Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 7 [4] April 2018 : 97-100

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

REVIEW ARTICLE **OPEN ACCESS**

Evaluation of suitable planting time for higher growth and yield of potato crop in tarai region of Uttarakhand

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ABSTRACT
Potato (Solanum tuberosum L.) is one of the world's most important non-cereal food crop and widely cultivated after wheat, rice and maize. In India, more than 80 % of the potato crop is raised in the winter season (Rabi) under assured irrigation during short winter days from October to March. About 8 % area lies in the hills during long summer days from April to October. It was observed that the temperature range from 15 to 20^{0}C is well suited for growth and development of potato. Above the 20^{0}C the potato production decreased drastically. For higher growth and development of potato, the planting time from 15 to 30 October was found better than early and late planting.
Keywords: *potato, planting time and yield*

Received 23.02.2018 Revised 19.03.2018 Accepted 18.04.2018

INTRODUCTION

Potato belongs to genetically diverse genus *Solanum* which contains about 2,000 species of which, 235 are tuber bearing species. The commonly cultivated potato is an auto-tetraploid (2n=4x=48) and belongs to the species *tuberosum* which includes two subspecies *viz*. ssp. *tuberosum* adapted to long day conditions and ssp. *andigena* adapted to short day conditions [21]. It is mainly a rabi season crop but in Karnataka, Maharashtra, Himachal Pradesh, Jammu-Kashmir and Uttarakhand it is also grown in rainy season (Kharif) crop.

Climate change and global warming is now an acknowledged fact and reality. The rate of global warming in last 50 years is double than that for the last century [24]. Climate change poses serious challenges to human and places unprecedented pressures on the sustainability of horticulture industry. Two major effects of climate change that has far reaching implications on agriculture in general are increase in temperature and changes in the rainfall (both in terms of quality and intensity). The current level of tropospheric concentration of main greenhouse gas CO_2 (399.5 ppm) is 29.91% more than the pre-industrial level and is rising [4]. The CO_2 level is predicted to be 393, 543 and 789 ppm in year 2020, 2050 and 2080, respectively. The corresponding rise in temperature would be 1, 3 and 5 ^{0}C approximately during main potato growing winter season in India [32].

The climate change and global warming will have a profound effect on potato growth story in India affecting not only production and profitability, but also seed multiplication, storage, marketing and processing of this perishable vegetative propagated crop [33]. Potato productivity is likely to increase in Punjab, Haryana and Western and central U.P. by 3.46 to 7.11 % in 2030, but in rest of India particularly West Bengal and Pleateau region potato production may decline by 4 to 16 % [33].

A rise in temperature of 1^{0}C will raise soil temperature much earlier in spring hence the planting time also will advance and requirement of annual irrigation will increase. High temperature is one of the major abiotic stresses on potato production in many areas and may leads to drastic reduction in tuber development and yields [18]. As virus vectors, aphids represent a threat particularly to potato seed production. It is possible that in certain regions aphid's population will occur in greater number and in different seasons that so far due to more favorable climatic conditions. These parameters necessitate the intensification of research towards abiotic stress. Thus suitable time of planting for higher production

and productivity with changing agro-climatic conditions have to be evaluated. The choice of best time of planting can conserve the agricultural resources for sustainable agriculture in India.

POTATO PERFORMANCE WITH DIFFERENT PLANTING TIMES

Potato is an important widest distributed crop after maize in the world. The crop is grown in about 140 countries in more than 100 countries are located in tropical and subtropical areas, but the highest production in the temperate zones [35]. The planting time is an important factor in deciding the potato yield. The planting date should be calculated based on the length of the growing season. In areas where the growing season is limited, planting time should be selected in such a way that the tuber formation and growth period do not coincide with warm conditions *i.e*. above 20^0C [19]. The results of studies conducted in India and abroad indicated that planting dates in different climatic conditions has great influence on growth and yield of potato. Therefore, selection of suitable planting time is an important aspect to study [37].

Birhman *et al*., [3] reported significant difference in number of tubers and yield under 5, 15 and 25 October planting dates at Modipuram. Ahmad and Rashid [1] reported that tuber yield was found maximum with planting on 23rd November. However, average tuber size increased with delay in planting. Emergence decreased from 98.6-100 to 82.5 per cent by the later planting date only. Stem height and number of stem per hill were not affected by planting dates. Ewing [7] observed that tuber initiation and bulking are favoured by temperature below 20^0C. With the increase in temperature in above than 18-20^0C tend to stimulate haulm growth and depress tuber yield.

Rioux *et al.,* [25] studied the effect of planting dates on growth and quality of potato tubers. They found that the total yield of tuber at 90 days after planting was higher in plots planted in mid-June than in those planted at the end of May. They further found that total yield at 90 days after planting was higher in plots planted in first week of May than in those planted in the end of May. Kondratowicz and Paprocki [15] reported that the fresh tuber yield decreased with delay in planting from 4th May to 1st June. Samul [28] observed the reduced number of tubers per plant in all cultivars with delayed planting. Jones and Allen [11 found that the delayed planting increase the yield only in the early cultivar which had the smallest leaf areas. In main crop date of planting had little effect on final yield.

According to White and Sanderson [37] delayed planting (June) reduce the yield of potato significantly. Caliskan and Incekara [5] reported that, planting in January, February and March gave higher yields, whereas yields after planting in July and August were moderate.

