highly influenced the curd yield (ton per hectare) as curd yield is determined by environmental factors as well as genetic factors of cultivars.

## Conclusion

The finding of this research study shows that increased level of P enhances the growth and yield parameters of cauliflower. Phosphorus (P) application in the soil enhances the number of leaves, hasten reproductive stage and increases curd weight and root length which finally increases the yield [25]. However, varieties response to soil application of P also affect the yield. Snow Grace variety shows more P use efficiency as it can produce highest yield under P deficient soils at 160 kg P ha<sup>-1</sup>.

Furthermore, research is required for the confirmation of present findings at different location of Lamjung district.

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## Conflict of Interest

No conflict of interest.

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