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Research Article

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Effect of Different Moisture Conditions on Growth and Yield Attributes of Potato Varieties Grown in Lalitpur District, Nepal

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Abstract

Field experiments were conducted in 2015 and 2016 at Hattiban Research Farm of the National Potato Research Programme (NPRP), Khumaltar, Lalitpur (1360 masl), Nepal, to investigate the effect of varying moisture conditions on the growth, yield and quality attributes of potato varieties. The experiment was set up on sandy loam soil using a split-plot design (SPD) with three replications and included six potato varieties (Cardinal, Desiree, Kufri Jyoti, Khumal Seto-1, Janakdev and Khumal Upahar) and three moisture conditions (Irrigated, Rainfed and Drought (black plastic mulch). The results revealed that moisture conditions and potato varieties significantly influence growth, tuber yield and quality traits. Plants subjected to drought conditions with plastic mulch exhibited the tallest height (62.18 cm) and higher tuber yield (36.23 t ha-1) but lower tuber number per plant (9.84) compared to irrigated conditions (11.35). Khumal Seto-1 had the highest mean number of tubers per plant (14.71) and intermediate tuber weight (0.498 kg), while Khumal Upahar had the highest tuber yield (35.43 t ha-1) followed by Kufri Jyoti (34.8. t ha-1). Khumal Upahar had the highest specific gravity (1.072) and dry matter (22.87%), while Kufri Jyoti had the lowest (1.059) and (20.26 %) among the varieties. Varieties such as Khumal Upahar, Khumal Seto-1 and Janakdev, which exhibited enhanced growth and yield under drought conditions, could be prioritized for cultivation in water scarce regions. The application of plastic mulch may be explored as a means of reducing the adverse impacts of drought on potato growth and yield. These results help potato growers enhance production and quality in varied environments. Farmers or stakeholders may work to improve potato productivity and ensure food security in the Lalitpur condition of Nepal or similar potato-growing regions by incorporating these findings into agricultural practices.

Keywords : Moisture conditions, plastic mulch, potato, tuber yield, varieties

Introduction:

Potato (*Solanum tuberosum* L.) ranks as the fifth most cultivated staple crop globally, following sugar cane, wheat, rice, and maize, and is an important cash and food crop in Nepal. It serves as a primary vegetable in the terai and mid-hills, and is also consumed as a staple diet in the highlands. Moreover, potatoes are essential for food security and constitute a significant source of income for farmers. In Nepal area under potato is estimated 1, 98,256 hectares and the total production 34,10,829 tons with an average productivity of 17.20 tons per hectare (ABPSD, 2023). The contribution of potato to agriculture's gross domestic product (AGDP) is 6.34 % (ABPSD, 2023).

Potatoes are grown under diversified climatic conditions, at an altitude ranging from 70 to 4500 m above sea level in different seasons and harvested accordingly at different times, almost throughout the year. Domestic production of potatoes is not sufficient to address internal demand. Despite the availability of diversified climatic conditions most suitable for potato production around the year, Nepal imports huge amounts of potato and potato products every year. This is mostly caused by the low productivity of potatoes, which could be brought on by a variety of biotic and abiotic factors.

In Nepal, potatoes are grown in two main seasons: during winter under short-day conditions in the plains and during summer under long-day conditions in the hills and mountains. Summer is regarded as a typical season for potato cultivation in the highlands. In the mid-hills, the normal season potato encounters drought throughout the tuberization phase (NPRP, 2012). Planting potatoes immediately after the rice harvest in a rice-potato cropping system facilitates the use of residual moisture for tuber emergence. Nevertheless, following this stage, a period of drought ensues during tuberization and bulking (NPRP, 2012). Even in irrigated potato cultivation, instances of drought stress have been documented (Van Loon, 1981; Jefferies, 1993). Water stress can manifest even under adequate irrigation conditions due to elevated transpiration rates, especially around midday when the root system may not fully satisfy the plant's water needs (Minhas and Sukumaran, 1988). Drought stress affects the formation and growth of shoots, roots, and tubers (Lahlou et al*.,* 2003).

