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RESEARCH ARTICLE

EVALUATION OF GROWTH AND YIELD ATTRIBUTES OF DIFFERENT POTATO (*Solanum tuberosum* L.) VARIETIES AT GOKULESHWOR, BAITADI, NEPAL

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ARTICLE DETAILS

ABSTRACT

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A varietal trial was conducted to evaluate growth and yield attributing characteristics of five varieties namely; Cardinal, Janakdev, Khumal seto-1, Lal gulab, MS 42.3. The experiment was laid out on randomized complete block design (RCBD) with four replications. Parameters on, growth parameter such as plant height (cm), number of leaves per plant, number of main stem per hill, canopy diameter (cm) (at different days after planting) and yield parameters such as tuber weight per plant (g), tuber number per plant, grading of tuber according to weight. Collected data were analyzed using MS-Excel and Gene stat. At harvest, the tallest plant (30.05cm) was recorded in Janakdev and shortest in (20.08 cm) MS 42.3. Maximum number of leaves per plant (29.35) was observed in MS 42.3 and minimum number of leaves per plant (23.1) in Khumal seto-1. The highest (6.75) and lowest (3.15) number of main stem per hill was recorded in Cardinal and Khumal seto-1 while maximum (30.75 cm) and minimum (26.55 cm) canopy diameter was recorded in Lal gulab and MS 42.3 respectively. All the yield attributing parameters was found significant at 5% level. The maximum tuber weight per plant (330.5g) was found on Cardinal and minimum (152 g) on MS 42.3. The highest tuber of small size tuber (38.25) was found on MS 42.3 while highest number of large size tuber (14) was recorded on Cardinal. Tuber did not differ significantly among the varieties but numerically highest yield (14.703 ton/ha) was obtained from variety MS 42.3 and lowest (6.267 ton/ha) from Cardinal.

KEYWORDS

Growth parameters, Potato, Gene stat, Yield, varieties

1. INTRODUCTION

1.1 Background

Potato is the tuber crop belong to family Solanaceae. Its scientific name is *Solanum tuberosum*. Potato is food crop in mountain region but commercially cultivated in hills and terai belts of Nepal as cash crop. Western South America is taken as origin of the potato. Later on distributed to other parts of the world in 15th and 17th century (Reddy et al., 2018). It is taken as the third most important food crops in the world in the consumption basis after the rice and the wheat (FAO, 2011). It is the major temperate crop but practiced is done from an altitude 100 to 4000m above sea level in Nepal (Gustafsson et al., 2013). It contains about 17% of carbohydrate, 2% protein with excess vitamin B and vitamin C and high-quality nutritional fiber. It is the source of vegetable and also be used to manufacture beverages, starch and other processed product such as chips, nutrient media, French fries etc. in the industries.

Potato is the primary vegetable crop of the mid hill and terai and staple food crops for high hill and mountain region of Nepal (NPDP, 2007). In the context of Nepal, the average per capita potato consumption of potatoes is 29.9 kg/year (Sthapit, n.d.). The area under potato cultivation is 193997 hector with an average production and productivity about 3112947 ton and 16.04 ton/ha respectively. For the total area under potato, 20% is in the high hills, the mid-hills hold the highest 41.5% and the terai region is 38.5% (Gotame et al., 2021). The crops solely contribute about 6.57% of Agriculture GDP and 2.17% in National GDP (MOALD, 2020).

The average growth rate of potato production is 214.49 kg per hectare per year, which has risen at a compound annual growth rate of 1.76 percent per year (Gairhe, Gauchan, & Timsina, n.d.). So talking about production in

Nepal seed cost occupied a major portion 33.33% of the cost of production followed by human labor (26.3%), FYM (12.3%), chemical fertilizer cost (7%) irrigation cost 1.7% micronutrient (0.8%) and pesticide (5.2%) lastly packaging storage and transportation cost jointly attribute 3.3% to total variable costs and lack of quality seed in sowing time is one of the major causes for higher seed cost and government subsidiary on fertilizer is major causes for lower fertilizer cost (Subedi et al., 2019).

