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Effects of Date of Planting on Red Ant (*Dorylus orientalis*) Management and Tuber Yield of Potato

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Authors' contributions

This work was carried out in collaboration between both authors. This trial was carried out in close collaboration with author. Both the authors reviewed the first draft paper, commented, suggested and approved the final paper for submission.

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ABSTRACT

An experiment was conducted to identify the appropriate time of planting for red ant management and increase the tuber yield of potato at Agriculture Research Station (ARS), Jaubari, Ilam, Nepal (2900 masl) during 2020 and 2021 planting season. Seed potatoes were planted in 9 different plant dates that were December 1, December 15, January 1, January 15, February 1, February 15, March 1, March 15 and April 1. The experiment was laid out in Completely Randomized Block Design (RCBD) with three replications. The variety used for experiment was Janakdev. The plot size for the experiment for each treatment was 4.5m^2 with spacing of 75 cm x 25 cm. Data were collected on vegetative characteristics, tuber yield parameters, red ant damage scoring (1-5 scale), red ant incidence (%) in tuber and red ant infested yield (t/ha). Potatoes planted at first January produced highest tuber yield and minimum red ants infestation. Early planting delayed emergence but had maximum ground coverage. In both the years tuber was highest (19.86 t/ha and 25.48 t/ha respectively in 2020 and 2021) with seed tuber planted on January 1. Tuber yield was less both in early and late planted potatoes. Along with higher tuber yield potatoes planted on January 1 had

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the lowest red ant damaged score, red ant incidence (%) and less red ant infested potato tuber yield (t/ha) in both the years. It is recommended that for maximum tuber yield and minimum red ants infestation seed potatoes should be planted during first week of January in Jaubari area and similar conditions in the hills of Nepal.

Keywords: Potato; early planting; Janakdev; red ant; tuber yield; infested yield.

1. INTRODUCTION

Potato (*Solanum tuberosum* L,) is one of the important and predominant tuber crops in Nepal. It is second in consumption and first in productivity [1] as compared to cereals. It is taken as a staple food crop in high hills and the Himalayan region. Nutritionally potato is rich in carbohydrates (61.5-91.5%) which is essential for energy, protein (1.6 g), dietary fiber, vitamin C (25 mg), starch (16.3 g), and minerals like phosphorous, calcium, and chlorine [2]. Potato required long-day conditions for good growth and short day for tuberization [3]. Day length is an important factor for potato production [4]. Seed potato due to its high cash, food, and nutritive value plays an important role in food security and livelihood [5].

Agriculture Research Station (ARS), Jaubari is located at an altitude of 2900 masl with temperate type of climatic conditions. Farmers in Jaubari plant potatoes in March regardless of the crop sensitivity to biotic and abiotic stress. Like other crops, the optimum date of planting for potato is highly location specific and the production region has an optimum planting period during which conditions are favorable for producing the highest potential yield. Research conducted by researchers [6] in Amritsar, India where they found maximum tuber yield on the seed tuber planted on October 10 due to optimum moisture and temperature conditions along with good crop growth. Researchers [7] found that delays in planting date cause yield reduction. Planting dates affects directly the match between cold temperature and frost damage leading to yield decline. Thus, to find out the optimum time of planting the present study was conducted during the main season (Mid-winter to early spring) in Jaubari, Ilam.

The productivity of potato in Nepal is 16.65 mt/ha [1] which is lower than its potentiality. Many production factors are responsible for reduction of production and productivity of potato. Poor management practices may lead to loss of valuable local genotypes. Lack of improved cultivation practices, weed infestation and other factors caused potato crop loss upto 80% [8], inadequate supply of quality seed; occurrence of pest (red ants, potato tuber moth and White grub) and disease especially late blight causes great damage in developing countries and low soil and nutrient management practices. Apart from other factors red ant (*Dorylus orientalis*) have been playing a significant role in yield reduction and have become serious to manage with some of the common chemicals and even with a single control method.

The government organizations have been playing a significant role in creating awareness against use of pesticides. Governonfirm itment is giving priority for the use of natural pesticides, organic material for the control of insect pests. Pest infestation can be minimized by altering the planting time, use of resistant varieties and biological control measures. The use of natural resources is more stable, sustainable and cost-effective. Insect pest population can be managed by altering planting tie in different agro-ecological situation. In Jaubari area of Illam it is necessary to identify appropriate planting time to maximize tuber production and minimizes red ant's infestation. This objective of this study was to find out suitable time of planting seed potatoes for maximum tuber production along with minimum infestation of red ants.