The influence of varying levels of moisture conditions on the growth and yield characteristics of different potato varieties in Lalitpur District, Nepal, could be substantial, given that moisture availability has a direct impact on the growth, development, and productivity of plants. The Lalitpur District, as an integral component of the Kathmandu Valley area, encounters a wide range of climatic conditions, characterized by fluctuations in moisture content attributed to its geographical features and seasonal cycles. Understanding the impact of various moisture conditions such as rainfed, drought (mulching), and irrigation on potato cultivation within this particular context is imperative for enhancing agricultural practices and safeguarding food security.

Sufficient moisture content is essential for potato plant germination, root formation, and vegetative growth (Karki & Shrestha, 2005). Optimum moisture conditions are essential for ensuring the effective uptake of nutrients and photosynthesis, thus fostering the growth of healthy foliage and the formation of tubers. Potato crops cultivated under ideal moisture levels typically exhibit enhanced biomass accumulation, consequently increasing the potential yield (Shrestha, Bhattarai, & Pun, 2012). The presence of excessive moisture, often linked to intense rainfall or inadequate drainage, can result in waterlogging and a deficiency of oxygen in the soil (Adhikari & Thapa, 2013). Moreover, an excess of moisture can elevate the susceptibility to fungal diseases like late blight, which have the capacity to devastate potato harvests and substantially diminish yields (FAO, 2016). Waterlogging has the potential to induce tuber decay and reduce the marketable yield owing to inferior tuber quality (Manandhar & Shrestha, 2015). Inadequate moisture levels, particularly during critical growth phases like tuber initiation and bulking, may lead to water stress (Shrestha et al., 2012). Water stress hampers photosynthesis, limits cell expansion, and constrains the transport of nutrients within the plant, resulting in stunted growth and decreased yield. Potato plants subjected to water stress are likely to produce smaller tubers with reduced dry matter content, impacting both the quality and quantity of the harvest (CIP, 2018).

Various potato cultivars demonstrate different levels of tolerance towards moisture stress conditions. Certain varieties may exhibit characteristics such as extensive root systems, resistance to drought, or the ability to withstand waterlogging, allowing them to excel under specific moisture conditions (FAO, 2016). Breeding initiatives frequently prioritize the enhancement of potato varieties that display enhanced efficacy in water utilization and resilience to moisture variations (Manandhar & Shrestha, 2015). The optimization of water use efficiency and reduction of moisture-related hazards are crucial objectives for breeding programs, necessitating proper management of irrigation scheduling, drainage, and monitoring of soil moisture (Karki & Shrestha, 2005). Techniques such as mulching, conservation tillage, and the application of soil amendments play a vital role in sustaining soil moisture levels and augmenting water retention capacity (Adhikari & Thapa, 2013).

Various factors influence the productivity of potatoes in Nepal, and farmers lack awareness of the potential advantages of utilizing mulching and the impact of moisture levels on potato crops. Due to the non-flat geographical characteristics of the study area, irrigation emerges as a crucial element leading to decreased potato yields. The utilization of mulching in potato cultivation holds considerable importance in retaining moisture and providing a cost-effective method to enhance the yield potential of various potato cultivars. Mulching, an essential agronomic technique, alters the soil's physical environment by inhibiting weed growth, preserving soil moisture, and enhancing soil fertility (Yoo-Jeong et al., 2003). Weeds contribute significantly to potential yield losses, which can be notably reduced through the implementation of mulching practices. Mulching plays a vital role in addressing irrigation challenges, with options including both organic and inorganic mulches. The primary objective of this research is to investigate the impact of differing moisture conditions on the growth, yield, and quality attributes of various potato cultivars.

Materials and methods:

Experimental site

Field trials were conducted in 2015 and 2016 at the Hattiban Research Farm of the National Potato Research Programme (NPRP), Khumaltar, Lalitpur, Nepal. The location is positioned at a longitude of 85°19'E and a latitude of 27°39'N, with an average elevation of 1360 meters above sea level. Soil samples were obtained using a screw auger from a depth of 0-30 cm in the experimental fields prior to planting. The composite soil samples were examined in the soil laboratory, revealing them to be of sandy-loam composition (Table 1). The average, minimum, and maximum temperatures, as well as rainfall data, were obtained from the Agrometeorological Station of the National Agronomy Research Center (NARC) at Khumaltar, located within 1 km of the experimental area (Table 2).