To date, National Potato Research Program (NPRP) has followed the selection program on advanced clones provided by the International Potato Center (CIP), Lima, Peru. NPRP first attempted to set up the crossing program of potato since 2004 at Hattiban Research Farm, Khumaltar followed by the selection of segregating breeding population (NPRP, 2007). National Potato Research Program (NPRP) plays the important role for the varietal development, research and promotion of the potatoes in Nepal (Gairhe et al., n.d.). Now days high yielding, late blight resistance and early maturing with red skin varieties are more concerns and demand of the potato farmers in hills (Sharma et al., 2013; NPRP 2014). The improved varieties are more affected by the proper trials, training and seed sources (Upadhyay et al., 2020a).

Potato production is more beneficial than the production of food grains in most of the case studies and shows the five times more net return as compared to cereals (DOAD, 1992). Despite of large importance, most of the farmers are unable to produce sufficient yield for the home consumption and market chain. In some literature education, training, and organization membership and family income were found as the key factors for the adoption of improved varieties of potato (Upadhyay et al., 2020b). So, to uplift the farmer's progress we are conducting the program the study as different varietal trail to get more benefit in the agricultural community within Gokuleshwor, Baitadi, Nepal.

1.2 Objectives

1.2.1 General Objectives

- To evaluate the different potato varieties at Gokuleshwor, Baitadi, Nepal.

1.2.2 Specific Objectives

- To observe the growth parameters of different potato varieties.
- To evaluate different varieties of potato for the yield and yield attributing characters.

2. LITERATURE REVIEW

2.1 Cost of production

The total variable cost for the potato Production in the study area (Bara, Kailali, Jhapa) eastern, central and far-western terai region of Nepal in 1 kattha land was calculated as NRs. 5850. Seed cost occupied the major portion (33.3%) of the cost of production followed by human labor cost (26.3%), FYM cost (12.3%), Chemical fertilizer cost (7%), irrigation cost (1.7%), micro nutrient (0.8%) and pesticides (5.2%) (Subedi et al., 2019).

2.2 Growth parameter

Cardinal possesses the height of 53.3 cm, number of tubers per hill is 9.67, main stems per hill is 5.2, weight of tubers per hill is 405.00 gram and having the yield of 27.00 metric ton per hectore (Eaton et al., 2017). The maximum plant height was recorded on Janakdev (57.25cm). The height of Cardinal, Khumal seto-1, MS 42.3 were 23.8cm, 54.73cm and 40.08 respectively. Similarly, the number of leaves per potato plant on Janakdev, Cardinal, Khumal seto-1 and MS 42.3 were 109.8, 50.4, 64.18 and 107.58 respectively (Banjade et al., 2019).

2.3 Yield

The yield of potato variety (cardinal) is 20-25 metric ton per hectore and it has the maturity days of 90 to 110 days according to sowing time (Upadhyay et al., 2020a). Performance of the potato varieties cardinal, Janakdev and MS-42.5 in the straw mulching condition provides the production of yield having 16.57, 34.29 and 18.11 metric ton per hectore (Shrestha et al., 2020). Mean height of plant treated with inorganic fertilizer at 105 days after sowing was 54.1 cm which was significantly higher than plant (46.5 cm) treated with organic fertilizers. The highest number of tuber was recorded in khumal seto-1 (9.167) and lowest in Janakdev (5.75). The effect of fertilizer on the number of tubers per plant was found non-significant. Plant treated with inorganic and organic

fertilizer had 8.00 and 7.62 tubers respectively (Bhujel et al., 2021).

The study in horticulture farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU). During the analysis of varieties of potato, Cardinal gives the production yield of 27.27 metric ton per hectore (Howlader and Hoque, 2018). The total yield of potato in black plastic mulch, white-on-black plastic mulch, silver-on-black plastic mulch and aluminum-on-black plastic mulch is 33.4, 42.9, 37.0, 41.2 ton per hectore respectively (Ibarra-Jiménez et al., 2011). Total yield of potato in black, silver/black, white/black, aluminum plastic mulch is 39.3, 40.5, 42.2, 36.8 ton per hectore respectively (Scandinavica et al., 2015).