2. MATERIALS AND METHODS

The experiments were conducted at Agricultural Research Station (ARS), Jaubari, Illam, Nepal during 2020 and 2021 to identify the appropriate time of planting for red ant management and the seed tuber yield of potato at the high hill of Ilam district. Seed potatoes were planted on Nine planting dates i.e., December 1, December 15, January 1, January 15, February 1, February 15, March 1, March 15, and April 1. The experiment was carried out in Completely Randomized Block Design (RCBD) with three replications. The variety used in the experiment was Janakdev. The size of the each experimental plots were 4.5 m^2 with 75 cm row to row and 25 cm plants to plant spacing. A single seed was planted at a depth of about 6 cm. There were 30 seeds per

plot. The manure and fertilizer were applied at 20 t FYM/ha and 100:100:60 NPK kg/ha. The cultural operations were carried out as per the recommendation of National Potato Research Program (NPRP). Data taken were days to 50% emergence, ground coverage (%), main stem/plants, number of tubers per plant, total yield (kg/plant), red ant damage scoring (1-5 scale), red ant incidence (%) and red ant infested yield (kg). Ground coverage was measure 100% when all the plants covers almost all the ground, then based on the canopy of plant to cover the ground percentage was estimated. Similarly damaged of red ant was measured as 1-5 scoring scale as; 1=No infestation to 5= severe infestation. The percentage of insects damaged potato tuber was calculated as follows:

$$Red\ ant\ incidence\ \% = \frac{No.of\ red\ ant\ infected\ tuber}{Total\ No\ of\ tuber} \times 100$$

2.1 Data Analysis

The collected data were entered on MS-excel and data analysis was done using GEN-STAT software and mean separation was done by LSD at 5% level of significance.

3. RESULTS

3.1 Vegetative Parameters

The date of planting had significant effects on the growth behaviour, yield of potatoes and red ant infestation. Date of planting had significant effects on days to 50% emergence. Seed tuber planted on December 1 takes maximum (120.00 days in 2020 and 70.00 days in 2021) days to 50% emergence while seed tuber planted on April 1 takes a minimum (46.00 days in 2020 and 63.00 days in 2021) days to 50% emergence**.** The results indicate that early planting takes longer days to emergence and late plating takes short days to emergence this might be due to the rise in soil temperature in late planting. Results on main stem /plant, tuber/plant were non-significant with the date of planting. Data on ground coverage (%) was significant with the date of planting. Significantly maximum ground coverage (90.00%) was found in seed tuber planted on January 1 and February 1 whereas minimum ground coverage (53.30%) was found in seed tuber planted on April 1. Ground coverage (%) had significant effects on tuber yield more the ground coverage (%) more is the yield.

3.2 Red Ant Damaged and Infested Yield

The date of planting had significant effects on the red ant occurrence on 2020. Potato planted on January 1 had the lowest red ant score (1.00) scale, red ant incidence % (1.46) and less infected tuber yield (0.43 t/ha) respectively whereas the potato planted on February 15 had the highest score (2.0), red ant incidence % (10.58) and the highest (2.84 t/ha) infested tuber yield.

Table 1. Effects of planting time on yield attributing traits of potato at ARS, Jaubari during 2020 and 2021

Treatments	Days to 50% emergence		Ground coverage (%)		Main stem/plant	
	2020	2021	2020	2021	2020	2021
December1	120.00	70.00	62.00	68.30	4.00	4.00
December 15	113.00	69.00	52.00	75.00	4.00	4.00
January 1	107.00	64.00	72.00	90.00	4.00	4.00
January 15	93.00	61.00	50.00	66.70	4.00	3.00
February 1	82.00	63.00	52.00	90.00	4.00	6.00
February 15	71.00	64.00	55.00	81.70	4.00	5.00
March 1	69.00	63.00	58.00	81.70	3.00	5.00
March 15	59.00	64.00	42.00	70.00	4.00	3.00
April 1	46.00	63.00	37.00	53.30	3.00	4.00
GM	85.00	64.00	53.00	75.20	4.00	4.00
F-test	**	*	NS	*	NS	NS
LSD 0.05	5.50	4.023	-	18.35	-	-
CV%	3.80	3.60	26.70	14.10	14.20	27.30

*GM-Grand mean NS – Non significant; * – Significant; **– Highly significant*

Table 2. Effects of time of planting on red ant damage, incidence and infested yield of potato at ARS, Jaubari during 2020 and 2021

Treatment	Red ant scoring (1-5) scale		Red ant incidence %		Red ant infested yield (t/ha)	
	2020	2021	2020	2021	2020	2021
December1	1.00	1.00	3.41	4.35	0.80	0.86
December 15	1.00	1.00	2.22	4.10	0.52	0.52
January 1	1.00	1.00	1.46	3.02	0.43	0.43
January 15	2.00	1.00	5.75	6.29	1.60	1.57
February 1	1.66	1.00	7.22	3.54	1.54	0.80
February 15	2.00	1.67	10.58	6.38	2.84	1.72
March 1	1.66	1.33	6.74	5.03	1.35	1.42
March 15	1.00	1.33	5.40	5.92	1.17	1.05
April 1	1.00	1.00	3.48	2.67	0.25	0.49
GM	1.37	1.18	5.14	4.64	1.21	0.99
F-test	***	*	**	**	**	**
LSD	0.28	0.69	2.443	2.08	0.44	0.60
CV (%)	20.50	34.00	27.50	26.0	21.0	35.40

*GM-grand mean; *– Significant; **– Highly significant*

Similarly, the date of planting had significant effects on the red ant occurrence on 2021. Potato planted on January 1 had the lowest red ant score (1.00) scale, red ant incidence % (3.02) and less infested tuber yield (0.43 t/ha) respectively whereas the potato planted on February 15 had the highest score (1.67), red ant incidence % (6.38) and the highest (1.72 t/ha) infected tuber yield.