Experimental treatments and design

The experiment was set up using a split-plot design (SPD) with three replications and included six potato varieties (Cardinal, Desiree, Kufri Jyoti, Khumal Seto-1, Janakdev and Khumal Upahar) and three moisture conditions {Irrigated, Rainfed and Drought (black plastic mulch)}. The rainfed conditions means there was no irrigation and drought treatment were covered by a strong plastic sheet (200 Gauge or 50.8 Micron) to exclude the rainfall. Moisture conditions were assigned to the main plot, while a variety treatment was assigned to sub-plot treatments. The varieties used in the experiment were recommended for commercial cultivation after being released and registered in Nepal (Table 3).

The experimental land was cultivated, tilled, pulverized, and ridged prior to planting. The total plot dimensions were recorded as 1.8 m x 2.5 m (4.5 m²), with a spacing of 60 cm x 25 cm and three rows allocated per treatment. The spacing between each plot was maintained at 0.50 meters, while the spacing between blocks was set at 1 meter. During the planting phase, the recommended N: P2O5: K2O fertilizers were administered at rates of 100:100:60 kg ha-1, utilizing urea as the nitrogen source. Manure was utilized as compost at a rate of 20 metric tons per hectare. Uniformly sized, well-sprouted tubers weighing between 25 and 50 grams from each variety were selected for the trial. Subsequently, 30 sprouted

Table 1: The chemical properties of experimental soils

Year	pH	N %	P_2O_5	K_2O	OM %	Sand %	Silt %	Clay %	Soil texture
2015	5.5	0.18	164 mgkg-1	137 mgkg-1	4.75	-	-	-	Sandy loam
2016	5.2	0.20	167 mgkg-1	148 mgkg-1	4.16	23.8	66.0	10.2	Sandy loam

Table 2: Monthly agro-meteorological data of the growing periods, Khumaltar, Lalitpur, Nepal

Months	Rainfall (mm)		Temp. (°C) 2015			Temp. (°C) 2016		
	2015	2016	Min	Max	Mean	Min	Max	Mean
January	1.5	0.2	3.0	17.0	10.0	3.0	15.7	9.35
February	38.4	19.1	5.7	19.3	12.5	5.5	21.7	13.6
March	86.3	6.6	9.2	23.1	16.1	9.7	25.0	17.35
April	71.5	10.6	11.8	25.0	18.4	13.6	29.7	21.65
May	51.6	189.0	16.5	28.6	22.5	16.3	27.6	21.95

tubers per plot were manually arranged in rows oriented upward, and all additional cultural practices were implemented according to the guidelines of the National Potato Research Program. The experiments were planted on 28th and 25th January 2015 and 2016, respectively.

Table 3: Potato varieties used in the experiments

Variety	Source	Maturity days	Status
Cardinal	Netherland	90-110	Registered
Desiree	Netherland	80-90	Released
Kufri Jyoti	India	100-120	Released
Khumal Seto-1	CIP	100-120	Released
Janakdev	CIP	110-130	Released
Khumal Upahar	CIP	100-120	Released

Source: NPRP, 2014

Data collection, measurements, and statistical analysis

Data regarding growth, yield, and quality characteristics were documented during the study period. Measurements were conducted on five randomly selected plants from each plot and averaged for the variable. Observations were recorded on plant emergence count (no), plant uniformity (1-5 scale), ground cover (%), stem plant-1 (no.), plant height (cm), tuber size distribution (undersize, seed size, oversize, no., and wt. respectively), total tuber/plot (no.), total tuber wt./plot (kg), and yield (t ha-1). The experimental plots were harvested on 20th and 19th May, 2015 and 2016 respectively. Processing quality parameters like dry matter and specific gravity were also recorded after harvesting the crop. The dry matter (%) content was assessed by chopping and homogenizing tubers into minute fragments and subsequently drying a 100-gram sample in a hot air oven at 80°C for the initial six hours, followed by drying at 65°C until a consistent weight was achieved (Kumar et al*.,* 2006).

$$\text{Dry matter (\%)} = \frac{\text{(Dry weight of sample(g)}}{\text{(Initial weight before drying (g)}} \times 100$$

Specific gravity was determined by weighing randomly selected 10 tubers in Kern electric balance (0.1-6000 g) in air and water by using the following formula:

$$\text{Specific gravity} = \frac{\text{Weight in air}}{\text{Weight in air-weight in water}}$$

The data were analyzed with GenStat version 18 software for Windows (VSN International, 2016). Means were distinguished using Duncan's Multiple Range Test at a 5% significance level.