Application of potassium in potato production in different dose response for different yield. The production yield of potato in no application of potassium, 150kg per ha, 300 kg per ha, 450 kg per ha and 600 kg per ha is 17.91, 21.53, 28.66, 31.90 and 31.96 respectively (Bhattarai and Swarnima, 2018). The yield performance of potato in Mulching with banmara, back polythene sheet, white polythene sheet and commercial mulch paper at saliza, Parbat, Nepal is 14.06, 16.67, 14.5 and 17.19 ton per hectore respectively (Timilsina et al., 2021).

2.4 Post-harvest loss

The study in Panauti, Kavreplanchowk district having an altitude of 1330 meter above sea level, the percentage of weight loss by the potato variety MS 42.3 in 20, 40, 60, 80 days are 7.04%, 11.02%, 17.68% and 23.01% respectively. The difference in number of eyes and infected eyes by Potato Tuber Moth was least (0.1) in MS 42.3. The longest sprouts (5.6 cm) was observed in this variety. It has short self-life. So, it should be used for the fresh consumption (Upadhyay et al., 2020).

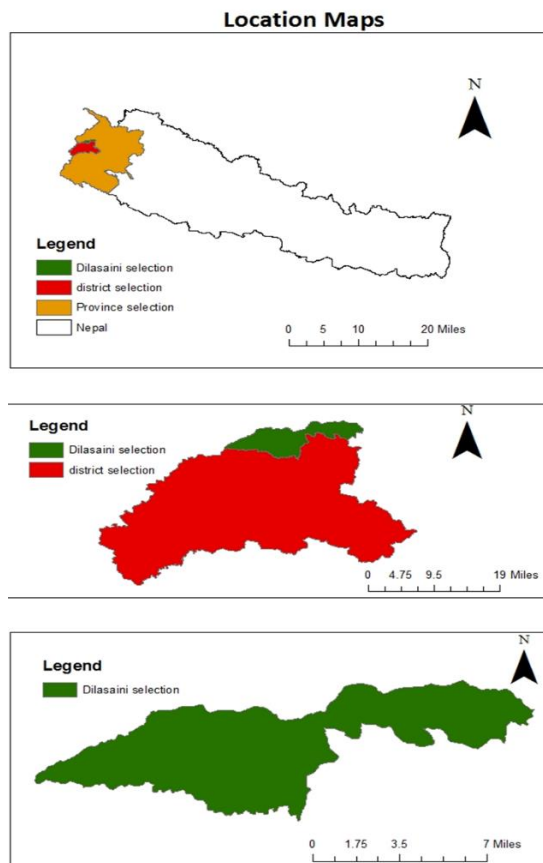
2.5 Adaptability of improved varieties

The incidence and intensity of adoption of lal gulab variety of potato is 6.5% and 5.53% in the district of Bihar, India (Singh et al., 2020). Lal gulab is Indian variety of potato and adaptability of this variety in Nepal is 5.44% (Upadhyay, 2020).

3. MATERIALS AND METHODS

3.1 Study area

The study will be conducted in Dilasaini Rural Municipality, Baitadi falls in Sudurpaschim province of Nepal. The latitude and longitude of the study area is 29.5186 ° north and 80.4688° east. Gokuleshwor village is at an altitude of 800-950 masl. Cardinal variety of potato is majority of production in that area.