3.3 Tuber Number and Tuber Yield

The number of tubers per plant was found non-significant in both years of different dates of planting. The number of tubers/plant ranges from 5.00 – 7.00 in 2020 where as it was recorded as 4.00 – 7.00 in 2021. The yield was found significant with the date of planting in both the year. Significantly higher tuber yield (t/ha) was found in January 1 planting in both years (Table 3). January 1 planted crops gave yield as 19.86 t/ha and 25.48 t/ha respectively in 2020 and 2022. Significantly lower yield was observed when planting was done earlier (December 1 and 15). The results showed that as planting date was delayed the trend of yield was found decreasing. Minimum tuber yield was recorded when planting was done in April 1. It was observed as 9.45 t/ha and 6.66 t/ha respectively in 2020 and 2021. All the treatments were harvested on July irrespective of their planting dates. Crop duration was longest for December 1 planted (205.00 – 231.00 days) and shortest for April 1 planted ones (135.00 – 150.00 days), while it was 194.00 – 207.00 days for January 1 planted potatoes.

Table 3. Effects of time of planting on yield of potato at ARS, Jaubari during 2020 and 2021

Treatments	Maturity days		Tubers # /plant		Tuber yield (t/ha)	
	2020	2021	2020	2021	2020	2021
December 1	231.00	205.00	6.00	6.00	13.61	14.85
December 15	220.00	201.00	6.00	5.00	13.53	16.32
January 1	207.00	194.00	8.00	7.00	19.86	25.48
January 15	194.00	181.00	6.00	4.00	19.16	19.72
February 1	180.00	175.00	6.00	4.00	19.79	22.82
February 15	178.00	163.00	7.00	5.00	18.49	19.27
March 1	165.00	157.00	7.00	5.00	16.82	13.65
March 15	150.00	158.00	5.00	5.00	13.22	13.26
April 1	135.00	150.00	4.00	3.00	9.45	6.66
GM	184.00	176.00	6.11	5.00	15.99	16.89
F-test	**	**	NS	NS	*	*
LSD 0.05	0.10	2.30	-	-	2.22	3.20
CV%	0.03	0.80	17.30	31.40	21.53	27.4

*GM- Grand mean; NS – Non significant; * – Significant*

4. DISCUSSION

Seed tuber planted on January 1 produced maximum tuber number in both the years this could be due to optimal environment like temperature during plant growth which reflected in good tuber count, though it was found non-significant. It could be due to the one genotype used in experiment and number of tubers is a genetic characters. The total yield is associated with size of the tubers. Most ideal temperature for tuber development is 17 ^{0}C. Beyond 22 ^{0}C tuber yield drastically reduced. Similar results were reported by researcher [9]. The results indicate that the tuber yield was gradually decreased from the February 1 planting to April 1. Lower yield in December planted potatoes could be as because they require more time for sprouting due to low temperature unfavorable for sprouting of seed tubes. Researcher [10] reported that delayed planting decline yield is caused by a reduction in the number of tuber and shrinkage of leaves. January 1 planted potatoes receive suitable environment for tuber initiation and tuber growth. Seed tuber planted during January received enough soil moisture and temperature for optimum bulking of tubers resulting in higher yield. Similar results were reported by the researchers [11]. Prevailing high temperature during growing period in March - April was not suitable for tuber initiation and tuber growth. In addition to tuber yield red ant infestation was lower in early planted potatoes. As the planting time was delayed the red ant infestation was higher, however it was further decreased in April planted potatoes. Lower infestation of ant in April planted ones could be due to low temperature and high moisture content in the soil due to early monsoon during tuber growing period (May-June). Relatively high soil moisture and low temperature in January planted potatoes was not much favorable for the infestation of ants as that of February and March planted ones. More infestation of ants in February-March planting could be because of favorable environment for their growth.

5. CONCLUSION

The study revealed that observed parameters were significantly affected by the time of planting. Time of planting significantly affected days to 50% emergence, ground coverage (%) and seed tuber yield. Planting potato at an earlier date delayed emergence but produced maximum yield. The highest yield 19.86 t/ha in the year 2020 and 25.48 t/ha in the year 2021 and red ant incidence (1.46%) in the year 2020 and (3.02%) in the year 2021 were obtained from the potato planted on January 1. Therefore, planting on first week of January is appropriate for higher tuber yield of potato and lower down red ant incidence at Jaubari area.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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