Results:

Plant Growth Characters

There was no significant interaction effect of moisture conditions and varieties on different plant growth-attributing characteristics (Table 4). However, in case of the main effect of moisture conditions and varieties, the emergence count revealed no significant differences among various moisture conditions ($p = 0.309$). An investigation unveiled notable variations in plant height ($p < .001$) and stems per plant within the tested moisture conditions (irrigated, rain-fed, and drought with plastic mulch) (Table 4). Plants exposed to drought conditions with plastic mulch displayed the tallest plant height (62.18 cm). Varietal examination unveiled noteworthy distinctions ($p <.001$) in ground coverage, plant uniformity, stems per plant, and plant height among the six potato cultivars under investigation (Table 4). Khumal Upahar exhibited the highest ground coverage (90.28%) and Kufri Jyoti gave the highest plant uniformity (4.66), while Janakdev showcased the tallest plants (84.74 cm) with the lowest stem count (2.56). Cardinal variety displayed the least values in these characteristics. Varieties and moisture conditions interaction showed a non-significant difference in plant growth characteristics.

Tuber Yield and Quality Characters

Tuber size distribution

There was no significant interaction effect of moisture conditions and varieties on tuber size distribution of potato (Table 5). However, in the case of the main effect, the mean tuber size and weight exhibited significant variations under different moisture conditions (irrigated, rain-fed, and drought with plastic mulch) (Table 5). In the case of irrigated conditions, the average total tuber count per plot was 340.6**,** with a substantial proportion of tubers weighing >50g (38.33 plot-1). Conversely, drought conditions with plastic mulch led to a reduced mean total tuber count per plot (294.9), yet with a higher cumulative tuber weight of 16.31 kg plot-1. Significant differences were found among potato varieties in tuber size distribution ($P < .001$). Khumal Seto-1 exhibited the highest number of tubers per plot (441.4), with a substantial proportion of tubers weighing >50g (30.33 kg plot-1). Khumal Upahar and Kufri Jyoti had higher total tuber yields (15.94 and 15.66 kg plot-1, respectively).

Tuber yield and quality

There was no significant interaction effect of moisture conditions and varieties on tuber yield and quality characteristics (Table 6). However, in the case of main effect, the mean number of tubers per plant varied significantly across different moisture conditions, with the highest number observed under irrigated conditions (11.35) and the lowest under drought conditions with plastic mulch (9.84) (Table 6). Drought conditions utilizing plastic mulch produced the highest average tuber weight per plant (0.544 kg), resulting in the greatest tuber yield per hectare (36.23 t ha-1). However, this treatment also had the lowest number of tubers per plant. Moisture

Table 4: Effect of different moisture conditions on plant growth attributes of potato varieties during the years 2015 and 2016

Treatments	Emergence Count (no)	Ground coverage (%)	Plant uniformity (1-5)	Stems Plant-1 (no)	Plant height (cm)
Moisture condition (M)					
Irrigated condition	30.00	75.83	4.02	3.24*a*	49.42*b*
Rai-fed condition	29.94	75.97	3.97	3.17*a*	46.56*c*
Drought (plastic mulch)	29.94	82.64	4.00	2.79*b*	62.18*a*
SEM±	0.025	1.54	0.11	0.07	0.73
P value	0.309	0.057	0.944	0.024	<.001
LSD (0.05)	0.099	6.056	0.449	0.287	2.080
Varieties (V)					
Cardinal	29.94	61.39d	3.50	3.56a	33.47e
Desiree	29.94	71.39c	3.83	3.28a	41.66d
Kufri Jyoti	29.94	85.56b	4.66	3.21a	45.44c
Khumal Seto-1	30.00	74.44c	3.66	3.31a	44.54cd
Janakdev	30.00	85.83b	3.94	2.56b	84.74*a*
Khumal Upahar	29.94	90.28a	4.38	2.49b	66.46*b*
SEM (±)	0.047	1.14	0.14	0.14	1.043
P-value	0.869	<.001	<.001	<.001	<.001
LSD (0.05)	0.137	3.301	0.410	0.422	2.942
CV (%)	0.6	7.1	13.0	19.8	8.4
M	ns	ns	ns	*	***
V	ns	***	***	***	***
Y (Year)	ns	***	**	***	*
M×V	ns	ns	ns	ns	ns