Source: DIVA GIS

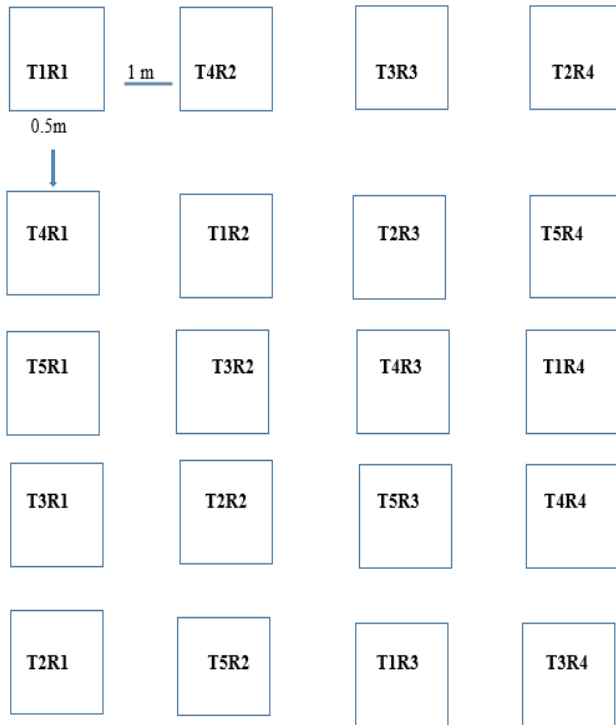
3.2 Agro climatic and soil conditions

The experiment was conducted in warm subtropical climatic condition. The average temperature of summer was 31 degree Celsius. Here the annual average receiving precipitation was about 96.39mm (Meteorological station Gokuleshwor, Baitadi)

3.3 Field Preparation

One day before, the field was lightly irrigated to control the dustiness during the tillage. The primary tillage was done by using tractor and the secondary tillage was done manually by using spade, hoe, rake etc. Total 4 quintal farm yard manure (FYM) was mixed in the field during the field preparation. All the crop stubs and other inert matters from soil were removed and let the field to be treated in the sun light. Each plot was raised to prevent from water logging condition and flooding.

3.4 Framework of the study



3.5 Data Collection

3.5.1 Primary data

The primary information collection through the field work and field visit.

3.6 Sample size and Sampling Techniques

The total field size is 18m in length and 8m in breadth having area of 144 m². In the field, small plots are made having 3.5m length and 1m in breadth. The field have five treatment as variety (cardinal, janakdev, khumal seto-1, lal gulab, MS 42.3) of potato with four replication. The varieties cardinal and MS 42.3 are registered varieties, Janakdev is released variety and lal gulab is Indian variety. The space between replication is maintained to 1m and space between treatments is 0.5m. The experimental design is performed in random complete block design. The main propose of the study is to include the problem of low yielding in potato in Gokuleshwor, Baitadi.

3.7 Treatment detail

SN	Treatment
T1	Cardinal
T2	Janakdev
T3	Khumal seto-1
T4	Lal gulab
T5	MS 42.3

3.8 Fertilizer application

The Recommended dose of fertilizer= 60:100:120 kg NPK per hector. So, fertilizer dose with the size of plots was used. The recommended dose of FYM= 6 ton/ha.

Particulars	Details
Nitrogen	32 gm./plot
Phosphorus	76 gm./plot
Potassium	70 gm./plot
FYM	6 kg/plot

3.9 Research Detail

SN	Particular	Details
1.	Experimental design	RCBD
2.	No. of treatment	5
3.	No. of replication	4
4.	No. of plots	20
5.	Net area of experiment	144 m ²
6.	Plant population	400
7.	Plant distance	25cm
8.	Distance between treatment	0.5m
9.	Distance between replication	1m
10.	Day of planting	2078/08/26

3.10 Irrigation

First pre sowing or pre emergence irrigation was done. Then after second irrigation was done 35 days after plantation. Mild irrigation was done before 2 weeks of dehauling as per necessary due to dryness.

3.11 Weeding

Weeding was done manually two times during the experiment. First weeding was done 45 days after planting. Second weeding was done on 65 days after plantation. During weeding spade and scraper were used.

3.12 Earthing up

Earthing up was done on the 45 days after planting. About 15cm soil was raised to the ridge from the ground surface.

3.13 Dehauling

Dehauling was the part of curing of potato tuber. It was done at 90 days after transplanting. We cut out the stem portion from the soil surface by twisting the stem portion or cutting by the help of sickle.

3.14 Harvesting

After the completion of 100 days, we harvested the potato tuber crop and data was taken.