Bhatti *et al.* [2] found that planting of potato on 15th October produced maximum tuber length and weight. Cardiz *et al.,* [6] found that seed tubers of December planting were physiologically younger than those obtained from November planting. Sharma and Verma [31] observed that potato tuber obtained from 30 October contained higher P, Ca, Fe, Mg and Cu content as compared to other dates of planting in variety Kufri Sindhuri and Kufri Chandramukhi. Roy and Jaiswal [26] recorded significantly higher tuber yield when planting was done on 15th and 25th October. It was also found that 25th October planting proved economically superior over 15th October planting. Gupta *et al.,* [10] reported that crop planted on 20th October gave the highest tuber yield, followed by 10th October and 30th October date of planting. They were concluded that delay in planting beyond 20th October decreased the total tuber yield of potato. The yield losses were increased with delay in planting and lowest yield recorded on 30th November planting.

Kabir *et al.,* [12] reported that cv. Patrones seems to be more responsive to early planting, Kufri Sindhuri to late planting and Cardinal to mid November planting. They reported highest yield of potato with planting in end of November followed by planting on 15th November and 1st November. Krishnanappa *et al.,* [16] observed that planting done beyond 30 November in Karnataka gave the lowest weight of tuber per plant. Plant height, internodes length, leaf number and tuber yield were decreased as planting was delayed after 21st October, while maximum tuber was found with 15th November planting [8].

Saini *et al.,* [27] were planted potato cv. Kufri Jyoti on 25th April, 10th, 25th May and 6th June in H.P. and observed that the tuber yield was decreased as delay in planting. Yield of large sized tuber (> 75 g and 51-75 g) was highest when planting on 25th April. Ezekiel and Bhargava [8] observed that the low yield potato in the early crop was mainly due to a smaller and short canopy leading to reduced interception of solar radiation, further high temperature during early crop season lowered tuber yield through reduced partitioning of photosynthates to the tubers.

According to Nandekar and Sharma [20], the yield of potato was highest when tuber planted on 20th October followed by 30th October and 10th November plantings. For middle Gujarat region the third week of November was found superior planting date for potato growth and development by Patel *et al.* [22]. They also found that the highest tuber yield and number of large size tubers were obtained from 3rd week of November planting followed by 1st week of December and 3rd weed of December plantings. Singh *et al.,* [34] reported that A gradual increase in the yield was seen with delayed planting towards the optimum

date *i.e*. end of October. Yenagi *et. al*. [38] reported tuber higher of potato variety Chandramukhi by early planting i.e. 18th June. They recorded 10.03 and 20.45 % decreased yield after 18th June planting i.e. 25 June and 10th July, respectively. This higher yield was mainly due to increased yield components of potato crop. Yenagi *et al.,* [39] reported that higher yield with early planting of Kufri Chandramukhi could be attributed to higher plant height, LAI and increase total dry matter production. These parameters were decreased with delayed planting date.

Effect of planting date on the growth and yield of potato (*Solanum tubrosum* L.) plants grown from conventional seed tubers and micro tubers was studied by Kawakami *et al.,* [13]. They found that the delayed planting from 13th May to 25th June reduce the tuber yields significantly. This reduced yield of tubers was mainly because of the shortening growing period of plants. Kumar *et al.,* [17] reported the interaction effect of planting dates and cultivars showed remarkable variation for growth and yield parameters except per cent plant emergence. Significantly highest value was recorded for plant height at 45 DAP, number of leaves per stem, leaf area index with planting on 20 October. They were found that the variety Kufri Pushkar produced highest total tuber yield when planted on 20th October, which was followed by Kufri Bahar planted on 10th October. According to Khan *et al*., [14], the total number of stem was increased due to the delay in planting. Total number of tubers per unit area and percentage of large sized tubers (>55 mm) were the highest at the earliest planting of September as compared to planting at later dates.

Sandhu *et al.,* [29] were evaluated the potato varieties in relation to different planting times (1st October, 15th October and 25th December) and haulm cuttings (70, 80 and 90 days after planting) at Amritsar. They obtained significantly higher yield of potato with desirable processing attributes when planting was done in October only. Sandhu *et. al*. [30] studied the effect of planting dates on plant growth attributes and nutrient uptake of potato (*Solanum tuberosum*). The experiment was conducted with four planting dates *i.e.* 22nd October, 1st, 11th and 21st November. They observed that the planting date had significant effect on all vegetative characteristics and recorded the highest values at 1st November planting date. They were also found maximum uptake of nitrogen, phosphorus and potassium by leaves, stems and tubers at 1st November planting date.

CONCLUSION

The results of different studies shows the planting time in different agro-ecological conditions has great influence on growth and development of potato tuber. The planting date of potato for higher growth and development should be calculated based on the length of the growing season. The time should be selected in such a way that the tuber formation and growth period coincide to 16-18^{0}C, particularly in northern India. The area where potato mainly grown as a rabi season crop, farmers can plant potato in second fortnight of October for higher economic yield as the climatic conditions are suitable for potato planting.

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CITATION OF THE ARTICLE

Girish Chandra. Evaluation of suitable planting time for higher growth and yield of potato crop in tarai region of Uttarakhand. Bull. Env. Pharmacol. Life Sci., Vol 7 [5] April 2018 : 97-100.