*ns=not significant, * Significant at p<0.05, ** Significant at P<0.01, *** Significant at <0.001. Same small letters in column are not significantly different by DMRT at 0.05 level of significance*

conditions significantly influenced specific gravity (SG), with the highest SG observed under irrigated conditions (1.070). Rain-fed conditions had the lowest SG, while drought conditions with plastic mulch and rain-fed conditions had similar SG values.

Significant differences were observed among potato varieties in terms of tuber yield and quality traits. Khumal Seto-1 exhibited the highest mean number of tubers per plant (14.71) and intermediate values for tuber weight per plant (0.498 kg) and tuber yield per hectare (33.23 t ha-1). However, the highest tuber yield was recorded in Khumal Upahar (35.43 t ha-1) followed by Kufri Jyoti (34.80 t ha-1). Varieties also differed in specific gravity, with Cardinal having the highest SG (1.070) and Kufri Jyoti the lowest (1.059).

Interaction Effects

Table 7 indicated that, despite the absence of a significant interaction effect between moisture conditions and potato cultivars on plant growth parameters, irrigated conditions resulted in reduced ground covering (60.00%), with the Cardinal cultivar exhibiting the lowest percentage. There were no significant differences in plant uniformity, stems per plant and plant height across moisture conditions or potato varieties. Nonetheless, some variations were noted, particularly with Desiree and Khumal Upahar displaying relatively higher uniformity ratings.

The results indicated the absence of an interaction effect between varying moisture conditions and potato cultivars on tuber production and quality attributes (Table 8). Khumal Seto-1 displayed the highest number of tubers per plant (15.63) and a relatively substantial tuber weight per plant (0.460 kg) under irrigated conditions, resulting in a yield of 30.67 t ha-1. Conversely, the maximum tuber yield was observed in the presence of drought plastic mulch with the Khumal Upahar variety (40.89 t ha-1), closely followed by Khumal Seto-1 (40.48 t ha-1). Rain-fed conditions led to a decrease in tuber yield and quality compared to irrigated conditions, with Cardinal and Desiree varieties displaying diminished values for tuber yield and specific gravity. Nevertheless, Khumal Seto-1 maintained relatively high tuber quality even under rain-fed conditions. Drought conditions with black plastic mulch led to variable responses among potato varieties, highlighting the importance of genetic factors

Table 5: Effect of different moisture conditions on the tuber size distribution of potato varieties during the years 2015 and 2016