3.15 Data collection

Data collection was started after germination of potato seed and continued up to final harvesting 100 DAG. The total crop period from germination to final harvesting was of 120 days. Data collection was done on the basis of different parameters taken in the study. Data was collected for determining growth and yield of potato. Data was collected after randomly tagging 5 plants from each plot and 100 plants were taken as sample plant to collect data. Different parameters taken in research are:

3.15.1 Plant height (cm)

The height of 5 sample plants was measured in cm scale from the soil surface up to the terminal portion of plant with the help of measuring tape. The height was measured with the respective time of 15,30,45,60 and 90 DAG and average was calculated for each plot.

3.15.2 Number of leaves

Numbers of leaves were counted from the five-sample plant on 15, 30, 45 and 90 DAG and the average was calculated for each plot.

3.15.3 Canopy diameter (cm)

Canopy diameter was taken at 45, 60 and 90 DAG. The total area covered by the leaves from left to right or vice versa to measure the canopy area. Scale was used to measure it.

3.15.4 Number of stems per hill

The total number of stems raised from the single tuber was counted from each sample plant of different varieties.

3.15.5 Yield

Yield was taken from selected five plant and calculated average yield per plant. Similarly yield per plot was also calculated by weighting fruits from all plants of each plot.

3.16 Secondary Data

Secondary data will be collected from document related to the objectives such as; research articles, case studies, papers, journals etc. Furthermore, essential information will be downloaded from the related websites.

Treatment	Plant height				
	15 DAG	30 DAG	45 DAG	60 DAG	90 DAG
Cardinal	3.35 ^{cd}	11.65 ^{bc}	25 ^b	19.6 ^{bc}	20.55 ^c
Janakdev	4.7 ^b	13.65 ^b	32.2 ^a	28.25 ^a	30.05 ^a
Khumal seto-1	4.4 ^{bc}	14.3 ^b	29.3 ^{ab}	25.1 ^a	28.15 ^{ab}
Lal gulab	8.05 ^a	20.7 ^a	27.45 ^b	24.3 ^{ab}	25 ^b
MS 42.3	3.05 ^d	9.2 ^c	18.55 ^c	17.2 ^c	20.08 ^c
SEM±	0.416	1.314	1.464	1.584	1.342
LSD	1.281	4.084	4.51	4.88	4.135
CV%	17.7	18.9	11	13.8	10.8
Grand mean	4.17	13.9	26.5	22.89	24.77
F value (0.05)	***	***	***	***	***

4.2 Number of Leaves per Potato plants

The result of statistical analysis showed the effect of different varieties on leaves number at 90 DAG was found non-significant (Table 2). At 15 DAG maximum leaf number was recorded on cardinal (24.35) and khumal seto-1 (10.25) was recorded minimum leaf number. At 30 DAG maximum leaf

4. RESULT AND DISCUSSION

4.1 Potato Plant Height

The treatment involving the application of mustard cake to the soil, tuber treatment, and foliar spray with *T.viride* recorded the highest plant height at 30 days of age, measuring 11.16 cm. This was followed by treatments involving the application of mustard cake to the soil, tuber treatment, and foliar spray with *Azotobacter*, and neem cake to the soil with PSB, which represented values of 11.06 cm and 10.73 cm, respectively (Singh et al., 2017). Effect of potatoes varieties on plant height was found significant (Table 1). At 15 DAG Lal gulab was recorded maximum height (8.05 cm) and MS 42.3 (3.05 cm) was recorded minimum height. At 30 DAG Lal gulab was recorded maximum height (20.7 cm) and MS 42.3 (9.2) was recorded minimum height. At 45 DAG Janakdev was recorded maximum height (32.2 cm) and MS 42.3 (18.55cm) was recorded minimum height. At 60 DAG Janakdev was recorded maximum height (28.25cm) at par with khumal seto-1 (25.1cm) and MS 42.3 (17.2cm) was recorded minimum height. At 90 DAG Janakdev was recorded maximum height (30.05cm) and MS 42.3 (20.08cm) was recorded. The result found for cardinal (23.8) was similar to findings but contradictory to other varieties (Banjade et al., 2019).

number was recorded on cardinal (37.45) and khumal seto-1 (18.75) was recorded minimum leaf number. At 45 DAG maximum number of leaves was recorded on Janakdev (47.85) at par with cardinal (44.6) and khumal seto-1 (21.6) was recorded minimum leaf number. Our result finding was found to be contradictory to the finding of (Banjade et al., 2019).