Treatments	Tuber size (no) plot-1				Tuber size wt. (kg) plot-1			Total
	<25g	25-50g	>50g	Total	<25g	25-50g	>50g	
Moisture condition (M)								
Irrigated condition	104.81a	197.4	38.33b	340.6a	0.986a	7.64	4.55b	13.18b
Rain-fed condition	101.1a	181.9	30.78b	313.8ab	0.911a	7.46	3.91b	12.29b
Drought (plastic mulch)	64.5b	172.0	58.42a	294.9b	0.611b	7.62	8.06a	16.31a
SEM±	2.53	5.05	2.57	6.85	0.05	0.21	0.23	0.28
P value	<.001	0.056	0.004	0.023	0.020	0.816	<.001	0.001
LSD (0.05)	9.95	19.82	10.097	26.19	0.219	0.840	0.907	1.119
Varieties (V)								
Cardinal	88.72b	175.3c	20.00e	284.1c	0.833b	6.42d	2.17f	9.43c
Desiree	91.22b	218.6b	37.94c	346.8b	0.833b	8.51b	4.55d	13.90b
Kufri Jyoti	81.11b	158.7c	62.56a	302.3c	0.778bc	7.02c	7.86b	15.66a
Khumal Seto-1	142.72a	268.3a	30.33d	441.4a	1.178a	10.46a	3.31e	14.95a
Janakdev	75.22bc	162.6c	46.17b	284.0c	0.756bc	7.05c	5.87c	13.68b
Khumal Upahar	61.67c	119.3d	59.06a	240.0d	0.656c	5.99d	9.29a	15.94a
SEM (±)	5.26	5.83	2.25	8.56	0.05	0.20	0.23	0.33
P value	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
LSD (0.05)	15.20	16.84	6.51	24.74	0.158	0.590	0.685	0.961
CV (%)	29.2	17.6	21.8	11.4	31.3	16.3	15.5	8.2
M	***	ns	**	*	*	ns	***	**
V	***	***	***	***	***	***	***	***
Y (Year)	***	*	***	***	***	ns	***	***
M×V	*	ns	***	ns	ns	**	**	ns

*ns=not significant, * Significant at p<0.05, ** Significant at P<0.01, *** Significant at <0.001. Same small letters in column are not significantly different by DMRT at 0.05 level of significance*

influencing drought tolerance. Some varieties, such as Khumal Upahar, exhibited higher tuber yield and specific gravity under drought conditions, while others, like Cardinal, displayed reduced yield and quality. Varieties with inherent drought tolerance, such as Khumal Upahar, demonstrated better performance under water-limited environments.

Dry matter content and specific gravity are crucial markers of tuber quality. Dry matter content, which influences the texture and cooking quality of potatoes, varied among potato varieties and moisture conditions. Khumal Upahar consistently exhibited higher (22.97%) dry matter content compared to other varieties under drought conditions.

Discussion:

The utilization of plastic mulch in drought conditions significantly enhanced ground coverage compared to irrigated and rain-fed conditions. This finding is consistent with prior studies emphasizing the effectiveness of plastic mulch in soil moisture preservation and promotion of plant growth under drought-induced stress (Smith et al., 2018a; Li et al., 2020). The varietal disparities in growth performance align with prior research emphasizing the impact of genetic variability in potato cultivars on plant morphology and yield (Singh et al., 2019; Mishra et al., 2021). The absence of significant interaction effects between moisture conditions and varieties on the measured parameters ($p > 0.05$) indicates a consistent response of potato plants to moisture conditions across all varieties tested. Nevertheless, exploring genotype × environment interactions further could offer valuable insights into genotype-specific responses to different moisture levels (Foolad, 2020; Bassi et al., 2021). These findings align with prior research demonstrating the impact of moisture conditions on potato growth and yield (Smith et al., 2018b; Brown & Jones, 2020). Previous studies have highlighted that the use of plastic mulch under drought conditions can enhance soil moisture retention, leading to improved plant growth (Gao et al., 2017). Prior studies have illustrated the influence of moisture availability on the growth and yield of potatoes (Smith et al., 2018c). Adequate irrigation enhances tuber formation and size, while drought stress can lead to smaller tubers but potentially higher dry matter content (Sadok & Schmidhalter, 2013). Previous studies have documented varietal differences in potato yield and tuber size distribution (Khan et al., 2020).

Varieties with diverse genetic backgrounds may exhibit varied responses to environmental conditions and management techniques, impacting the development of tubers and their potential yield. The selection of specific varieties played a pivotal role in indicating the distribution of tuber sizes, with Kufri Jyoti, Khumal Seto-1, and Khumal Upahar emerging as highly productive varieties in terms of both total tuber yield and the percentage of larger tubers. This underscores the importance for farmers to carefully choose suitable varieties based on environmental factors and market demands. Notably, there were significant interaction effects between moisture levels and potato varieties concerning tuber size (25-50g &>50g) distribution ($P < 0.05$). The influence of moisture levels varied depending on the specific potato variety, suggesting that certain varieties may exhibit distinct performance under different moisture conditions. Hence, farmers might need to adapt their irrigation practices and selection of varieties to optimize the distribution of tuber sizes and overall yield in response to varying environmental conditions.

The previous research indicates that water stress can lead to a reduction in vegetative growth but an increase in tuber dry matter content, potentially enhancing tuber quality (Sadok & Schmidhalter, 2013). The higher specific gravity observed under irrigated conditions may be attributed to increased water availability, which can promote cell expansion and influence tuber density. Varietal differences in tuber yield and quality traits highlight the importance of selecting appropriate varieties based on desired characteristics and environmental conditions (Khan et al., 2020). Drought conditions with black plastic mulch promoted higher ground coverage and taller plants due to reduced resource competition and increased soil temperature. This discovery aligns with prior studies which suggest that plant growth can be enhanced under water stress conditions through the modulation of hormonal equilibrium and the stimulation

Table 6: Effect of different moisture conditions on tuber yield and quality traits of potato varieties during the years 2015 and 2016

Treatments	Tuber plant-1 (no)	Tuber wt. plant-1 (kg)	Tuber Yield (t ha-1)	SG	Dry matter (%)
Moisture condition (M)					
Irrigated condition	11.35a	0.439b	29.30b	1.070a	21.47
Rain-fed condition	10.48ab	0.410b	27.31b	1.067b	22.48
Drought (plastic mulch)	9.84b	0.544a	36.23a	1.067b	20.90
SEM±	0.22	0.009	0.63	0.0003	0.34
P value	0.023	0.001	0.001	0.006	0.075
LSD (0.05)	0.885	0.036	2.48	0.001	1.357
Varieties (V)					
Cardinal	9.48c	0.314d	20.95c	1.070ab	22.19ab
Desiree	11.58b	0.464c	30.89b	1.066c	20.57c
Kufri Jyoti	10.09c	0.523ab	34.80a	1.059d	20.26c
Khumal Seto-1	14.71a	0.498b	33.23a	1.068b	21.71b
Janakdev	9.47c	0.455c	30.04b	1.071a	22.11ab
Khumal Upahar	8.01d	0.532a	35.43a	1.072a	22.87a
SEM (±)	0.28	0.01	0.73	0.0007	0.26
P value	<.001	<.001	<.001	<.001	<.001
LSD (0.05)	0.813	0.031	2.13	0.002	0.761
CV (%)	11.5	8.3	8.2	0.2	5.1
M	*	**	**	**	ns
V	***	***	***	***	***
Y (Year)	***	***	***	ns	***
M×V	ns	ns	ns	ns	ns

*ns=not significant, * Significant at p<0.05, ** Significant at P<0.01, *** Significant at <0.001. Same small letters in column are not significantly different by DMRT at 0.05 level of significance*

Table 7: Interaction effect of different moisture condition and potato varieties on plant growth traits during the years 2015 and 2016

Moisture condition (M)	Varieties	GC (%)	Plant Uniformity (1-5)	Stem plant -1 (no)	Plant height (cm)
Irrigated condition	Cardinal	60.00	3.83	3.933	30.77
	Desiree	71.67	3.66	3.342	40.75
	Kufri Jyoti	83.33	4.83	3.225	42.47
	Khumal Seto-1	70.00	3.66	3.642	41.47
	Janakdev	80.83	3.66	2.633	76.80
	Khumal Upahar	89.17	4.50	2.708	64.47
Rain-fed condition	Cardinal	60.00	3.16	3.542	27.76
	Desiree	66.67	4.00	3.650	33.10
	Kufri Jyoti	82.50	4.66	3.575	40.73
	Khumal Seto-1	73.33	3.50	3.325	36.33
	Janakdev	85.00	4.33	2.600	81.15
	Khumal Upahar	88.33	4.16	2.367	60.27
Drought (Black plastic mulch)	Cardinal	64.17	3.50	3.233	41.90
	Desiree	75.83	3.83	2.867	51.13
	Kufri Jyoti	90.83	4.50	2.833	53.13
	Khumal Seto-1	80.00	3.83	2.967	56.03
	Janakdev	91.67	3.83	2.475	96.26
	Khumal Upahar	93.33	4.50	2.400	74.63
	Grand Mean	78.15	4.00	3.073	52.72
	SEM (±)	2.37	0.25	0.24	1.80
	P value	0.446	0.362	0.730	0.057
	LSD (0.05)	7.060	0.726	0.696	5.096
	CV (%)	7.1	13.0	19.8	8.4
	M×V	ns	ns	ns	ns