Treatment	No. of leaves			
	15 DAG	30 DAG	45 DAG	90 DAG
Cardinal	24.35 ^a	37.45 ^a	44.6 ^a	29.05 ^a
Janakdev	18.1 ^{abc}	29.1 ^{ab}	47.85 ^a	27.15 ^a
Khumal seto-1	10.25 ^c	18.75 ^c	21.6 ^b	23.1 ^a
Lal gulab	22.65 ^{ab}	28.55 ^{ab}	32.75 ^{ab}	24.4 ^a
MS 42.3	14.45 ^{bc}	22.6 ^{bc}	38.85 ^a	29.35 ^a
SEM	2.79	2.81	4.26	2.69
LSD	8.6	8.65	14.22	8.29
CV%	31.1	20.6	24.9	20.2
Grand mean	18	27.3	37.1	26.6
F value (0.05)	*	***	*	NS

4.3 Number of main stems per hill

Treatment	Number of stems per hill	
	30 DAG	45 DAG
Cardinal	7.1 ^a	6.75 ^a
Janakdev	6.05 ^{ab}	6.35 ^a
Khumal seto-1	3 ^b	3.15 ^b
Lal gulab	5.65 ^{ab}	5.3 ^{ab}
MS 42.3	6.2 ^{ab}	5.3 ^{ab}
SEM	0.993	0.71
LSD	3.061	2.187
CV%	35.5	26.4
Grand mean	5.6	5.37
F value (0.05)	NS	*

The effect of different varieties of potato on number of stems per hill at 30 DAG was found non-significant (Table 3). At 45 DAG maximum number of stems per hill was recorded on cardinal (6.75) at par with janakdev (6.35) and khumal seto-1 (3.15) was recorded minimum number of stems per hill. Our result finding was found similar to the finding of (Banjade et al., 2019). But contradictory to the finding of (Eaton et al., 2017).

4.4 Canopy diameter

The result of statistical analysis showed the effect of different varieties of

Treatment	Canopy diameter		
	45 DAG	60DAG	90 DAG
Cardinal	29.55 ^a	31.7 ^a	29.9 ^a
Janakdev	28.85 ^{ab}	29.25 ^a	27.55 ^a
Khumal seto-1	26.90 ^{ab}	29.55 ^a	29.75 ^a
Lal gulab	27.65 ^{ab}	30.05 ^a	30.75 ^a
MS 42.3	26.05 ^b	29.05 ^a	26.55 ^a
SEM	1.017	1.1	1.726
LSD	3.133	3.39	5.318
CV%	7.5	7.4	11.9
Grand mean	27.8	29.92	28.9
F value (0.05)	NS	NS	NS

4.5 Number and weight of tuber per plant

The effect of different potato varieties on number of tubers per plant was non-significant but the weight of tuber per plant was significant. The highest weight of tuber per plant was recorded on cardinal (330.05g). And lowest weight of tuber per plant was recorded on MS 42.3 (152g). Our result finding was found to be contradictory to the finding of (Banjade et al., 2019).

Treatment	Tuber no. per plant	Tuber weight per plant (g)
Cardinal	8.05 ^b	330.5 ^a
Janakdev	8.95 ^{ab}	314.5 ^{ab}
Khumal seto-1	7.55 ^b	272 ^b
Lal gulab	11.6 ^a	273 ^b
MS 42.3	10 ^{ab}	152 ^c
SEM	1.026	17.13
LSD	3.162	52.77
CV%	22.2	12.8
Grand mean	9.23	268.4
F value (0.05)	NS	***

4.6 Tuber grading

The effect of different potato varieties on size based on the weight was non-significant on small (<25g) and medium (25-50g) but significant on large size (>50g). The large sized tuber was maximum on cardinal (14) and no large sized tuber was recorded on MS 42.3.