of root growth (Sadok & Schmidhalter, 2013). The absence of notable variations in the uniformity of plants under different levels of moisture or diverse potato cultivars implies that uniformity might be less affected by these variables and instead reliant on other aspects like planting density and agricultural techniques.

Conclusion:

Optimizing cultivation practices and improving crop resilience in the face of climate change requires an understanding of how different potato varieties respond to varying moisture conditions. Water-scarce locations should prioritize cultivating varieties like Khumal Upahar, Khumal Seto-1 and Janakdev, which showed higher growth and yield performance during drought conditions. Furthermore, the application of plastic mulch may be explored as a means of reducing the adverse impacts of drought on potato yield and growth. The findings suggest that moisture conditions and potato varieties significantly influence tuber yield and quality traits. Drought conditions with plastic mulch resulted in higher tuber yield per hectare but lower tuber number per plant compared to irrigated conditions. Varietal differences were observed in tuber yield and quality traits, emphasizing the importance of selecting suitable varieties for specific growing conditions.

These results provide valuable insights for potato growers aiming to optimize yield and quality in different environmental conditions. To improve productivity and sustainability in potato agriculture, our findings highlight the significance of taking into account both varietal characteristics and moisture management strategies. Further research is needed to explore management practices that optimize potato growth under varying moisture conditions. Farmers or stakeholders may work to improve potato productivity and guarantee food security in Lalitpur condition of Nepal or similar potato-growing regions by incorporating these findings into agricultural practices.

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Table 8: Interaction effect of different moisture conditions and potato varieties on tuber yield and quality traits during the years 2015 and 2016

Moisture condition (M)	Varieties	Tuber plant-1 (no)	Tuber wt. plant-1 (kg)	Yield (t ha-1)	SG	DM (%)
Irrigated condition	Cardinal	10.76	0.295	19.70	1.072	22.01
	Desiree	12.82	0.432	28.81	1.068	20.62
	Kufri Jyoti	11.22	0.501	33.41	1.063	20.25
	Khumal Seto-1	15.63	0.460	30.67	1.070	21.76
	Janakdev	9.45	0.438	29.26	1.073	21.29
	Khumal Upahar	8.24	0.508	33.93	1.074	22.90
Rain-fed condition	Cardinal	9.08	0.265	17.56	1.070	23.51
	Desiree	11.23	0.396	26.26	1.066	21.11
	Kufri Jyoti	10.19	0.482	32.15	1.059	21.56
	Khumal Seto-1	14..64	0.427	28.52	1.068	22.78
	Janakdev	9.99	0.418	27.93	1.070	23.18
	Khumal Upahar	7.72	0.472	31.48	1.068	22.75
Drought (Black plastic mulch)	Cardinal	8.61	0.383	25.59	1.068	21.05
	Desiree	10.68	0.503	37.59	1.064	19.99
	Kufri Jyoti	8.87	0.585	38.85	1.056	18.97
	Khumal Seto-1	13.87	0.607	40.48	1.067	20.59
	Janakdev	8.96	0.510	34.00	1.072	21.85
	Khumal Upahar	8.08	0.616	40.89	1.073	22.97
	Grand Mean	10.56	0.464	30.95	1.068	21.62
	SEM (±)	0.49	0.019	1.32	0.001	0.54
	P value	0.263	0.435	0.446	0.206	0.109
	LSD (0.05)	1.437	0.056	3.837	0.003	1.603
	CV (%)	11.5	8.3	8.2	0.2	5.1
	M×V	ns	ns	ns	ns	ns

ns= not significant

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PB served as the principal investigator and was accountable for field data collection, literature review, and report composition. DC conducted the fieldwork and observations throughout the project. All the authors reviewed and endorsed the final manuscript. The authors declare no conflict of interest.

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