Treatment	Small(<25g)	Medium(25-50g)	Large(>50g)
Cardinal	15 ^{ab}	12 ^b	14 ^a
Janakdev	16.25 ^{ab}	17 ^{ab}	11.75 ^{ab}
Khumal seto-1	13.5 ^b	13.5 ^{ab}	10.5 ^{ab}
Lal gulab	34.5 ^{ab}	23 ^a	8.5 ^b
MS 42.3	38.25 ^a	14 ^{ab}	0 ^c
SEM	7.14	3.23	1.48
LSD	22	9.96	4.57
CV%	60.8	40.7	33.2
Grand mean	23.5	15.9	8.95
F value (0.05)	NS	NS	***

potato on canopy diameter was found non-significant at 45 DAG, 60 DAG and 90 DAG. Our result finding was found to be contradictory to the finding of (Banjade et al., 2019). Similarly, At 80 days following planting, the quantity of viable and fallen leaves in potato genotypes under non-stress and water-stress circumstances. The resistant clones showed the least amount of decrease (5.22%) above the control environment after 10 days of water stress (at 40 DAP), whereas the sensitive clones (CIP 391004.18 and Asterix) showed reductions of 22.55% and 23.81%, respectively (Abdullah-Al-Mahmud et al., 2015).

4.7 Tuber yield (t/ha)

The effect of different potato varieties on tuber yield (t/ha) was significant. The highest tuber yield (16.04ton/ha) was recorded on Cardinal and the lowest yield was recorded on MS 42.3 (7.27t/ha). Our finding was found contradictory to the performance of potato in straw mulch of (Shrestha et al., 2020).

Treatment	Yield (ton/ha)
Cardinal	16.04 ^a
Janakdev	13.98 ^a
Khumal seto-1	14.98 ^a
Lal gulab	15.51 ^a
MS 42.3	7.27 ^b
SEM	1.85
LSD	2.85
CV%	19.7
Grand mean	13.8
F value (0.05)	***

5. CONCLUSION

In conclusion, the study indicates that a variety of potato varieties are available for farmers in Gokuleshwar, Baitadi, Nepal. Each variety has distinct advantages in terms of growth characteristics and production potential, offering flexibility and possibilities for better potato farming in the area. The frequently produced potato cultivars in the area differ significantly in terms of growth factors. Certain growth indicators show advantage for different kinds. The largest number of leaves per plant is found in Janakdev, the biggest number of main stems per hill is found in Cardinal, and the maximum canopy diameter is found in Lal gulab. The Cardinal and Lal Gulab cultivars are notable for producing tubers in different ways. While Cardinal gives the highest overall weight of tubers per hectare, Lal gulab produces the most tubers per plant in terms of both quantity and weight. The size distribution of the tubers produced by the variety varies as well. The greatest number of little tubers are found in MS 42.3, the greatest number of medium-sized tubers are found in Lal Gulab, and the greatest number of huge tubers are found in Cardinal. With a yield of 16.04 tons per hectare, Cardinal has the best production potential of all the types studied. Every variety that has been evaluated has demonstrated good adaptability to the local agro-ecological conditions.

RECOMMENDATION

Farmers in Gokuleshwar, Baitadi, Nepal can choose the best potato variety by having a thorough understanding of the growth and yield

characteristics of several cultivars. Enhancing total potato output and quality can be facilitated by identifying resistant features and high yield potential cultivars, such as Cardinal. Farmers may efficiently manage disease risks by knowing how well cultivars such as Janakdev and Khumal seto-1 perform in terms of resistance to late blight. Policymakers and agricultural extension agencies might use the study's insightful recommendations to encourage the production of appropriate potato varieties in areas with comparable agro climates. Any of these cultivars can be grown by farmers in the area, according on their particular goals—which may include improving tuber size distribution, increasing production, or taking other growth characteristics into account. Because each variety has unique benefits, farmers may customize their selection to suit their requirements and tastes.

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